10. AIR AND CLIMATE

10.1 Air Quality

10.1.1 Introduction

This chapter identifies, describes and assesses the potential significant direct and indirect effects on air quality and climate arising from the construction, operation and decommissioning of the proposed Croagh Wind Farm.

The site of the Croagh Wind Farm development is located on the boundary of Counties Leitrim and Sligo, approximately 5km west of the village of Drumkeeran and 7km southeast of Dromahair. The townlands within which the proposed development site, ancillary works and grid connection cabling route are located can be found in Chapter 1 Table 1-1 of this EIAR.

The primary land-uses within and in the vicinity of the site comprises commercial forestry. 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 renewable sources 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 Proposed Development include vehicular and dust emissions.

10.1.1.1 Relevant Guidance

The air quality and climate section of this EIAR is carried out in accordance with the EIA Directive 2011/92/EU as amended by Directive 2014/52/EU and having regard, where relevant, to guidance contained in the Section 1.8.1 of this EIAR.

10.1.1.2 Statement of Authority

This chapter of the EIAR was completed by Eoin McCarthy and Michael Watson. Eoin is a Senior Environmental Scientist with McCarthy O'Sullivan Ltd. with over 8 years of experience in private consultancy. Eoin holds B.Sc. (Hons) in Environmental Science from NUI, Galway. Michael Watson is Project Director and head of the Environment Team in MKO. Michael has over 18 years' experience in the environmental sector. Following the completion of his Master's Degree in Environmental Resource Management, Geography, from National University of Ireland, Maynooth he worked for the Geological Survey of Ireland. Between them, they have completed Air and Climate EIAR chapters for over twenty wind energy projects.

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).
- The 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 and was transposed into Irish law by the Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations, 2009 (S.I. No. 58 of 2009).

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 PM2.5 (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 PM10) 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 ($\mu g/m^3$) and parts per billion (ppb). The notation PM10 is used to describe particulate matter or particles of ten micrometres or less in aerodynamic diameter. PM2.5 represents particles measuring less than 2.5 micrometres in aerodynamic diameter.

The CAFE Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011) as amended by the Air Quality Standards (Amendments) and Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations, 2016 (S.I. 659 2016). 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 200/69/EC (Source: https://www.epa.ie/air/quality/standards/)

Pollutant	Limit Value Objective	Averaging Period	Limit Value (ug/m^3)	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

Pollutant	Limit Value Objective	Averaging Period	Limit Value (ug/m^3)	Limit Value (ppb)	Basis of Application of Limit Value	Attainment Date
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 (SO_2)	Upper assessment threshold for the protection of Human Health	24 hours	75	28	Not to be exceeded more than 3 times in a calendar year	1st Jan 2005
Sulphur dioxide (SO_2)	Lower assessment threshold for the protection of human health	24 hours	50	19	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
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 dioxide (NO_2)	Upper assessment threshold for the protection of human health	1 hour	140	73	Not to be exceeded more than 18 times in a calendar year	1st Jan 2010

Pollutant	Limit Value Objective	Averaging Period	Limit Value (ug/m^3)	Limit Value (ppb)	Basis of Application of Limit Value	Attainment Date
Nitrogen dioxide (NO_2)	Lower assessment threshold for the protection of human health	1 hour	100	52	Not to be exceeded more than 18 times in a calendar year	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 10 (PM_{10})	Upper assessment threshold for the protection of human health	24 hours	30	-	Not to be exceeded more than 7 times in a calendar year	Based on the indicative limit values for 1 January 2010
Particulate matter 10 (PM_{10})	Lower assessment threshold for the protection of human health	24 hours	20	-	Not to be exceeded more than 7 times in a calendar year	Based on the indicative limit values for 1 January 2010
Particulate matter 2.5	Protection of human health	Calendar year	20	-	Annual mean	1st Jan 2020

Pollutant	Limit Value Objective	Averaging Period	Limit Value (ug/m^3)	Limit Value (ppb)	Basis of Application of Limit Value	Attainment Date
(PM2.5) Stage 2						

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/m^3 not to be exceeded more than 25 days per calendar year averaged over 3 years	120 mg/m^3
Protection of vegetation	AOT40* calculated from 1-hour values from May to July	18,000 mg/m^3.h averaged over 5 years	6,000 mg/m^3.h
Information Threshold	1-hour average	180 mg/m^3	-
Alert Threshold	1-hour average	240 mg/m^3	-

*The sum of the differences between hourly ozone concentration and 40 ppb for each hour when the concentration exceeds 40 ppb during a relevant growing season, e.g. for forest and crops.

10.1.2.1 Air Quality and Health

The Environmental Protection Agency (EPA) report '*Air Quality in Ireland 2018'* noted that in Ireland, the premature deaths attributable to poor air quality are estimated at 1,180 people per annum. A more recent European Environmental Agency (EEA) Report, '*Air Quality in Europe – 2019 Report'* highlights the negative effects of air pollution on human health. The report assessed that poor air quality accounted for premature deaths of approximately 412,000 people in Europe in 2016, with regards to deaths relating to $PM_{2.5}$. The estimated impacts on the population in Europe of exposure to NO_2 and O_3 concentrations in 2016 were around 71,000 and 15,100 premature deaths per year, respectively. From this, 1,100 Irish deaths were attributable to fine particulate matter ($PM_{2.5}$), 50 Irish deaths were attributable to nitrogen oxides (NO_2) and 30 Irish deaths were attributable to Ozone (O_3) (Source: *Air Quality in Europe – 2019 Report',* EEA, 2019. These emissions, along with others including sulphur oxides (SO_x) are produced during fossil fuel-based electricity generation in various amounts, depending on the fuel and technology used.

Whilst there is the potential of such emissions and also dust emissions to be generated from the site operations, a number of mitigation measures will be implemented at this site to reduce the impact from dust and vehicle emissions, which are discussed in Sections 10.2.4 below.

10.1.3 Air Quality Zones

The EPA has designated four Air Quality Zones for Ireland:

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

These zones were defined to meet the criteria for air quality monitoring, assessment and management described in the Framework Directive and Daughter Directives. The 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 Sligo town, Co, Sligo, located approximately 17.8 km northwest of the site of the Proposed Development. EPA air quality data is available for in the report 'Ambient Air Monitoring in Sligo 20th January 2003 – 2nd October 2003', as detailed below in Tables 10-3 to 10-6. 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.

Ozone data for 2019 was obtained from the closest active atmospheric monitoring station at Lough Navar, Glenasheevar Road, Co. Fermanagh, located approximately 37.5 km northeast of the site. (https://www.airqualityni.co.uk/site/LN#statistics). This can be found in Table 10-7 below.

10.1.5 Sulphur Dioxide (SO_2)

Sulphur dioxide data for the period January 2003- October 2003 recorded at the Sligo town air monitoring station 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 for Sligo town in 2003.

Parameter	Measurement
No. of hours	6101
No. of measured values	5926
Percentage Coverage	97.1
Maximum hourly value	52.1 ug/m^3
98 percentile for hourly values	38 ug/m^3
Mean hourly value	11 ug/m^3
Maximum 24-hour mean	37.4 ug/m^3
98 percentile for 24-hour mean	28.5 ug/m^3

10.1.5.1 Particulate Matter (PM_{10})

Particulate matter (PM10) data for the 2003 monitoring period in Sligo town is presented in Table 10-4. The 24-hour limit value for the protection of human health (50 µg/m^3) was not exceeded during the measurement period. The upper assessment threshold was exceeded on 26 days and the lower assessment threshold was exceeded on 55 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 Sligo Town January 2003 to October 2003

Parameter	Measurement
No. of days	254
No. of measured values	184
Percentage Coverage	72.4
Maximum daily value	63.2
Mean daily value	17.7

10.1.5.2 Nitrogen Dioxide (NO_2)

Nitrogen dioxide and oxides of nitrogen data for the 2003 monitoring period in Sligo town is presented in Table 10-5. No 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 Sligo Town January 2003 to October 2003

Parameter	Measurement
No. of hours	6101
No. of measured values	4850
Percentage Coverage	79.5
Maximum hourly value (NO_2)	245 ug/m^3
98 percentile for hourly values (NO_2)	39.5 ug/m^3
Mean hourly value (NO_2)	11.7 ug/m^3
Mean hourly value (NOx)	18.7 ug/m^3

10.1.5.3 Carbon Monoxide (CO)

Carbon monoxide data for the 2003 monitoring period in Sligo town, 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 for 2003 in Sligo Town

Parameter	Measurement
No. of hours	6101
No. of measured values	4784
Percentage Coverage	78.4
Maximum hourly value	7.4 mg/m^3
98 percentile for hourly values	1.0 mg/m^3
Mean hourly value	0.3 mg/m^3
Maximum 8 hour mean	1.6 mg/m^3
98 percentile for 8-hour mean	0.9 mg/m^3

10.1.5.4 Ozone (O_3)

Ozone data for the Lough Navar Atmospheric Monitoring Station, for 2019, is presented in Table 10-7. The mean hourly concentration of ozone recorded was 50 µg/m^3.There were no exceedances of the daily maximum 8-hour running mean of 120 µgm^3 and no exceedances of the 180 µg/m^3 information threshold value set for the protection of the general population.

Table 10-7 Summary statistics for O_3 concentrations for year to date 2019: Lough Navar

Parameter	Measurement
Percentage Coverage	98
Annual hourly Mean	50 µg/m^3
Annual Mean Daily Max 8 Hour	66 µg/m^3
Max Daily Mean	124 µg/m^3
Max Hourly Mean	153 µg/m^3
Max 8-hour running mean > 120µg/m^3 on more than 25 days	0

10.1.5.5 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 10.1.6.3 below.

10.1.6 Likely and Significant Impacts and Associated Mitigation Measures

10.1.6.1 'Do-Nothing' Effect

If the Proposed Development were not to proceed, the opportunity to reduce emissions of carbon dioxide, oxides of nitrogen (NOx), 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 renewable energy development. This would result in an indirect negative impact on air quality nationally..

10.1.6.2 Construction Phase

10.1.6.2.1 *Exhaust Emissions*

Turbines and Other Infrastructure

The construction of turbines, the anemometry mast, site roads and other onsite infrastructure 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 short-term, slight, negative impact. Mitigation measures to reduce this impact are presented below.

Borrow Pit

The proposed borrow pit 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 Cable

The construction of the proposed substation and the grid connection cabling route to the Garvagh 110kV substation 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.

Transport to Site

The transport of turbines and construction materials to the site, which will occur on specified routes only (see Section 14.1 of this EIAR), will also give rise to 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.

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.
- The majority of aggregate materials for the construction of the proposed development will be obtained from the borrow pit on site. 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 direct or indirect effects on air quality due to the construction of the proposed development.

10.1.6.3 Dust Emissions

Turbines and Other Infrastructure

The construction of turbine bases and hardstands, anemometry mast, site roads and other onsite infrastructure (as outlined in Chapter 4 of this EIAR) will give rise to dust emissions during the construction phase. The potential for impacts on off-site receptors is limited due to the isolated nature of the site and the vegetative screening that exists surrounding the site. 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 Pit

The extraction of material from the borrow pit 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 Cable

The construction of the proposed substation, and the excavation of the grid connection cabling route 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.

Transport to Site

The transport of turbines and construction materials to the wind farm site will give rise to some localised dust emissions during periods of dry weather. This is a short-term slight negative impact. Mitigation measures to reduce the significance of this effect are presented below.

Mitigation

- In periods of extended dry weather, dust suppression may be necessary along haul roads, site roads, substation and construction compounds and around the borrow pit area to ensure dust does not cause a nuisance. If necessary, de-silted 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 which may have the potential to generate dust will be undertaken with tarpaulin cover or similar, where necessary.
- The transport of dry excavated material from the on-site borrow pit which may have potential to generate dust will be minimised. If necessary, excavated material will be dampened prior to transport from the borrow pits.
- 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 direct or indirect effects on air quality due to dust emissions during the construction phase of the Proposed Development.

10.1.7 Operational Phase

10.1.7.1.1 *Exhaust Emissions*

Exhaust emissions associated with the operational phase of the Proposed Development will arise from occasional machinery and Light Goods Vehicles (LGV) that are intermittently required onsite for maintenance. This will give rise to a long-term, imperceptible, negative 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 direct or indirect effects on air quality from exhaust emissions during the operation of the Proposed Development.

10.1.7.1.2 *Air Quality*

By providing an alternative to electricity derived from coal, oil or gas-fired power stations, the proposed development 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 10.2.3.

Residual Impact

Long-term Significant Positive Impact

Significance of Effects

Based on the assessment above there will be a significant positive effect on air quality due to the operation of the Proposed Development.

10.1.7.1.3 *Human Health*

Exposure to chemicals such as SO_2 and NO_x are known to be harmful to human health. The production of clean renewable energy from the Proposed Development will offset the emission of these harmful chemicals by fossil fuel powered sources of electricity and, therefore, will have a long term slight positive impact on human health. Further information on the impact of the proposed development on Human Health is contained in Chapter 5: Population and Human Health.

Residual Impact

Long-term Slight Positive Impact

Significance of Effects

Based on the assessment above there will be a significant positive effect on human health due to the operation of the Proposed Development.

10.1.7.2 Decommissioning Phase

Any impact and consequential effect that occurs during the decommissioning phase are similar to that which occurs during the construction phase, albeit of less impact. The mitigation measures prescribed for the construction phase of the proposed development will be implemented during the decommissioning phase thereby minimising any potential impacts.

10.2 Climate

All relevant legislation and policy in relation to climate is outlined in detail in Chapter 2 of this EIAR. A summary of the same is provided in the following sections.

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 5% below 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18% below 1990 levels in the eight-year period from 2013 to 2020. The composition of Parties in the second commitment period is different from the first; however, Ireland and the EU signed up to both the first and second commitment periods.

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 COP25 Climate Change Conference

The 25th United Nations Climate Change conference COP25 was held in Madrid and ran from December 2nd to December 13th, 2019. While largely regarded as an unsuccessful conference, the European Union launched its most ambitious plan, 'The European Green New Deal' which aims to lower CO_2 emissions to zero by 2050. The deal includes proposals to reduce emissions from the transport, agriculture and energy sectors and will affect the technology chemicals, textiles, cement and steel industries. Measures such as fines and pay-outs by member states who rely on coal power will be in place to encourage the switch to renewable clean energies such as wind. On the 4th of March 2020, the European Commission put forward the proposal for a European climate law. This aims to establish the framework for achieving EU climate neutrality. It aims to provide a direction by setting a pathway to climate neutrality and to this end, aims to set in legislation the EU's 2050 climate-neutrality objective. If accepted, this climate law will likely be implemented in 2021. Decisions regarding the global carbon market were postponed until the next Climate Conference (COP26) which will be held in Glasgow in November 2020.

10.2.1.1.4 Emissions Projections

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. The Environmental Protection Agency (EPA) publish Ireland's Greenhouse Gas Emission Projection and at the time of writing, the most recent report, 'Ireland's Greenhouse Gas Emissions Projections 2018– 2040 was published in June 2019. The report includes an assessment of Ireland's progress towards achieving its emission reduction targets out to 2020 and 2030 set under the EU Effort Sharing Decision (Decision No 406/2009/EU) and Effort Sharing Regulation (Regulation (EU) 2018/842).

The 2019 emission projections report include the impact of new climate mitigation policies and measures which were outlined in the National Development Plan 2018. These projections see a greater impact from policies and measures and a greater reduction in emissions over the longer term, particularly in the "With Additional Measures" scenario. The 2019 emissions projections do not take into account policies and measures set out in the Climate Action Plan 2019. Such measures will be taken into consideration in an updated future projections report in 2020.

Greenhouse gas emissions are projected to 2040 using two scenarios; 'With Existing Measures' and 'With Additional Measures'. The 'With Existing Measures' scenario assumes that no additional policies and measures, beyond those already in place by the end of 2017 (latest national greenhouse gas emission inventory) are implemented. The 'With Additional Measures' scenario assumes the implementation of the "With Existing Measures" scenario and further implementation of the governments renewable and energy efficiency policies including those set out in the National Renewable Energy Action Plan (NREA), the National Energy Efficiency Action Plan (NEEAP) and the National Development Plan 2018-2027.

The EPA Emission Projections Update notes the following key trends:

- Total emissions are projected to increase from current levels by 1% and 6% by 2020 and 2030, respectively, under the "With Existing Measures" scenario.
- Under the "With Additional Measures" scenario, emissions are estimated to decrease by 0.4% and 10% by 2020 and 2030, respectively.
- Ireland's non-Emissions Trading Scheme (ETS) emissions are projected to be 5% and 6% below 2005 levels in 2020 under the 'With Existing Measures' and 'With Additional Measures' scenarios, respectively. The target for Ireland is a 20% reduction.

- Ireland has exceeded its annual binding limits in 2016 and 2017 under both scenarios, 'With Existing Measures' and 'With Additional Measures'.
- Over the period 2013 – 2020, Ireland is projected to cumulatively exceed its compliance obligations by 10 Mt CO_2 (metric tonnes of Carbon Dioxide) equivalent under the 'With Existing Measures' scenario and 9 Mt CO_2 equivalent under the 'With Additional Measures' scenario.

The report concludes:

- *"Projections indicate that Ireland will exceed the carbon budget over the period 2021-2030 by 52-67Mt CO_2 equivalent with the gap potentially narrowing to 7-22 Mt CO_2 equivalent if both the ETS and LULUCF flexibilities described in the Regulation are fully utilised."*
- *"To determine compliance under the Effort Sharing Decision, any overachievement of the binding emission limit in a particular year (between 2013 and 2020) can be banked and used towards compliance in a future year. However, even using this mechanism Ireland will still be in non-compliance according to the latest projections."*
- "*A significant reduction in emissions over the longer term is projected as a result of the expansion of renewables (e.g. wind), assumed to reach 41-54% by 2030, with a move away from coal and peat... [...] ... However, Ireland still faces significant challenged in meeting EU 2030 targets in the non-ETS sector and national 2050 reduction targets in the electricity generation, built environment and transport sectors. Progress in achieving targets is dependent on the level of implementation of current and future plans."*

10.2.1.1.5 Climate Action Plan

The Climate Action Plan 2019 (CAP) was published on the 1st of August 2019 by the Department of Communications, Climate Action and Environment. The CAP sets out an ambitious course of action over the coming years to address the impacts which climate may have on Ireland's environment, society, economic and natural resources. This Plan clearly recognises that Ireland must significantly step up its commitments to tackle climate disruption.

Chapter 1 of the CAP sets out the nature of the challenge which Ireland faces over the coming years. The CAP notes that the evidence for warming of our climate system is beyond dispute with observations showing that global average temperatures have increased by more than 1°C since pre-industrial times. These changes will cause extensive direct and indirect harm to Ireland and its people, as well as to other countries more exposed and less able than we are to withstand the associated impacts environmental impacts such as extremes in weather, flooding, displacement of population by the creation of climate refugees, poorer water quality and poorer air quality. In order to help reduce CO_2 emissions and reach our 2030 and 2050 emissions targets, CAP has set out a list of renewable energy goals which includes implementing up to 8.2 GW total of increased onshore wind capacity on the island.

The Proposed Development can assist in reaching this target not only by fulfilling the implementation of renewable energy and much needed grid infrastructure, it has the capacity to offset 1,655,640 tonnes of CO_2 thereby reducing the Greenhouse Gas effect and improving air quality as we transition to cleaner energy industries. Please see Section 10.2.3 for details on Carbon offset calculations.

10.2.1.1.6 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 Chapter 2: Background to the Proposed Development of this EIAR. Regarding progress on targets, the 'Europe 2020 indicators – climate change and energy' report provides a summary of recent statistics on climate change and energy in the EU.

In 2015, EU greenhouse gas emissions, including emissions from international aviation and indirect carbon dioxide (CO2) emissions, were down by 22.1% 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 2015, Malta was the farthest from reaching their national target, followed by Ireland, Belgium and Luxembourg.

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 projected to miss its national targets.

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 provides a summary of recent statistics on climate change and energy in the EU.

10.2.1.1.7 United Nations Sustainable Development Summit 2015

Transforming our World: the 2030 Agenda for Sustainable Development which includes 17 Sustainable Development Goals (SDGs) and 169 targets was adopted by all UN Member States at a UN summit held in New York in 2015. The Agenda is universally applicable with all countries having a shared responsibility to achieve the goals and targets. Coming into effect on January 1st, 2016, the goals and targets are to be actions over the 15-year period, are integrated and indivisible i.e. all must be implemented together by each Member State.

The Sustainable Development Goals National Implementation Plan 2018-2020 was published by the Department of Communications, Climate Action & Environment in partnerships with OSI, Esri Ireland and the Central Statistics Office. The Plan sets out how Ireland will work to achieve the goals and targets of the Agenda for Sustainable Development both domestically and internationally. Relevant SDGs and how they are implemented into Irish National plans and policies can be found in Table 10-8.

Table 10-8 United Nations Sustainable Development Goals adopted in 2015. https://sustainabledevelopment.un.org/sdgs

SDG	Targets	International Progress to Date (2019)	National Relevant Policy
SDG 7 Affordable and Clean Energy: *Ensure access to affordable, reliable, sustainable and modern energy for all*	- By 2030, ensure universal access to affordable, reliable and modern energy services - By 2030, increase substantially the share of renewable energy in the global energy mix - By 2030, double the global rate of improvement in energy efficiency - By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with	The renewable energy share of total final energy consumption gradually increased from 16.6 per cent in 2010 to 17.5 per cent in 2016, though much faster change is required to meet climate goals. Global primary energy intensity (ratio of energy used per unit of GDP) improved from 5.9 in 2010 to 5.1 in 2016, a rate of improvement of 2.3 per cent, which is still short of the 2.7 per cent annual rate needed to reach target 3 of Sustainable Development Goal 7.	*Ireland's Transition to a Low Carbon Energy Future 2015-2030* *Strategy to Combat Energy Poverty in Ireland* *Ireland's Transition to a Low Carbon Energy Future 2015- 2030* *National Mitigation Plan* *National Energy Efficiency Action Plan for Ireland # 4 2017-2020* *Better Energy Programme* *One World, One Future* *The Global Island*

	their respective programmes of support		
SDG 13 Climate Action: *Take urgent action to combat climate change and its impacts** **Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.*	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries Integrate climate change measures into national policies, strategies and planning Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible	In 2017, greenhouse gas concentrations reached new highs, with globally averaged mole fractions of CO_2 at 405.5 parts per million (ppm), up from 400.1 ppm in 2015, and at 146 per cent of pre-industrial levels. Moving towards 2030 emission objectives compatible with the 2°C and 1.5°C pathways requires a peak to be achieved as soon as possible, followed by rapid reductions. During the period 1998–2017, direct economic losses from disasters were estimated at almost $3 trillion. Climate-related and geophysical disasters claimed an estimated 1.3 million lives. As of April 2019, 185 parties had ratified the Paris Agreement. Parties to the Paris Agreement are expected to prepare, communicate and maintain successive nationally determined contributions, and 183 parties had communicated their first nationally determined contributions to the secretariat of the United Nations Framework Convention on Climate Change, while 1 party had	*National Adaptation Framework* *Building on Recovery: Infrastructure and Capital Investment 2016-2021* *National Mitigation Plan* *National Biodiversity Action Plan 2017-2021* *National Policy Position on Climate Action and Low Carbon Development*

		communicated its second. Under the Agreement, all parties are required to submit new nationally determined contributions, containing revised and much more ambitious targets, by 2020. Global climate finance flows increased by 17 per cent in the period 2015–2016 compared with the period 2013–2014. As at 20 May 2019, 75 countries are seeking support from the Green Climate Fund for national adaptation plans and other adaptation planning processes, with a combined value of $191 million.	

10.2.1.1.8 Climate Action Network Europe Off Target Report 2018

The June 2018 '*Off Target Report*' published by the Climate Action Network (CAN) Europe which ranks EU countries ambition and progress in fighting climate change listed Ireland as the second worst performing EU member state in tackling climate change. It also stated that Ireland is set to miss its 2020 climate (20% reduction in greenhouse gases) and renewable (40% increase in overall energy from renewable electricity sources) energy targets. Additionally, it was noted that Ireland is also off course for its 2030 emissions target.

In March 2019, the Minister for Communications, Climate Action, and the Environment, Richard Bruton, announced a renewable electricity target of 70% by 2030 for Ireland. Furthermore, the release of the Climate Action Plan in June 2019 has noted a 30% reduction in greenhouse gases by 2030. Considering only renewable energy from electricity as part of this plan and to meet the required level of emissions reduction by 2030, Ireland will:

- Reduce CO_2 eq. emissions from the sector by 50–55% relative to 2030 NDP projections.
- Deliver an early and complete phase-out of coal- and peat-fired electricity generation.
- Increase electricity generated from renewable sources to 70%, indicatively comprised of:
    - at least 3.5 GW of offshore renewable energy;
    - up to 1.5 GW of grid-scale solar energy; and
    - up to 8.2 GW total of increased onshore wind capacity.
- Meet 15% of electricity demand by renewable sources contracted under Corporate PPAs.

Achieving 70% renewable electricity by 2030 will involve phasing out coal and peat-fired electricity generation plants, increasing our renewable electricity, reinforcing our grid (including greater interconnection to allow electricity to flow between Ireland and other countries), and putting systems in place to manage intermittent sources of power, especially from wind.

As noted previously, Ireland is not on track for meeting its 2020 renewable energy targets. It is now more critical than ever that we continue to progress renewable energy development in Ireland so as we are successful in meeting our 2030 target.

The Climate Action Plan noted specific sectors which are required to step-up in order to help Ireland achieve its EU targets. The renewable energy sector was cited alongside the country's commitment to increase onshore wind capacity by up to 8.2 GW. The proposed development will help contribute towards this target.

The proposed wind farm development is compatible with the relevant provisions as set out in the Climate Action Plan 2019, relating to the harnessing of renewable energy. In summary, the proposed development will contribute the following:

- Production of 147,168 MWh of electricity which would be sufficient to supply 35,040 Irish households with electricity per year. This calculation is presented in Chapter 4 of this EIAR.
- Helping to meet the target that 70% of our electricity needs will come from renewable sources by 2030.
- Helping to reduce carbon emissions and improving Ireland's security of energy supply.
- Provision of grid connection infrastructure to support the renewable energy output from the proposed development.

Further detail on the EU 2030 targets are noted in Chapter 2, Section 2.3 of this EIAR.

10.2.1.1.9 Climate Change Performance Index

Established in 2005, the Climate Change Performance Index (CCPI) is an independent monitoring tool which tracks countries climate protection performance. It assesses individual countries based on climate policies, energy usage per capita, renewable energy implementation and Greenhouse Gas Emissions (GHG) and ranks their performance in each category and overall. The 2020 CCPI was published in December 2019 and presented at the COP25. While the CCPI 2020 indicated signs of potential reductions in global emissions, no country achieved its Paris Climate targets and therefore the first three places of the ranking system remain unoccupied.

Ireland, ranked the worst EU performer in the CCPI 2019, climbed 7 places from 48th out of 60 globally ranked countries to 41st place and has moved from a "very low" to "low" in international performance. However, it remains at "very low" at a national performance level. The CCPI report states that while some improvements have been made, GHG per capita emissions are at a high level and "significant challenges lie ahead in closing Ireland's emission gap, meeting the current (2030) target and aligning Ireland's emission trajectory with a net zero goal for 2050. Therefore, the country still ranks among the bottom ten performers in this indicator." Recognising Ireland's Climate Action Plan 2019, the CCPI states:

"*the government must go much further in implementing policies across all sectors that drive sustained emissions reductions over the next decade. Near-term ambition needs to be ratcheted up quickly by specifying deep cuts in fossil fuel and reactive nitrogen usage to put Ireland on a net zero emissions pathway aligned with the Paris temperature goals".*

10.2.2 Climate and Weather in the Existing Environment

Ireland has a temperate, oceanic climate, resulting in mild winters and cool summers. The nearest meteorological monitoring station, with data over a 30-year period (1971-2000), is the Claremorris monitoring station which is located 69km southwest of the development site. Meteorological data for this period at this location can be found in Table 10-9. The wettest months are October and December, and April is usually the driest. July is the warmest month with an average temperature of 18.9° Celsius. The mean annual temperature recorded at Claremorris was 12.9° Celsius.

Table 10-9 Data from Met Eireann Weather Station at Claremorris 1979-2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
TEMPERATURE (degrees Celsius)													
mean daily max	7.5	8.1	9.8	12.1	14.9	17.0	18.9	18.7	16.4	13.1	9.9	8.1	12.9
mean daily min	1.7	1.8	2.9	3.9	6.1	8.8	11.0	10.6	8.6	6.4	3.5	2.5	5.7
mean temperature	4.6	4.9	6.3	8.0	10.5	12.9	15.0	14.7	12.5	9.8	6.7	5.3	9.3
absolute max.	13.3	13.6	16.2	22.3	25.4	29.8	30.5	28.0	25.1	19.9	15.9	14.3	30.5
min. maximum	-2.9	0.1	0.0	5.0	6.1	11.2	11.7	12.2	10.5	6.8	1.3	-1.5	-2.9
max. minimum	11.3	10.9	10.4	11.3	14.2	15.3	17.0	16.7	16.7	15.6	12.5	12.1	17.0
absolute min.	-11.7	-9.1	-8.0	-5.5	-3.1	0.7	0.6	2.6	-1.2	-4.3	-5.3	-12.9	-12.9
mean num. of days with air frost	8.7	7.3	5.2	3.3	0.8	0.0	0.0	0.0	0.1	1.2	5.3	7.6	39.5
mean num. of days with ground frost	15	14	12	10	5	0	0	0	2	5	12	14	89
mean 5cm soil	3.2	3.1	4.5	7.3	10.9	14.1	15.5	14.6	12.0	8.9	5.3	4.2	8.6
mean 10cm soil	3.5	3.4	4.7	7.0	10.3	13.5	15.0	14.3	12.0	9.3	5.8	4.5	8.6
mean 20cm soil	4.2	4.2	5.5	7.7	10.7	13.8	15.3	15.0	13.0	10.3	6.9	5.3	9.3
RELATIVE HUMIDITY (%)													
mean at 0900UTC	90.7	90.3	88.7	82.5	79.3	80.4	83.6	86.2	88.1	91.6	91.2	91.0	87.0

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
mean at 1500UTC	85.6	79.8	75.7	67.9	68.0	71.1	73.2	73.4	74.7	80.2	84.4	88.1	76.8
SUNSHINE (hours)													
mean daily duration	1.3	1.9	2.6	4.3	5.0	4.4	3.7	3.8	3.2	2.4	1.7	0.9	2.9
greatest daily duration	7.9	9.3	10.8	13.4	15.1	15.8	14.8	13.7	11.4	9.3	8.6	6.7	15.8
mean num. of days with no sun	9.5	7.3	5.7	2.8	2.0	2.2	2.2	2.1	3.4	5.0	8.1	10.8	61.1
RAINFALL (mm)													
mean monthly total	127.9	102.1	101.6	63.7	68.1	64.5	70.1	95.7	94.3	128.2	127.7	129.6	1173.6
greatest daily total	31.5	107.0	26.8	34.0	51.3	38.0	42.2	49.7	41.0	46.7	54.9	41.2	107.0
mean num. of days with >= 0.2mm	21	18	21	16	16	15	17	18	18	21	21	22	224
mean num. of days with >= 1.0mm	18	15	17	12	12	11	12	13	14	17	18	17	176
mean num. of days with >= 5.0mm	9	7	7	4	4	4	4	6	5	8	8	9	75
WIND (knots)													
mean monthly speed	10.2	10.3	10.2	8.7	8.1	7.7	7.2	6.8	7.7	8.7	8.9	9.7	8.7
max. gust	96	85	74	74	62	51	66	78	58	70	67	81	96
max. mean 10-minute speed	59	48	45	41	41	34	39	32	37	46	40	52	59

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
mean num. of days with gales	1.4	0.9	0.7	0.1	0.1	0.0	0.0	0.0	0.1	0.3	0.4	0.8	4.8
WEATHER (mean no. of days with..)													
snow or sleet	5.7	4.4	3.8	1.6	0.2	0.0	0.0	0.0	0.0	0.1	1.2	3.1	20.0
snow lying at 0900UTC	2.3	0.7	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.7	4.6
Hail	4.4	3.2	5.4	3.2	1.6	0.4	0.1	0.0	0.7	0.8	2.6	2.7	25.2
Thunder	0.3	0.1	0.2	0.2	0.4	0.7	0.7	0.2	0.2	0.2	0.3	0.5	4.0
Fog	3.4	2.3	1.6	1.8	1.2	1.4	2.0	3.2	3.3	3.2	2.6	3.4	29.5

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 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, locally, 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. The web-based version of the carbon calculator, which supersedes the excel based versions of the tool, was released in 2016. The tool 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 can take 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. 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 *Geotechnical Peat Stability Assessment Report* 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 allow for the construction of the proposed development footprint and the erection of the wind turbines, to avoid reductions in the wind energy yield of the wind farm proposal and to protect local bat populations. 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 Scottish Government on-line carbon calculator as outlined in the sections above, 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, forestry felling and site restoration.

A copy of the outputs 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 10-10.

Table 10-10 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. due to production, transportation, erection, operation and dismantling of the wind farm)	41,945	41,945
Losses due to backup (i.e. electricity obtained from fossil fuel source to stabilise electricity supply to the national grid)	28,382	28,382
Losses due to reduced carbon fixing potential	1,401	2,624
Losses due to leaching of dissolved and particulate organic carbon	0	0
Losses from soil organic matter (CO2 loss from removed and drained peat)	29,232	74,910
Losses due to felling forestry	21,463	24,095
Total	122,074	171,606

The worksheet model calculates that the proposed development is expected to give rise to 122,074 tonnes of CO_2 equivalent losses over its 30-year life. Of this total figure, the proposed wind turbines directly account for 41,495 tonnes, or 34%. Losses due to backup account for 28,382 tonnes, or 23%. Losses from soil organic matter, reduced carbon fixing potential and the felling of forestry accounting for the remaining 43% or 52,096 tonnes. The figure of 29,232 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 commercial forestry rather than the acid bog assumed by the model that gives rise to the 21,463 tonnes and therefore the actual CO_2 losses are expected to be lower than this value.

The figures discussed above are based on the assumption that the hydrology of the site and habitats within the site are 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 wind farm 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 49,535 tonnes, or by 41% to 171,606 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 122,074tonnes 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:

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

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 approximately 48 MW.

A load factor of 0.35 (or 35%) has been used for the proposed 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 2018 and was published in Sustainable Energy Authority Ireland's (SEAI) December 2019 report, '*Energy in Ireland, 2019 Report.*' The emission factor for electricity in Ireland in 2018 was 375 g CO_2/kWh.

The calculation for carbon savings is therefore as follows:

$$CO2 \text{ (in tonnes)} = \frac{(48 \times 0.35 \times 8{,}760 \times 375)}{1000}$$

$$= 55{,}188 \text{ tonnes per annum}$$

Based on this calculation, approximately 55,188 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, 1,655,640 tonnes of carbon dioxide will be displaced from traditional carbon-based electricity generation.

As noted previously areas cleared of forestry for the proposed development at Croagh will be replaced by replanting at alternatives sites. A total of 54.2 hectares of new forestry will be replanted at alternative sites to compensate the loss of forestry at the development site. Given that losses due to felling forestry account for 21,463 tonnes of CO_2, it has been assumed for the purposes of this calculation that the same quantity of CO_2 can be saved by replanting forestry at alternative sites.

In total, it is estimated that 1,655,640 tonnes of carbon dioxide will be displaced over the proposed thirty-year lifetime of the wind farm.

Based on the Scottish Government carbon calculator as presented above 122,074 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 7.4% of the total amount of carbon dioxide emissions that will be offset by the proposed wind farm project. The 122,074 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 26.5 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, greenhouse gas emissions, e.g. carbon dioxide (CO2), carbon monoxide and nitrogen oxides associated with construction vehicles and plant would not arise. However, the opportunity to further 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 long-term, moderate, negative impact.

10.2.4.2 Construction Phase

10.2.4.2.1 *Greenhouse Gas Emissions*

Turbines and Other Infrastructure

The construction of turbine bases and hardstands, site roads, site entrances, anemometry mast bases and all associated infrastructure will require the operation of construction vehicles and plant on site. Greenhouse gas emissions, e.g. carbon dioxide (CO_2), carbon monoxide and nitrogen oxides associated with vehicles and plant will arise as a result of the construction and demolition activities. This potential impact will be slight, given the insignificant quantity of greenhouse gases that will be emitted, and will be restricted to the duration of the construction phase. Therefore, this is a short-term slight negative impact. Mitigation measures to reduce this impact are presented below.

Grid Connection

The construction of 1 No. 38 kV substation and excavation of associated cable trenches will require the use of construction machinery 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.

Transport to Site

The transport of turbines and construction materials to the site, which will occur on specified routes only (see Section 14.1 of this EIAR), will give rise to greenhouse gas emissions associated with the transport vehicles. This constitutes a slight negative impact in terms of air quality. Mitigation measures in relation to greenhouse gas emissions are presented below.

Mitigation

- All construction vehicles and plant will be maintained in good operational order while onsite, thereby minimising any emissions that arise.
- Turbine components and construction materials will be transported to the site on specified routes, assessed in Section 14.1 of this EIAR and agreed with the Planning Authority prior to the construction phase.
- The majority of aggregate materials for the construction of site access tracks and all associated infrastructure will be won from the borrow pit onsite, which will further reduce potential emissions.

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 direct or indirect 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. 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.

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 long-term positive effects.

10.2.4.4 Decommissioning Phase

Any impact and consequential effect that occurs during the decommissioning phase are similar to that which occur during the construction phase, be it of less impact. The mitigation measures prescribed for the construction phase of the proposed development will be implemented during the decommissioning phase thereby minimising any potential impacts.

10.3 Cumulative Assessment

Potential cumulative effects on air quality and climate between the Proposed 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 2.5 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 wind farm 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 10.2.4.2 and Section 10.3.4.2 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 negative cumulative effect with other developments on air quality and climate.

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