10 AIR AND CLIMATE

10.1 Air Quality

10.1.1 Background

The site of the proposed wind farm development ('Proposed Development') is located in southeast County Donegal, approximately 8 kilometres southwest of the towns of Ballybofey and Stranorlor. The town of Castlederg is located approximately 17 kilometres east of the Proposed Development. The townlands in which the proposed development site is located, including ancillary works, are listed in Table 1.1 in Chapter 1 of this EIAR.

For the purposes of this EIAR, where the 'proposed development site' or 'the site' is referred to, this relates to the primary study area for the proposed development, as delineated on the EIAR figures (maps).

The primary land-uses within and in the vicinity of the site comprise forestry and some agriculture. Due to the non-industrial nature of the Proposed Development and the general character of the surrounding environment, air quality sampling was deemed to be unnecessary for this EIAR. It is expected that air quality in the existing environment is good, since there are no major sources of air pollution (e.g. heavy industry) in the vicinity of the site.

The production of energy from wind turbines has no direct emissions as is expected from fossil fuel-based power stations. Harnessing more energy by means of wind farms will reduce dependency on fossil fuels, thereby resulting in a reduction in harmful emissions that can be damaging to human health and the environment. Some minor short-term or temporary indirect emissions associated with the construction of the wind farm include vehicular and dust emissions.

10.1.2 Air Quality Standards

In 1996, the Air Quality Framework Directive (96/62/EC) was published. This Directive was transposed into Irish law by the Environmental Protection Agency Act 1992 (Ambient Air Quality Assessment and Management) Regulations 1999. The Directive was followed by four Daughter Directives, which set out limit values for specific pollutants:

- The first Daughter Directive (1999/30/EC) addresses sulphur dioxide, oxides of nitrogen, particulate matter and lead.
- The second Daughter Directive (2000/69/EC) addresses carbon monoxide and benzene. The first two Daughter Directives were transposed into Irish law by the Air Quality Standards Regulations 2002 (SI No. 271 of 2002).
- A third Daughter Directive, Council Directive (2002/3/EC) relating to ozone was published in 2002 and was transposed into Irish law by the Ozone in Ambient Air Regulations 2004 (SI No. 53 of 2004).
- The fourth Daughter Directive, published in 2007, relates to polyaromatic hydrocarbons (PAHs), arsenic, nickel, cadmium and mercury in ambient air.

The Air Quality Framework Directive and the first three Daughter Directives have been replaced by the Clean Air for Europe (CAFE) Directive (Directive 2008/50/EC on ambient air quality) (as amended by Directive EU 2015/1480) which 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 particles) 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.

Table 10.1 below sets out the limit values of the CAFE Directive, as derived from the Air Quality Framework Daughter Directives. 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.

The CAFE Directive was transposed in to 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). These Regulations supersede the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), the Ozone in Ambient Air Regulations 2004 (S.I. No. 53 of 2004) and the Ambient Air Quality Assessment and Management Regulations 1999 (S.I. No. 33 of 1999).

Table 10.1 Limit values of Directive 2008/50/EC, 1999/30/EC and 2000/69/EC (Source: EPA)

Pollutant	Limit Value Objective	Averaging Period	Limit Value (μg/m3)	Limit Value (ppb)	Basis of Application of Limit Value	Attainment Date
Sulphur dioxide (SO2)	Protection of Human Health	1 hour	350	132	Not to be exceeded more than 24 times in a calendar year	1st Jan 2005
Sulphur dioxide (SO2)	Protection of human health	24 hours	125	47	Not to be exceeded more than 3 times in a calendar year	1st Jan 2005
Sulphur dioxide (SO2)	Protection of vegetation	Calendar year	20	7.5	Annual mean	19th Jul 2001
Sulphur dioxide (SO2)	Protection of vegetation	1st Oct to 31st Mar	20	7.5	Winter mean	19th Jul 2001

Pollutant	Limit Value Objective	Averaging Period	Limit Value (μg/m3)	Limit Value (ppb)	Basis of Application of Limit Value	Attainment Date
Nitrogen dioxide (NO2)	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year	1st Jan 2010
Nitrogen dioxide (NO2)	Protection of human health	Calendar year	40	21	Annual mean	1st Jan 2010
Nitrogen monoxide (NO) and nitrogen dioxide (NO2)	Protection of ecosystems	Calendar year	30	16	Annual mean	19th Jul 2001
Particulate matter 10 (PM10)	Protection of human health	24 hours	50	-	Not to be exceeded more than 35 times in a calendar year	1st Jan 2005
Particulate matter 2.5 (PM2.5)	Protection of human health	Calendar year	40	-	Annual mean	1st Jan 2005
Particulate matter 2.5 (PM2.5) Stage 1	Protection of human health	Calendar year	25	-	Annual mean	1st Jan 2015
Particulate matter 2.5 (PM2.5) Stage 2	Protection of human health	Calendar year	20	-	Annual mean	1st Jan 2020
Lead (Pb)	Protection of human health	Calendar year	0.5	-	Annual mean	1st Jan 2005
Carbon Monoxide (CO)	Protection of human health	8 hours	10,000	8,620	Not to be exceeded	1st Jan 2005
Benzene (C6H6)	Protection of human health	Calendar Year	5	1.5	Annual mean	1st Jan 2010

The Ozone Daughter Directive 2002/3/EC is different from the other Daughter Directives in that it sets target values and long-term objectives for ozone rather than limit values. Table 10.2 presents the limit and target values for ozone.

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

Objective	Parameter	Target Value for 2010	Target Value for 2020
Protection of human health	Maximum daily 8-hour mean	120 mg/m3 not to be exceeded more than 25 days per calendar year averaged over 3 years	120 mg/m3
Protection of vegetation	AOT40 calculated from 1 hour values from May to July	18,000 mg/m3.h averaged over 5 years	6,000 mg/m3.h
Information Threshold	1-hour average	180 mg/m3	-
Alert Threshold	1-hour average	240 mg/m3	-

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 $\mu g/m^3$ and is expressed as $\mu g/m^3$ hours.

10.1.2.1 Air Quality and Health

Recent Environmental Protection Agency (EPA), EU and World Health Organisation reports estimate that poor air quality accounted for premature deaths of approximately 600,000 people in Europe in 2012, with 1,200 Irish deaths attributable to fine particulate matter ($PM_{2.5}$) and 30 Irish deaths attributable to Ozone (O_3) (*Source:* *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* and *'Ireland's Environment 2016 – An Assessment'*, EPA, 2016). These emissions, along with others including nitrogen oxides (NO_x) and sulphur oxides (So_x) are produced during fossil fuel based electricity generation in various amounts, depending on the fuel and technology used, but there are no such emissions associated with the operation of wind turbines. Therefore, the construction of wind turbines such as the proposed wind farm will result in lower environmental levels of such parameters, and consequential beneficial effects on human health.

10.1.3 Air Quality Zones

The Environmental Protection Agency (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 site of the Proposed Development lies within Zone D, which represents rural areas located away from large population centres.

10.1.4 Existing Air Quality

The EPA publishes Air Monitoring Station Reports for monitoring locations in all four Air Quality Zones. The ambient air quality monitoring carried out closest to the proposed development site is at Letterkenny, Co, Donegal, located approximately 30.0 kilometres northeast of the site of the Proposed Development . EPA air quality data is available for Letterkenny in the report *'Ambient Air Monitoring at Letterkenny, Co.*

Donegal 16th May 2008 – 14th July 2009', as detailed below. This monitoring location lies within Zone C. Lower measurement values for all air quality parameters would be expected for the proposed development site as it lies in a rural location, within Zone D.

10.1.4.1 Sulphur Dioxide (SO_2)

Sulphur dioxide data for the 2008/2009 monitoring period in Letterkenny is presented in Table 10.3. Neither the hourly limit value nor lower assessment threshold set out in the CAFE Directive were exceeded during the monitoring period.

Table 10.3 Sulphur Dioxide Data Letterkenny May2008 to July 2009

Parameter	Measurement
No. of hours	10,179
No. of measured values	9,882
Percentage Coverage	97.1%
Maximum hourly value	131.9 µg/m3
98 percentile for hourly values	25.5 µg/m3
Mean hourly value	6.3 µg/m3
Maximum 24-hour mean	33.9 µg/m3
98 percentile for 24-hour mean	17.9 µg/m3

10.1.4.2 Particulate Matter (PM_{10})

Particulate matter (PM_{10}) data for the 2008/2009 monitoring period in Letterkenny is presented in Table 10.4. The 24-hour limit value for the protection of human health (50 µg/m_3) was exceeded 15 times during the measurement period. The upper assessment threshold was exceeded on 33 days and the lower assessment threshold was exceeded on 53 days. The CAFE Directive stipulates that these assessment thresholds should not be exceeded more than 35 times in a calendar year. The mean of the daily values during the measurement period is below the annual limit value for the protection of human health (40 µg/m_3).

Table 10.4 Particulate Matter (PM10) Data Letterkenny May2008 to July 2009

Parameter	Measurement
No. of days	353
No. of measured values	312
Percentage Coverage	88.4%
Maximum daily value	160.2 µg/m3
Mean daily value	18 µg/m3

10.1.4.3 Nitrogen Dioxide (NO_2)

Nitrogen dioxide and oxides of nitrogen data for the 2008/2009 monitoring period in Letterkenny is presented in Table 10.5. One hourly mean NO_2 value was above the lower assessment threshold. The CAFE Directive stipulates that this threshold should not be exceeded more than 18 times in a calendar year. The mean hourly NO_2 value during the measurement period was below the annual lower assessment threshold for the protection of human health, which is 26 µg/m^3.

Table 10.5 Nitrogen Dioxide and Oxides of Nitrogen Data Letterkenny May2008 to July 2009

Parameter	Measurement
No. of hours	10,179
No. of measured values	9,864

Parameter	Measurement
Percentage Coverage	96.9%
Maximum hourly value (NO2)	111.9 μg/m^3
99.7 percentile for hourly values (NO2)	76.6 μg/m^3
Mean hourly value (NO2)	13.1 μg/m^3
Mean hourly value (NOx)	22.1 μg/m^3 NO2

10.1.4.4 Carbon Monoxide (CO)

Carbon monoxide data for the 2001 monitoring period in Letterkenny is presented in Table 10.6. The mean hourly concentration of carbon monoxide recorded was 0.3 mg/m^3. The carbon monoxide limit value for the protection of human health is 10 mg/m^3. On no occasions were values in excess of the 10 mg limit value set out in the CAFE Directive/ Air Quality Standards Regulations 2011 (as amended) recorded.

Table 10.6 Carbon Monoxide Data Letterkenny May2008 to July 2009

Hourly Values	Result
No. of hours	10,179
No. of measured values	10,103
Percentage Coverage	99.2%
Maximum hourly value	5.7 mg/m^3
98 percentile for hourly values	1.3 mg/m^3
Mean hourly value	0.3 mg/m^3
Maximum 8-hour mean	4.23 mg/m^3
98 percentile for 8-hour mean	1.25 mg/m^3

10.1.4.5 Ozone (O_3)

Ozone data for the Lough Navar Monitoring Station Atmospheric in, Co. Fermanagh, Northern Ireland, located approximately 29.3 kilometres south of the site, for 2017 is presented in Table 10.7. The maximum daily eight-hour mean limit of 120 μg/m^3 was exceeded on one day in 2017. The legislation stipulates that this limit should not be exceeded on more than 25 days.

Table 10.7 Summary statistics for O_3 concentrations for year to date 2017: Lough Navar

Parameter	Value
Annual Mean	54.3 μg/m3
Median	58.1 μg/m3
% Data Capture	100%
No. of days > 120	1 day
Maximum 8-hour mean	129 μg/m3

10.1.4.6 Dust

There are no statutory limits for dust deposition in Ireland. However, EPA guidance suggests that a deposition of 10 mg/m^2/hour can generally be considered as posing a soiling nuisance. This equates to 240 mg/m^2/day. The EPA recommends a maximum daily deposition level of 350 mg/m^2/day when measured according to the TA Luft Standard 2002.

Construction dust has the potential to be generated from on-site activities such as excavation and backfilling. The extent of dust generation at any site depends on the type of activity undertaken, the location, the nature of the dust, i.e. soil, sand, peat, etc., and the weather. In addition, dust dispersion is influenced by external factors such as wind speed and direction and/or, periods of dry weather. Construction traffic movements also have the potential to generate dust as they travel along the haul route. The potential dust-related effects on local air quality and the relevant associated mitigation measures are presented in Sections 10.1.5.2.2 and 10.1.5.3.2 below.

10.1.5 Likely Significant Effects and Associated Mitigation Measures

10.1.5.1 'Do-Nothing' Effect

If the Proposed Development were not to proceed, the opportunity to reduce emissions of carbon dioxide, oxides of nitrogen (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 proposed wind farm. This would result in an indirect negative impact on air quality.

10.1.5.2 Construction Phase

10.1.5.2.1 Exhaust Emissions

Turbines and Other Infrastructure

The construction of turbines, site roads and other onsite infrastructure (as outlined in Section 4.1 of this EIAR) will require the operation of construction vehicles and plant on site. Exhaust emissions associated with vehicles and plant will arise as a result of construction activities. This potential effect will not be significant, and will be restricted to the duration of the construction phase and localised to works locations. Therefore, this is considered a transient short-term slight negative impact. Mitigation measures to reduce this impact are presented below.

The transport of turbines and construction materials to the site, which will occur on specified routes only (see Section 4.4 of the EIAR), will also give rise to transient exhaust emissions associated with the transport vehicles. This constitutes a slight negative impact in terms of air quality. Mitigation measures in relation to exhaust emissions are presented below.

Borrow Pits

The proposed borrow pits will also require the use of construction machinery and plant, thereby giving rise to exhaust emissions. This is also a short-term slight negative impact, which will be reduced through use of the best practice mitigation measures as presented below.

Substation and Grid Connection

The construction of the proposed substation and associated grid connection will require the use of construction machinery, thereby giving rise to exhaust emissions. This is a short-term slight negative impact, which will be reduced through use of the best practice mitigation measures as presented below.

Mitigation

- All construction vehicles and plant will be maintained in good operational order while onsite, thereby minimising any emissions that arise.
- All machinery will be switched off when not in use.
- Aggregate materials for the construction of site tracks and turbine bases will be obtained from a borrow pits on the site of the Proposed Development. This will significantly reduce the number of delivery vehicles accessing the site, thereby reducing the amount of emissions associated with vehicle movements.

Residual Impact
Short-term Imperceptible Negative impact.
Significance of Effects
Based on the assessment above there will be no significant effects.

10.1.5.2.2 Dust Emissions

Turbines and Other Infrastructure
The construction of turbines, site roads and other onsite infrastructure (as outlined in Section 4.1 of this EIAR) will give rise to dust emissions during the construction phase. This potential effect will not be significant and will be restricted to the duration of the construction phase. Therefore, this is a short-term slight negative impact. Dust suppression mitigation measures to reduce this impact are presented below.

Borrow Pits
Development of the proposed borrow pits and the extraction of material from this location will give rise to localised dust emissions. This is a short-term moderate negative impact. Mitigation measures to reduce this impact are presented below.

Substation and Grid Connection
The construction of the proposed substation and associated grid connection will give rise to localised dust emission during their construction. This is a short-term slight negative impact. Mitigation measures to reduce this impact are presented below.

Mitigation

- In periods of extended dry weather, dust suppression may be necessary along haul roads and around the borrow pit area to ensure dust does not cause a nuisance. If necessary, water will be taken from stilling ponds in the site's drainage system, and will be pumped into a bowser or water spreader to dampen down haul roads, borrow pit and site compounds to prevent the generation of dust where required. Water bowser movements will be carefully monitored to avoid, insofar as reasonably possible, increased runoff.
- All plant and materials vehicles shall be stored in dedicated areas (on site).
- Areas of excavation will be kept to a minimum, and stockpiling will be minimised by coordinating excavation, spreading and compaction.
- Turbines and construction materials will be transported to the site on specified haul routes only.
- The agreed haul route roads adjacent to the site will be regularly inspected for cleanliness, and cleaned as necessary.
- The transport of construction materials to the site that have significant potential to cause dust, will be undertaken in tarpaulin or similar covered vehicles where necessary.
- A Construction and Environmental Management Plan (CEMP) will be in place throughout the construction phase (see Appendix 4.4). The CEMP includes dust suppression measures.

Residual Impact
Short-term Imperceptible Negative Impact

Significance of Effects
Based on the assessment above there will be no significant effects.

10.1.5.3 Operational Phase

10.1.5.3.1 Exhaust Emissions

Exhaust emissions associated with the operational phase of the Proposed Development will arise from machinery and vehicles that are intermittently required onsite for maintenance. This will give rise to a long-term imperceptible impact.

Mitigation
Any vehicles or plant brought onsite during the operational phase will be maintained in good operational order, thereby minimising any emissions that arise.

Residual Impact
Long-term Imperceptible Negative Impact
Significance of Effects
Based on the assessment above there will be no significant effects.

10.1.5.3.2 Air Quality

The proposed wind farm, by providing an alternative to electricity derived from coal, oil or gas-fired power stations, will result in emission savings of carbon dioxide (CO_2), oxides of nitrogen (NO_x), and sulphur dioxide SO_2. The production of renewable energy from the Proposed Development will have a long-term significant positive impact on air quality. Further details on the carbon dioxide savings associated with the Proposed Development are presented in Section 9.2.3 below.

Residual Impact
Long-term Significant Positive Impact

Significance of Effects
Based on the assessment above there will be a significant positive effect.

Exposure to chemicals such as SO_2 and NO_x are thought to be harmful to human health. The production of renewable energy from the Proposed Development will have a long-term slight positive impact on human health.

Residual Impact
Long-term Slight Positive Impact

Significance of Effects
Based on the assessment above there will be no significant effects.

10.2 Climate

10.2.1 Climate Change and Greenhouse Gases

Although variation in climate is thought to be a natural process, the rate at which the climate is changing has been accelerated rapidly by human activities. Climate change is one of the most challenging global issues facing us today and is primarily the result of increased levels of greenhouse gases in the atmosphere. These greenhouse gases come primarily from the combustion of fossil fuels in energy use. Changing climate patterns are thought to increase the frequency of extreme weather conditions such as storms, floods and droughts. In addition, warmer weather trends can place pressure on animals and plants that cannot adapt to a rapidly changing environment. Moving away from our reliance on coal, oil and other fossil fuel-driven power plants is essential to reduce emissions of greenhouse gases and combat climate change.

10.2.1.1 Greenhouse Gas Emission Targets

Ireland is a Party to the Kyoto Protocol, which is an international agreement that sets limitations and reduction targets for greenhouse gases for developed countries. It is a protocol to the United Nations Framework for the Convention on Climate Change. The Kyoto Protocol came into effect in 2005, as a result of which, emission reduction targets agreed by developed countries, including Ireland, are now binding.

Under the Kyoto Protocol, the EU agreed to achieve a significant reduction in total greenhouse gas emissions in the period 2008 to 2012. These EU emission targets are legally binding on Ireland. Ireland's contribution to the EU commitment for the period 2008 – 2012 was to limit its greenhouse gas emissions to no more than 13% above 1990 levels.

10.2.1.1.1 Doha Amendment to the Kyoto Protocol

In Doha, Qatar, on 8th December 2012, the "Doha Amendment to the Kyoto Protocol" was adopted. The amendment includes:

- New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020;
- A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period; and
- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

During the first commitment period, 37 industrialised countries and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020; however, the composition of Parties in the second commitment period is different from the first.

Under the protocol, countries must meet their targets primarily through national measures, although market based mechanisms (such as international emissions trading can also be utilised).

10.2.1.1.2 COP21 Paris Agreement

COP21 was the 21st session of the Conference of the Parties (COP) to the United Nations Convention. Every year since 1995, the COP has gathered the 196 Parties (195 countries and the European Union) that have ratified the Convention in a different country, to evaluate its implementation and negotiate new commitments. COP21 was organised by the United Nations in Paris and held from 30th November to 12th December 2015.

COP21 closed on 12th December 2015 with the adoption of the first international climate agreement (concluded by 195 countries and applicable to all). The twelve-page text, made up of a preamble and 29 articles, provides for a limitation of the temperature rise to below 2°C above pre-industrial levels and even to tend towards 1.5°C. It is flexible and takes into account the needs and capacities of each country. It is balanced as regards adaptation and mitigation, and durable, with a periodical ratcheting-up of ambitions.

10.2.1.1.3 Emissions Projections

In 2016, the EPA published an update on Ireland's Greenhouse Gas Emission Projections to 2020. Ireland's target is to achieve a 20% reduction of non-Emissions Trading Scheme (non-ETS) sector emissions, i.e. agriculture, transport, residential, commercial, non-energy intensive industry and waste, on 2005 levels, with annual binding limits set for each year over the period 2013 – 2020.

Greenhouse gas emissions are projected to 2020 using two scenarios; 'With Measures' and 'With Additional Measures'. The 'With Measures' scenario assumes that no additional policies and measures, beyond those already in place by the end of 2014 are implemented. The 'With Additional Measures' scenario assumes implementation of the 'With Measures' scenario in addition to full achievement of Government renewable and energy efficiency targets for 2020, as set out in the National Renewable Energy Action Plan and the National Energy Efficiency Action Plan.

The EPA Emission Projections Update notes the following key trends:

- Ireland's non-Emissions Trading Scheme (ETS) emissions are projected to be 6% and 11% below 2005 levels in 2020 under the 'With Measures' and 'With Additional Measures' scenarios, respectively. The target for Ireland is a 20% reduction.
- Ireland is projected to exceed its annual binding limits in 2016 and 2017 under both scenarios, 'With Measures' and 'With Additional Measures'.
- Over the period 2013 – 2020, Ireland is projected to cumulatively exceed its compliance obligations by 12 Mt CO_2 (metric tonnes of Carbon Dioxide) equivalent under the 'With Measures' scenario and 3 Mt CO_2 equivalent under the 'With Additional Measures' scenario.

The EPA report states that *"Failure to meet 2020 renewable and energy efficiency targets will result in Ireland's emission levels moving even further from its emission reduction targets"*. The report also concludes:

- *The latest projections estimate that by 2020 non-ETS emissions will be at best 11% below 2005 levels compared to the 20% reduction target. Emission trends from agriculture and transport are key determinants in meeting targets, however emissions from both sectors are projected to increase in the period to 2020.*
- *It is clear that Ireland faces significant challenges in meeting emission reduction targets for 2020 and beyond. ('Greenhouse Gas Emission Projections to 2020 – An Update'*, EPA, 2016)

10.2.1.1.4 Progress to Date

The 'Europe 2020 Strategy' is the EU's agenda for growth and jobs for the current decade. The Europe 2020 Strategy targets on climate change and energy include:

- Reducing greenhouse gas (GHG) emissions by at least 20% compared with 1990 levels;
- Increasing the share of renewable energy in final energy consumption to 20%; and
- Moving towards a 20% increase in energy efficiency.

Further details on the Europe 2020 Strategy are included in Section 2.2.3.3 of this EIAR in Chapter 2: Background to the Proposed Development. Regarding progress on targets, the *'Europe 2020 indicators – climate change and energy'* report[1] provides a summary of recent statistics on climate change and energy in the EU.

In 2014, EU greenhouse gas emissions, including emissions from international aviation and indirect carbon dioxide (CO2) emissions, were down by 23% when compared with 1990 levels. However, regarding the progress of individual Member States, and Ireland in particular, the Europe 2020 indicators include the following statements:

- 24 countries are on track to meet their GHG targets, except Austria, Belgium, **Ireland** and Luxembourg.
- Luxembourg emitted the most GHG per capita in the EU in 2014 … followed by Estonia, **Ireland**, the Czech Republic and the Netherlands.
- In 2014, France, the Netherlands, the United Kingdom and **Ireland** were farthest from reaching their national targets.

While the EU as a whole is projected to exceed it's 2020 target of reducing GHG emissions by 20%, Ireland is currently one of the countries project to miss its national targets.

10.2.2 Climate and Weather in the Existing Environment

Ireland has a temperate, oceanic climate, resulting in mild winters and cool summers. The Met Éireann weather station at Malin Head, Co. Donegal, is the nearest weather and climate monitoring station to the proposed development site that has meteorological data recorded for the 30-year period from 1981-2010. The monitoring station is located approximately 80 kilometres northeast of the site. Meteorological data recorded at Malin Head over the 30-year period from 1981 - 2010 is shown in Table 10.8 overleaf. The wettest months are January and November, and May is usually the driest. August is the warmest month with a mean daily temperature of 14.7° Celsius.

[1] http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_climate_change_and_energy

Table 10.8 Data from Met Éireann Weather Station at Malin Head, 1981 to 2010

	Monthly and Annual Mean and Extreme Values												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Year**
TEMPERATURE (degrees Celsius)													
Mean daily max	8.1	8.1	9.3	10.8	13.1	15.1	16.8	17	15.6	13	10.4	8.6	12.2
Mean daily min	3.6	3.5	4.4	5.8	7.8	10.3	12.1	12.3	10.9	8.5	6.1	4.2	7.5
Mean temperature	5.9	5.8	6.9	8.3	10.5	12.7	14.5	14.7	13.3	10.8	8.2	6.4	9.8
Absolute max.	14.4	14.5	15.9	20.7	22.4	24.6	25.9	25.9	23.4	20.6	17.6	15.1	25.9
Absolute Min.	-5.6	-6.2	-4.4	-1.5	0.7	2.6	6.5	6.4	4	0.4	-1.2	-4.8	-6.2
Mean No. of Days With Air Frost	2.4	2.1	1	0.2	0	0	0	0	0	0	0.3	2	8
Mean No. of Days With Ground Frost	8	7.1	5.2	2.9	0.6	0	0	0	0	0.4	2.6	6.9	33.6
RELATIVE HUMIDITY (%)													
Mean at 0900UTC	83.2	82.1	81.6	79.6	79.1	81.5	84.1	83.4	82.5	83	82.8	82.8	82.1
Mean at 1500UTC	80.8	77	77.1	75.7	75.7	78.7	80.6	79.8	77.5	77.6	79.7	81.3	78.5
SUNSHINE (Hours)													
Mean daily duration	1.2	2.3	3	5.1	6.5	5.5	4.6	4.4	3.7	2.6	1.5	1.1	3.5
Greatest daily duration	7.6	8.7	11.6	13.6	15.5	16	15.6	14.6	12.2	9.4	7.3	6.7	16
Mean no. of days with no sun	10.6	5.8	5.5	3.3	2.3	2.4	2.7	3.1	3.5	6	8.3	11.6	65.1
RAINFALL (mm)													
Mean monthly total	117.4	84.8	85.9	63.1	56.9	69.1	76.8	93.2	91.8	118.4	104.5	114.2	1076
Greatest daily total	32.6	34.3	31.4	26.3	35	26.7	38.7	49.9	48.6	60	31.6	39.6	60
Mean num. of days with >= 0.2mm	22	18	20	16	16	16	18	19	19	21	21	20	226
Mean num. of days with >= 1.0mm	18	13	15	12	11	11	14	14	14	17	17	16	172
Mean num. of days with >= 5.0mm	8	6	6	4	3	4	5	6	6	8	7	7	70
WIND (knots)													
Mean monthly speed	19	18.6	17.3	14.6	13.3	12.8	12.3	12.8	14.6	16.8	17.6	17.5	15.6
Max. gust	91	86	90	71	68	62	74	62	85	78	92	96	96
Max. mean 10-minute speed	65	57	67	52	49	42	55	44	61	57	61	67	67
Mean num. of days with gales	11.8	10.3	8.7	3.6	2.1	1	0.7	1.1	3	6.5	8	8.5	65.3
WEATHER (Mean No. of Days With:)													
Snow or sleet	5.1	5.2	3.4	1.6	0.1	0	0	0	0	0	1.1	3.8	20.4
Snow lying at 0900UTC	0.4	0.4	0.4	0	0	0	0	0	0	0	0	1	2.3
Hail	9.2	7.4	7.6	4.4	1.7	0.3	0.1	0.2	0.6	3.1	5.8	7.3	47.7
Thunder	0.7	0.6	0.3	0.2	0.4	0.7	0.8	0.6	0.3	0.5	0.5	0.6	6.1
Fog	0.4	0.4	0.8	1.3	1.7	1.6	1.6	1.2	0.6	0.1	0.4	0.3	10.5

10.2.3 Calculating Carbon Losses and Savings from the Proposed Development

10.2.3.1 Background

In addition to the combustion of fossil fuels, greenhouse gases are also released through natural processes such as the decomposition of organic material (which is composed of carbon). Bogs and peatlands are known to store large amounts of carbon. Due to the waterlogged nature of these habitats, stored carbon is not broken down and released into the atmosphere. The construction of wind farms on bog and peat habitats may affect the natural hydrological regime, thus exposing and drying out the peat and allowing the decomposition of carbon. It is necessary therefore to demonstrate that any wind farm constructed on such sites saves more carbon than is released. The site of the Proposed Development is partially situated on peat habitats. For this reason, the carbon balance between the use of a renewable energy and the loss of carbon stored in the peat is assessed in this section of the EIAR.

CO_2 emissions occur naturally in addition to being released with the burning of fossil fuels. All organic material is composed of carbon, which is released as CO_2 when the material decomposes. Organic material acts as a store of carbon. Peatland habitats are significant stores of organic carbon. The vegetation on a peat bog slowly absorbs CO_2 from the atmosphere when it is alive and converts it to organic carbon. When the vegetation dies, in the acidic waterlogged conditions of bogs and peatlands, the organic material does not decompose fully and the organic carbon is retained in the ground.

The carbon balance of proposed wind farm developments in peatland habitats has attracted significant attention in recent years. When development such as wind farms are proposed for peatland areas, there will be direct impacts and loss of peat in the area of the development footprint. There may also be indirect impacts where it is necessary to install drainage in certain areas to facilitate construction. The works can either directly or indirectly allow the peat to dry out, which permits the full decomposition of the stored organic material with the associated release of the stored carbon as CO_2. It is essential therefore that any wind farm development in a peatland area saves more CO_2 than is released.

10.2.3.2 Methodology for Calculating Losses

A methodology was published in June 2008 by scientists at the University of Aberdeen and the Macauley Institute with support from the Rural and Environment Research and Analysis Directorate of the Scottish Government, Science Policy and Co-ordination Division. The document, *'Calculating carbon savings from wind farms on Scottish peat lands'*, was developed to calculate the impact of wind farm developments on the soil carbon stocks held in peat. This methodology was refined and updated in 2011 based on feedback from users of the initial methodology and further research in the area. This provides a transparent and easy to follow method for estimating the impacts of wind farms on the carbon dynamics of peatlands. Previously guidance produced by Scottish Natural Heritage in 2003 had been widely employed to determine carbon payback in the absence of any more detailed methods.

Although the loss of carbon fixing potential from plants on peat land is not substantial, it is nonetheless calculated for areas from which peat is removed and the areas affected by drainage. This calculation takes account of the annual gains due to the carbon fixing potential of the peat land and the time required for any habitat restoration. The carbon sequestered in the peat itself represents a much more substantial potential source of carbon loss. During wind farm construction, carbon is lost as a result of peat excavation and peat drainage. The amount of carbon lost is estimated using default values from the Intergovernmental Panel on Climate Change (IPCC, 1997) as well as by more site-specific equations derived from the scientific literature. Carbon gains due to habitat improvement and site restoration are calculated in a similar fashion.

Peatlands are essentially unbalanced systems. When flooded, peat soils emit less carbon dioxide but more methane than when drained. In waterlogged soils, carbon dioxide emissions are usually exceeded by plant fixation, so the net exchange of carbon with the atmosphere is negative and soil carbon stocks increase. When soils are aerated, carbon emissions usually exceed plant fixation, so the net exchange of carbon with the atmosphere is positive. In order to calculate the carbon emissions resulting from the removal or drainage of the peat, the Macauley Institute method accounts for emissions occurring if the peat had been left in-situ, and subtracts these from the emissions occurring after removal and drainage.

The Macauley Institute methodology states that the total volume of peat impacted by the construction of the wind farm is strongly correlated to the extent of the peatland affected by drainage at the site.

The drainage of peat soils leads to continual loss of soil carbon until a new steady state is reached, when inputs are approximately equal to losses. For peats, this steady state approximates 0% carbon, so 100% carbon loss from drained peats is assumed if the site is not restored after decommissioning of the wind farm. The amount of carbon lost is calculated on the basis of the annual emissions of methane and carbon dioxide, the area of drained peat, and the time until the site is restored. However, the restoration proposal should demonstrate a high probability that the hydrological regime will be restored across the site, disturbance of the remaining peat will be minimised, and peat-forming vegetation will develop in areas from which peat was removed or drained. In the case of the proposed wind farm site, the model has been prepared on the basis of two scenarios, one where restoration of the wind farm areas will occur on decommissioning, and another where restoration will not occur.

The effects of drainage may also reduce dissolved and particulate organic carbon retention within the peat. Losses of carbon dioxide due to leaching of dissolved and particulate organic carbon are calculated as a proportion of the gaseous losses of carbon from the peat. The Macauley Institute method assumes that published good practice is employed in relation to avoiding the risk of peat landslides. This is certainly the case in respect of the Proposed Development, which has been the subject of a peat stability risk assessment, as described in the Peat Stability Assessment in Appendix 8.1 of this EIAR. Therefore, this potentially large carbon loss pathway is omitted from the calculations.

Clearfelling of existing forestry surrounding turbine locations may often be necessary to avoid reductions in the wind energy yield of wind farm proposals. Forestry may be felled earlier than originally planned due to the wind farm development, so limiting the nature and longevity of the resulting timber produced. If a forestry plantation was due to be felled with no plan to replant, the effect of the land use change is not attributable to the wind farm development and is omitted from the calculation. If, however, the forestry is felled for the development, the effects are judged to be attributable to the wind farm development. Carbon losses as a result of felling are calculated from the area to be felled, the average carbon sequestered annually, and the lifetime of the wind farm. Alterations in soil carbon levels following felling are calculated using the equations for drainage and site restoration already described.

10.2.3.3 Calculating Carbon Losses and Savings

10.2.3.3.1 Carbon Losses

The Macauley Institute method for calculating carbon losses from wind farm projects was used to assess the impacts of the proposed wind farm in terms of potential carbon losses and savings taking into account peat removal, drainage, habitat improvement and site restoration.

The worksheet made available as part of the *'Calculating carbon savings from wind farms on Scottish peat lands'* report, was downloaded and used to input the necessary data. A copy of this worksheet is provided as Appendix 10.1 of this EIAR. Where available and relevant, site-specific information was inserted into the worksheet. Otherwise, default values were used.

The worksheet was 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. Similar data to that used in the worksheet to calculate the CO_2 emissions from the UK electricity generation plant, was not available for the Irish electricity generation plant, and so the CO_2 emissions savings from the proposed wind farm development were calculated separately from the worksheet.

The main CO_2 losses due to the proposed wind farm development are summarised in Table 10.9.

Table 10.9 CO_2 losses from the Proposed Development

Origin of Losses	CO_2 Losses (tonnes CO_2 equivalent)	
	Expected	Maximum
Losses due to turbine life (e.g. manufacture, construction, decommissioning)	53,251	62,127
Losses due to reduced carbon fixing potential	796	1,464
Losses from soil organic matter	42,483	56,579
Losses due to felling forestry	29,148	34,951
Total	125,678	155,121

The worksheet model calculates that the Proposed Development will give rise to 125,678 tonnes of CO_2 equivalent losses over its 30-year life. Of this total figure, the proposed wind turbines directly account for 53,251 tonnes, or 42%, with losses from soil organic matter and reduced carbon fixing potential and the felling of forestry accounting for the remaining 58% or 72,427 tonnes. It should be noted that forestry on the proposed wind farm site forms part of a commercial crop, which would be felled in coming years whether the Proposed Development proceeds or not.

The figure of 125,678 tonnes of CO_2 arising from ground activities associated with the Proposed Development is calculated based on the entire development footprint being "Acid Bog", as this is one of only two choices the model allows (the other being Fen). The habitat that will be impacted by the development footprint comprises predominantly drained bog (cutover), rather than the acid bog assumed by the model that gives rise to the 125,678 tonnes CO_2 figure, and therefore the actual CO2 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 restored on decommissioning of the proposed wind farm after its expected 30-year useful life. As a worst-case scenario, the model was also used to calculate the CO_2 losses from the proposed project if the hydrology and habitats of the site were not to be restored, as may be the case if the turbines were replaced with newer models, rather than decommissioned entirely and taking account of the future peat extraction activities. This worst-case scenario would increase the expected carbon losses by an additional 29,443 tonnes, or 23% to 155,121 tonnes. Any failure to restore the site habitats or hydrology for the reasons outlined above would be further offset by the carbon-neutral renewable energy that the new turbines would generate.

10.2.3.3.2 Carbon Savings

According to the model described above, the proposed wind farm development will give rise to total losses of 125,678 tonnes of carbon dioxide.

A simple formula can be 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:

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

where: A = ... The rated capacity of the wind energy development in MW
B = ... The capacity or load factor, which takes into account the intermittent nature of the wind, 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 proposed wind farm is assumed to be 66.5 MW (based on 19 No. 3.5 MW turbines).

A load factor of 0.35 (or 35%) has been used for the proposed wind farm development.

The number of hours in a year is 8,760.

The most recent data for the carbon load of electricity generated in Ireland is for 2015, and was published in Sustainable Energy Authority Ireland's (SEAI) November 2016 report, *'Energy in Ireland, Key Statistics 2016'*. The emission factor for electricity in Ireland in 2014 was 457.5 g CO_2/kWh.

The calculation for carbon savings is therefore as follows:

$$CO_2 \text{ (in tonnes)} = \frac{\underline{(66.5 \times 0.35 \times 8{,}760 \times 457.5)}}{1000}$$

$$= 93{,}279 \text{ tonnes per annum}$$

Based on this calculation, 93,279 tonnes of carbon dioxide will be displaced per annum from the largely carbon-based traditional energy mix by the proposed wind farm. Over the proposed thirty-year lifetime of the wind farm, therefore, **2,798,370 tonnes** of carbon dioxide will be displaced from traditional carbon-based electricity generation.

Based on the Macauley Institute model as presented above, 125,678 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 Proposed Development. This represents 4.5% of the total amount of carbon dioxide emissions that will be offset by the proposed wind farm project. The 125,678 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 Proposed Development will be offset by the Proposed Development in approximately **16 months** of operation.

10.2.4 Likely Significant Effects and Associated Mitigation Measures

10.2.4.1 'Do-Nothing' Effect

If the Proposed Development were not to proceed, the opportunity to significantly reduce emissions of greenhouse gas emissions, including carbon dioxide (CO_2), oxides of nitrogen (NO_x), and sulphur dioxide (SO_2), to the atmosphere would be lost. The opportunity to contribute to Ireland's commitments under the Kyoto Protocol and EU law would also be lost. This would be a permanent slight negative impact.

10.2.4.2Construction Phase

10.2.4.2.1 Greenhouse Gas Emissions

Turbines and Other Infrastructure

The construction of turbine bases and hardstands, site roads and all associated proposed infrastructure (as outlined in Section 4.1 of this EIAR) will require the operation of construction vehicles and plant on site. Greenhouse gas emissions, e.g. carbon dioxide (CO_2), associated with vehicles and plant will arise as a result of the construction and demolition activities. This potential impact will be slight only, 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 presented below.

Borrow Pits

Development of the proposed borrow pit will also require the use of construction machinery and plant, thereby giving rise to greenhouse gas emissions. This is also a short-term slight negative impact, which will be reduced through use of the best practice mitigation measures as presented below.

Substation and Grid Connection

The construction of the proposed substation and associated grid connection will require the use of construction machinery, thereby giving rise to greenhouse emissions. This is a short-term slight negative impact, which will be reduced through use of the best practice mitigation measures as presented below.

Mitigation

- All construction vehicles and plant will be maintained in good operational order while onsite, thereby minimising any emissions that arise.
- Aggregate materials for the construction of the proposed wind farm will be obtained from the proposed borrow pit. This will significantly reduce the number of delivery vehicles accessing the site from significant distances, thereby reducing the amount of emissions associated with vehicle movements.

Residual Impact
Short-term Imperceptible Negative Impact on Climate as a result of greenhouse gas emissions.

Significance of Effects
Based on the assessment above there will be no significant effects.

10.2.4.3 Operational Phase

10.2.4.3.1 Greenhouse Gas Emissions

The Proposed Development will generate energy from a renewable source. This energy generated will offset energy and the associated emission of greenhouse gases from electricity-generating stations dependent on fossil fuels, thereby having a positive effect on climate. As detailed in Section 10.2.3.3.2 above, the Proposed Development will displace carbon dioxide from fossil fuel-based electricity generation, over the proposed 30-year lifespan of the proposed wind farm. The proposed project will assist in reducing carbon dioxide (CO_2) emissions that would otherwise arise if the same energy that the proposed wind farm will generate were otherwise to be generated by conventional fossil fuel plants. This is a long-term significant positive effect.

Some potential long-term slight negative impacts that may occur during the operational phase of the Proposed Development are the release of small amounts of carbon dioxide to the atmosphere due to the potential alteration to the drainage of the site and the removal of carbon fixing vegetation. These impacts will be slight and will be nullified by the quantity of carbon dioxide that will be displaced by the Proposed Development.

Residual Impact
Long-term Moderate Positive Impact on Climate as a result of reduced greenhouse gas emissions.

Significance of Effects
Based on the assessment above there will be no significant effects.

10.3 Cumulative Assessment

Potential cumulative effects on air quality and climate between the proposed wind farm development and other developments in the vicinity were also considered as part of this assessment. The developments considered as part of the cumulative effect assessment are described in Section 2.7 of this EIAR.

The nature of the Proposed Development is such that, once operational, it will have a long-term, moderate, positive impact on the air quality and climate.

During the construction phase of the Proposed Development and other developments within 20 kilometres of the Proposed Development site that are yet to be constructed, there will be minor emissions from construction plant and machinery and potential dust emissions associated with the construction activities. However, once the mitigation proposals, as outlined in Section 10.1.5.2 are implemented during the construction phase of the Proposed Development, there will be no cumulative negative effect on air and climate.

There will be no net carbon dioxide (CO_2) emissions from operation of the proposed wind farm. Emissions of carbon dioxide (CO_2), oxides of nitrogen (NO_x), sulphur dioxide

(SO_2) or dust emissions during the operational phase of the Proposed Development will be minimal, relating to the use of operation and maintenance vehicles onsite, and therefore there will be no measurable cumulative effect with other developments on air quality and climate.