10 AIR QUALITY AND CLIMATE

10.1 INTRODUCTION

This chapter assesses the impacts of the Project (**Figure 1.2**) on air and climate. The Project refers to all elements of the Proposed Development the subject of the planning application for the construction of Firlough Wind Farm and Hydrogen production facility together with other development and works which do not form part of the planning application all as described in **Chapter 2: Project Description**. Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment considers the potential effects during the following phases of the Development:

- Construction of the Development
- Operation of the Development
- Decommissioning of the Development

Common acronyms used throughout this EIAR can be found in **Appendix 1.3.** This chapter of the EIAR is supported by Figures provided in Volume III and by the following Appendix documents provided in Volume IV of this EIAR:

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

10.1.1 Statement of Authority

This section has been prepared by Sarah Jones and David Kiely of Jennings O'Donovan & Partners Limited.

Sarah Jones is an Environmental Scientist and Planner and holds a first-class MSc in Environmental Sustainability from University College Dublin and a Bachelor (Hons.) Degree in Geography from Manchester Metropolitan University. Sarah has recently developed a specialist knowledge of hydrogen production and her key capabilities include Environmental Impact Assessment (EIA) screenings, Appropriate Assessment (AA) screenings, Planning and Environmental reports and Applications, Environmental Impact Assessments, Feasibility Studies, Construction Environmental Management Plans, Stakeholder Engagement, Project Management.

David Kiely, has undertaken EISs/ EIARs for wind farms throughout Ireland. He has 40 years' experience in the civil engineering and environmental sector and has obtained a Bachelor of Engineering Degree in Civil Engineering and a Master of Science degree in Environmental Protection. David has overseen the development of over 50 wind farms from feasibility, planning and environmental assessment through to construction including air and climate assessments for other wind farms.

10.1.2 Assessment Structure

In line with the revised EIA Directive and current EPA guidelines, the structure of this Air and Climate chapter is as follows:

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

The desktop study as outlined in **Section 10.2 and 10.3** together with the other assessments are considered adequate to allow assessment of the Development to be carried out.

10.2 AIR QUALITY

10.2.1 Assessment Methodology

This assessment of air quality involved the following:

- A desk study of the air quality baseline in the area of the Proposed Development and nationally
- Evaluation of potential effects
- Evaluation of the significance of effects
- Identification of measures to avoid and mitigate potential effects

10.2.2 Relevant Legislation and Guidance

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

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

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

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

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

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

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

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

Pollutant	Limit Value Objective	Averaging Period	Limit Value (μg/m^3)	Limit Value (ppb)	Basis of Application of Limit Value
Sulphur Dioxide (SO_2)	Protection of vegetation	1 Oct to 31 Mar	20	7.5	Winter mean
Nitrogen dioxide (NO_2)	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year
Nitrogen dioxide (NO_2)	Protection of human health	Calendar year	40	21	Annual mean
Nitric oxide (NO) + Nitrogen dioxide (NO_2)	Protection of ecosystems	Calendar year	30	16	Annual mean
PM_{10}	Protection of human health	24 hours	50	-	Not to be exceeded more than 35 times in a calendar year
PM_{10}	Protection of human health	Calendar year	40	-	Annual mean
$PM_{2.5}$ - Stage 1	Protection of human health	Calendar year	25	-	Annual mean
$PM_{2.5}$ - Stage 2	Protection of human health	Calendar year	20	-	Annual mean
Lead (Pb)	Protection of human health	Calendar year	0.5	-	Annual mean
Carbon Monoxide (CO)	Protection of human health	8 hours	10,000	8,620	Not to be exceeded

Pollutant	Limit Value Objective	Averaging Period	Limit Value (µg/m^3)	Limit Value (ppb)	Basis of Application of Limit Value
Benzene (C_6H_6)	Protection of human health	Calendar year	5	1.5	Annual mean

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

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

Objective	Parameter	Target Value from 2010	Target Value from 2020
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	*AOT_{40} calculated from 1 hour values from May to July	18,000 mg/m^3 h^{-1} averaged over 5 years	6,000 mg/m^3 h^{-1}
Information Threshold	1-hour average	180 mg/m^3	-
Alert Threshold	1-hour average	240 mg/m^3	-

**AOT40 is a measure of the overall exposure of plants to ozone. It is the sum of the excess hourly concentrations greater than 80 µg/m^3 and is expressed as µg/m^3 hours.*

10.2.3 Air Quality & Health

Environmental Protection Agency (EPA, 2020)[1], European Environmental Protection Agency (EEA, 2020)[2] and World Health Organisation (WHO, 2014) reports estimate that poor air quality accounted for premature deaths of approximately 600,000 people in Europe in 2012, with 1,300 Irish deaths predominantly due to fine particulate matter ($PM_{2.5}$) in 2020

[1] Ireland's Environment – An Integrated Assessment 2020, EPA, 2020, accessed 01/12/2022
[2] EEA (European Environment Agency), 2020b. Air Quality in Europe 2020. EEA Report No. 09/2020. EEA, Copenhagen, accessed 01/12/2022

and 30 Irish deaths attributable to Ozone (O_3) in 2016[3,4]. Ground-level ozone (O3) is a major component of smog. It is formed from photochemical reactions with pollutants such volatile organic compounds, carbon monoxide and nitrogen oxides (NOx) emitted from vehicles, and industry. Due to the photochemical nature, the highest levels of ozone are seen during periods of sunny weather. Fine particulate matter, ozone, along with others including carbon dioxide (CO_2), nitrogen oxides (NO_x) and sulphur oxides (SO_x) are produced during the burning of fossil fuels for energy generation, transport or home heating. There are no such emissions associated with the operation of wind turbines. Therefore, the construction of wind turbines such as in the Development will result in lower environmental levels of such parameters, and consequential beneficial effects on human health. The only emission to air from the Hydrogen Plant is Oxygen (O_2), this is not considered a pollutant in the Air Quality Standard Regulations 2011 or CAFE Directive (Directive 2008/50/EC) or by the WHO or EPA.

10.2.4 Air Quality Zones

The EPA has designated four Air Quality Zones for Ireland:

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

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

10.2.5 Baseline; Existing Air Quality Conditions

Generally, Ireland is recognised as having some of the best air quality in Europe. However, from time to time, and under certain weather conditions, it is possible to experience some air pollution in the larger towns and cities. The most recent published report on air quality in Ireland is the 'Air Quality in Ireland 2020' report published by the EPA in 2021[5].

This report provides an overview of the ambient air quality in Ireland in 2020. It is based on monitoring data from 30 stations across Ireland. The measured concentrations are

[3] WHO. (2014). https://www.who.int/europe/news/item/25-03-2014-almost-600-000-deaths-due-to-air-pollution-in-europe-new-who-global-report accessed 01/12/2022
[4] Irelands Environment 2016 – An Assessment', EPA, 2016, accessed 01/12/2022
[5] EPA. (2020). Air Quality in Ireland 2020. https://www.epa.ie/publications/monitoring--assessment/air/Air-Quality-in-Ireland-2020.pdf Accessed 01/12/2022

compared with both EU legislative standards and WHO air quality guidelines[6] for a range of air pollutants.

The closest monitoring site to the Development within the same air quality zone is Castlebar (35 km south west of the Wind Farm Site, population 12,000).

Results from monitoring by the EPA for Castlebar[7] in 2021 show

- The annual mean PM_{10} levels for Castlebar were 14.4 µg/m^3
- The annual mean NO_2 levels for Castlebar were 6.4 µg/m^3
- The annual mean O_3 levels for Castlebar were 54.3 µg/m^3

These values are below the limit values set out by Directive 2008/50/EC as per **Table 10.1**. No pollutants were found at Castlebar over this period above the World Health Organization (WHO) guidelines[8]. It is important to note that both the Wind Farm Site and Hydrogen Plant Site are in a much more rural setting than the monitoring station in Castlebar, so air quality is expected to be even better than that recorded at Castlebar.

10.2.6 Do Nothing Impact

If the Development was not to proceed, the opportunity to reduce emissions of carbon dioxide, nitrogen oxides (NO_x), and sulphur dioxide (SO_2) to the atmosphere would be lost due to the continued dependence on energy derived from coal, oil and gas-fired power stations, rather than renewable energy sources such as the Proposed Development.

10.2.7 Potential Impacts of the Development

10.2.7.1 Construction Phase

10.2.7.1.1 Dust Emissions

The main potential source of impacts on air quality during construction is dust. There is potential for the generation of dust from excavations and from construction of access roads and hardstands at the Wind Farm Site, the underground water storage tanks and electrolyser buildings at the Hydrogen Plant Site and the trench for the cable ducting for the Grid Connection and Interconnector. The potential nuisance issues arising from these are dependent on the terrain, weather conditions, (i.e., dry and windy conditions), and the proximity of receptors. Dust from construction sites deposited on vegetation may create ecological stress within the local plant community. During long dry periods dust can coat

[6] WHO. (2021). Ambient (outdoor) air pollution https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health Accessed 01/12/2022
[7] EPA. (2022). https://airquality.ie/readings?station=EPA-26 Accessed 01/12/2022
[8] WHO. (2021). Ambient (outdoor) air pollution https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health Accessed 01/12/2022

plant foliage adversely affecting photosynthesis and other biological functions. Rainfall removes the deposited dust from foliage and can leach chemicals into the soil. Plant communities near short-term works are likely to recover within a year of the dust soiling stress ceasing. Dust from cement can cause ecological damage if allowed to migrate to water courses, though it is proposed that ready-mix concrete will be used with no on-site batching taking place, and therefore this will not be a potential source of emissions.

Potentially dust generating activities are as follows:

- Earth moving and excavation plant and equipment for handling and storage of soils and subsoils
- Transport and unloading of stone materials
- Rock will be extracted from turbine foundation construction and this will be subsequently used in construction of access roads and hardstands as needed
- Vehicle movements over dry surfaces such as access roads

The wind direction, wind speed and rainfall, at the time when a construction activity is taking place, will also influence whether there is likely to be a dust impact. Higher wind speeds will result in the highest potential for release of dust from a site. Buildings, structures and trees can also influence dispersion. Dust impacts are more likely to occur during drier periods, as rainfall acts as a natural dust suppressant.

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

Friable dust cannot remain airborne for a very long time. The distance it can travel depends on the particle sizes, disturbance activities and weather conditions. Larger dust particles tend to travel shorter distances than smaller particles. Particle sizes greater than 30 µm will generally deposit within approximately 100 m of its source, while particles between 10-30 µm travel up to approximately 250-500 m and particle sizes of less than 10 µm can travel up to approximately 1 km[9].

Generally, (depending on the conditions outlined), dust nuisance is most likely to occur at sensitive receptors within approximately 100 m of the source of the dust. It is considered that the principal locations of friable dust generation will be the turbine bases and hardstands at the Wind Farm Site, the building foundations at the Hydrogen Plant Site and

[9] http://www.dustscan.co.uk/Dust-Info/Definitions Accessed 01/12/2022

also along new access roads. All turbines are situated > 750 m away from inhabited houses and the Hydrogen Plant Site is located 299 m of from inhabited houses and therefore these principal locations of dust generation are greater than 100 m distant from these sensitive receptors. In addition, vegetation such as forestry, trees and hedgerows in the vicinity will help to mitigate any airborne dust migrating off the Wind Farm Site and Hydrogen Plant Site. Any effects of dust on vegetation will be confined to the construction and possibly the decommissioning phases and be short-term in duration.

If unmitigated, there would be dust deposition arising from mud on public roads, resulting from traffic leaving the Wind Farm Site and Hydrogen Plant Site. Impacts from dust deposition at sensitive receptors would give rise to nuisance issues for residents of those properties.

Mitigation measures to address the generation and suppression of dust from construction activities are outlined in **Chapter 15: Traffic and Transport** and in the **CEMP in Appendix 2.1**. The measures outlined in this chapter are in alignment with Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes (NRA, 2011)[10]. With strict adherence to mitigation measures and the distance from the main locations of dust generation, the impacts would be predicted to be slight and short-term.

10.2.7.1.2 Exhaust Emissions

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

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

[10] National Roads Authority (2011) Guidelines-for-the-Treatment-of-Air-Quality-during-the-Planning-and-Construction-of-National-Road-Schemes. Available online at: https://www.tii.ie/technical-services/environment/planning/Guidelines-for-the-Treatment-of-Air-Quality-during-the-Planning-and-Construction-of-National-Road-Schemes.pdf Accessed 01/12/2022.

measures such as dampening of stockpiles and wheel washing will significantly reduce the impacts of Particulate Matter that arises as a result of the construction phase of the Development.

Nitrogen oxides (NO_x), include the two pollutants, nitric oxide (NO) and nitrogen dioxide (NO_2). Anthropogenic (human) activities such as power-generation plants and motor vehicles are the principal sources of nitrogen oxides through high temperature combustion. Nitrogen oxides is an important air pollutant by themselves, but can also react in the atmosphere to contribute to the formation of tropospheric ozone (ozone in the air we breathe) and acid rain. Short-term exposure to nitrogen dioxide is associated with reduced lung function and airway responsiveness, and increased reactivity to natural allergens. Long-term exposure is associated with increased risk of respiratory infection in children.

The Institute of Air Quality Management document 'Guidance on the Assessment of Dust from Demolition and Construction'[11] states:
"*That Experience of assessing the exhaust emissions from on-site plant and site traffic suggests that they are unlikely to make a significant impact on local air quality.*"

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

10.2.7.2 Operational Phase

There will be a small number of light vehicles accessing the Wind Farm Site during the operational phase. This could lead to some localised dust being generated though this will be small and sporadic as only approximately one to two site visits per week will occur at the Proposed Development. In the unlikely event that a turbine would need to be replaced during the lifetime of the wind farm, there would be significantly less traffic than during the initial construction phase. There would only be one turbine delivered, compared to 13 no. turbines and the Wind Farm Site access roads and other site infrastructure will already have been established.

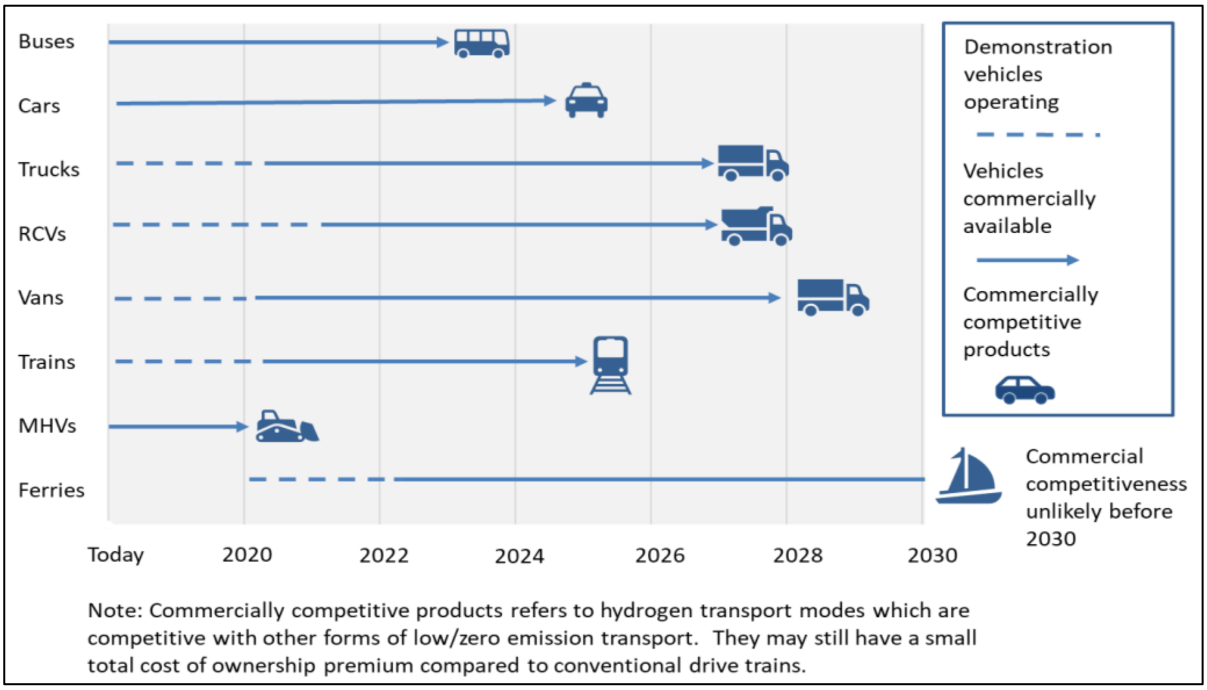
The Hydrogen Plant production capacity will be scaled up to a maximum 80 MW, to meet demand for green hydrogen in the Irish market. The physical infrastructure of the entire Hydrogen Plant (i.e. buildings, roads, water treatment, cooling and fuelling, etc) will be built

[11] IAQM. (2014). Guidance on the Assessment of Dust from Demolition and Construction'. https://iaqm.co.uk/text/guidance/construction-dust-2014.pdf

during a single construction phase with the modular electrolyser system installed in batches (the smallest of which is 5 MW). The smallest initial batch of electrolyser capacity will be 10 MW. Subsequent electrolyser capacity will be delivered via HGV with no abnormal loads required and no need for further construction works. The subsequent electrolyser capacity will be installed into existing physical infrastructure and integrated into existing electrolyser capacity and ancillary infrastructure such as cooling fans and water treatment. This could lead to a small volume of localised dust and emissions being generated through delivery vehicles. Due to the small volume of vehicles required, this will have an imperceptible impact.

10.2.7.2.1 Hydrogen Transportation

During the operational phase, green hydrogen will be transported along the national roads from the Hydrogen Plant Site located near the N59. These vehicles will produce some localised dust during the operational life of the Hydrogen Plant. It is anticipated that tube trailers, powered by zero emissions green hydrogen will be used to transport green hydrogen resulting in no CO_2 or NOx pollutants, these vehicles only emit water vapour and heat. A report by Hydrogen Mobility Ireland[12] in 2019 found that hydrogen vehicle introduction in Ireland could follow the time line as laid out in **Graphic 10.1**. Hydrogen buses are already in operation in Dublin and hydrogen vehicles are already being deployed around the world.



Graphic 10.1: Indicative timing of hydrogen fuel vehicle introduction in Ireland

[12] H2. (2019). A Hydrogen Roadmap for Irish Transport 2020-2030 https://h2mi.ie/wp-content/uploads/2019/12/20190930-Hydrogen-Mobility-Ireland-Final-External-Report-1.pdf

A study on green hydrogen in Ireland that surveyed haulage companies found that if a hydrogen vehicle was available at a similar price to other low-emission vehicles, 56.5% of the respondents would be willing to purchase between 1 and 5 vehicles over the next 5 years, and 21.7% would be willing to buy greater than 20 vehicles. The research modelled demand based on responses and found total annual hydrogen demand estimated for respondents was in the range of 2,023 – 4,626 tonnes, with a median estimate of 3,219 tonnes of hydrogen. The study found that due to carbon tax increases, weight requirements and the long distances involved, hydrogen fuel cell electronic vehicles were the most suitable low emissions vehicles for the haulage industry.

However, it is recognised that these may not be commercially available or commercially competitive when hydrogen production commences at the Proposed Development, if this is the case then diesel vehicles will be used, until a time when hydrogen trailers are available. These will produce emissions. The pollutants of most concern in relation to emissions from road traffic are nitrogen dioxide (NO_2) and particulate matter in the fractions of equal to or less than 10 µm (PM_{10}) and equal to or less than 2.5 µm ($PM_{2.5}$). In addition, the effects of ammonia and nitrogen oxides (NO_x) need to be considered with respect to the potential effects on sensitive designated habitats.

Transport Infrastructure Ireland (TII 2022) Air Quality Assessment of Proposed National Roads -Standard[13] gives guidance criteria on if changes to traffic due to a project will require assessment on the impact to air quality due to vehicle emissions. These are;

- Road alignment will change by 5 metres (m) or more;
- Annual average daily traffic (AADT) flows will change by 1,000 or more; or
- Heavy duty vehicle (HDV) (vehicles greater than 3.5 tonnes, including buses and coaches) flows will change by 200 AADT or more; or
- Daily average speed change by 10 kph or more; or
- Peak hour speed will change by 20 kph or more

The Hydrogen Plant operational traffic does not meet these criteria and is therefore able to be scoped out of having significant impacts to air quality by vehicle emissions.

10.2.7.2.2 Hydrogen Production

Results from a study on green hydrogen in the haulage sector in Ireland[14] showed that if 1000 green hydrogen trucks are rolled out, this could avoid approximately 74.6 kilotonnes

[13] TII. (2022). https://www.tiipublications.ie/library/PE-ENV-01107-01.pdf
[14] Laguipo, J. Forde, C. and Carton. J. (2022) Enabling the scale up of green hydrogen in Ireland by decarbonising the haulage sector. https://www.sciencedirect.com/science/article/pii/S0360319922026404

of CO_2 annually, requiring 6.8 kilotonnes of green hydrogen produced from a 42 MW electrolyser. Operating at the maximum capacity of 80 MW the Hydrogen Plant will produce a maximum of 31.2 tonnes of green hydrogen per day. However, based on the available wind data, this value will vary month to month as shown in **Table 10.3**, therefore hydrogen production per year has been more conservatively estimated at 4,547 tonnes (average 12.5 tonnes per day). Using the calculations on abatement in the haulage research paper, this avoids 49,883 tonnes of CO_2 per year by displacing approximately 669 diesel HGVs.

Table 10.3: Hydrogen Production Based on Wind Data

Month	Days per Month	Avg H_2 (kg)
Jan	31	447,823.11
Feb	28	526,237.29
Mar	31	401,975.29
Apr	30	329,194.51
May	31	332,200.21
Jun	30	317,078.60
Jul	31	228,249.20
Aug	31	302,366.95
Sep	30	333,919.33
Oct	31	442,871.59
Nov	30	403,722.63
Dec	31	481,295.58
Total Per Year	365	**4,546,934.29**
AVG. per day		**12,457.35**

The emissions limit for Diesel HGVs in Europe is 0.46 NO_x g per km and 0.01 PM g per km[15]. Driving 100,000 km per year, this totals 46 kg NO_x per year and 1 kg of PM per year per HGV. By replacing 669 diesel HGVs with green hydrogen, the 80 MW electrolyser gives a saving of 30,774 kg of NO_x and 669 kg of PM per year.

The Hydrogen Plant production capacity will be scaled up from a minimum of 10 MW, producing 568 tonnes of green hydrogen per year and displacing approximately 84 diesel trucks, avoiding 6,235 tonnes of CO_2, 3,864 kg of NO_x and 84 kg of PM per year.

When combined with the renewable electricity from the Wind Farm, the Proposed Development, at the lower turbine range (5 MW), will avoid between 44,485 and 57,652

[15] ICCT. (2016) https://theicct.org/sites/default/files/publications/ICCT_Euro6-VI_briefing_jun2016.pdf

tonnes of CO_2 per year. At the higher turbine range (6 MW) this is between 49,883 and 60,025 tonnes of CO_2 per year.

Over 40 years, the Hydrogen Plant and Wind Farm would displace between 1.6 and 2.5 million tonnes of CO_2. This will lead to a long-term significant positive indirect impact on air quality.

It is not anticipated that there will be any air pollution or hazardous emissions generated by the Hydrogen Plant Site. The green hydrogen produced by electrolysis at the Hydrogen Plant will result in zero greenhouse gas emissions due to using renewable wind energy. The only atmospheric emission to be emitted from the electrolysis process will be oxygen.

Oxygen (O_2) is produced as a biproduct of the green hydrogen production process at a volume of 8 kg O_2 for 1 kg hydrogen. At 10 MW it is expected that the Hydrogen Plant will produce 568 tonnes of Hydrogen per year and emit 4,547 tonnes of Oxygen. At 80 MW it will produce 4,547 tonnes of green hydrogen and emit 36,375 tonnes of Oxygen per year. This is released to the atmosphere via a vent stack. The oxygen vent stack is separated from the hydrogen vent outlets and away from building air takes. Sufficient ventilation will be installed inside the electrolyser building to prevent accumulation of oxygen. A licence will be required from the EPA for the process of venting O_2, application process for this licence is underway at the time of application. O_2 is not considered a pollutant by either the Air Quality Standard Regulations 2011, WHO, EPA or the CAFE Directive (Directive 2008/50/EC). This has an imperceptible neutral impact.

Hydrogen has a proven safety track record as a fuel for more than 100 years worldwide. Hydrogen has various properties that make it an ideal energy carrier:

- Hydrogen is non-toxic and non-poisonous, unlike conventional fuels. A hydrogen leak will not contaminate the environment or endanger the health of humans or wildlife. Hydrogen does not create "fumes."
- Hydrogen is 14 times lighter than air, consequently when it is released it dilutes quickly into a non-flammable concentration, significantly reducing the risk of ignition at ground level.
- Hydrogen has a higher oxygen requirement for explosion than conventional gasoline.
- Hydrogen has a lower radiant heat than conventional gasoline, i.e. the air around the hydrogen flame is less hot than around a gasoline flame, reducing the risk of secondary fires.

As with most combustion fuel sources, hydrogen is flammable, so any storage or handling of it has the potential to lead to a fire. Hydrogen fires are different than natural gas fires in in that the radiant heat of hydrogen fires is lower and because hydrogen is buoyant (lighter than air). These factors mean hydrogen fires tend to have a smaller area at risk for a comparable natural gas fire.

Hydrogen has higher design standards than natural gas for protection as it is easier to ignite and is extremely flammable in air (flammability limits of between 4 percent and 75 percent by volume) and has a low ignition energy (0.019 mJ). Ignition can occur when a hydrogen/oxidizer is exposed to processes such as flames, electrical spark or shock waves. This can ultimately lead to the occurrence of explosions under certain circumstances. Design Standards for Hydrogen can be found in **Chapter 2; Project Description, section 2.6.6.2.**

Hydrogen fires do not typically produce noxious or toxic combustion products and do not produce exhaust fumes, the only product is water and is therefore not considered to be a threat with the potential to affect air quality. There is a potential that other materials at the Hydrogen Plant could be impacted by a hydrogen fire and create emissions that impact air quality. These include:

- Potassium hydroxide (KOH), also known as lye, has been selected as the electrolyte for the electrolyser stacks and will be stored as a 25% KOH solution in tanks within the electrolyser building. KOH itself does not burn however poisonous gases can be produced in fires including potassium oxides. Inhaling potassium hydroxide can irritate the lungs and higher exposures can cause a build up of fluid in the lungs (pulmonary edema). Exposure can cause headache, dizziness, nausea and vomiting.
- Sodium bisulphite is used for the for de-chlorination of raw mains water if it is required. This is not combustible, however during a fire it produces irritating and toxic gases.
- Glycol for coolant. This is mixed with water, it is not consumed in the process but on site storage is required in case minor system losses need to be replenished. Thermal decomposition can lead to release of irritating gases and vapors including Carbon monoxide (CO) and Carbon dioxide (CO_2).
- Nitrogen gas and will be used at the facility to purge equipment and piping for both safety and maintenance purposes. Nitrogen is an inert gas and so is not toxic.
- Antiscalant used to prevent/reduce scaling of water treatment equipment (i.e. from build up of salts). While the specific Antiscalant to be used has not been identified, most antiscalants are proprietary organic man-made polymers. These products are

considered non-hazardous as defined by the US Occupational Safety and Health Act regulations.

- Building materials used in the construction of the Hydrogen Plant.
- Oils and lubricants.
- Cleaning Chemicals.

All chemicals will be stored in a bunded area on the Hydrogen Plant Site and will be subject to requirements of the Safety, Health and Welfare at Work (Chemical Agents) Regulations 2001 to 2021 (as amended) and compliance with the requirements of REACH, i.e., European Communities Regulation 1907/2006 for the Regulation, Evaluation, Authorisation and Restriction of Chemicals. Chemicals will be managed in accordance with European Chemicals Agency's Guidance for Downstream Users (2014). Final selection of bulk chemicals will be subject to an assessment of trace elements to ensure that they are within acceptable limits. Storage of large volumes of oils and other hazardous substances will have a secondary containment such as a bund to prevent hydrocarbon contamination to land/water. Waste oils and other chemicals, including oil rags/wipes will be disposed of as hazardous waste. Operational staff will receive training on the handling, containment, use, and disposal requirements for all potentially polluting products on the Hydrogen Plant Site.

Further details can be found in **Chapter 16: Major Accidents and Natural Disasters.** The Hydrogen Plant Site location is a significant distance from receptors. The public would have no access to the Hydrogen Plant. The nearest public road, the L6611, is 600 m to the west and the nearest buildings which are not associated with the facility are 299 m away. Due to these separation distances, the fire safety mechanisms (outlined in Chapter 16; Major Accidents and Natural Disasters) and the dilution effect of any air pollution created during a fire, the effects to air quality have been assessed as a temporary small adverse and direct impact in the event of a fire or explosion.

10.2.7.3 Decommissioning Phase

Impacts during the decommissioning phase of the Proposed Development are anticipated to be similar to those arising during the construction phase.

The Developer is applying for a consent for an operational period of 40 years for the wind farm. Cranes of similar size to those used for construction will disassemble each turbine using the same crane hardstands. The towers, blades and all components will then be removed from the Wind Farm Site and reused, recycled, or disposed of in a suitably licenced facility. The turbine transformers will also be removed from the Wind Farm Site. There is potential to reuse turbine components, while others can be recycled.

All Site access roads hardstanding areas and drainage will be left in situ for future use.

It is intended that all above ground components and underground cabling (ducting left in-situ) will be removed from the Wind Farm Site as part of the decommissioning of the Development. The following elements are included in the decommissioning phase:

- Wind turbines dismantling and removal off the Wind Farm Site
- Underground cabling removal (ducting left in-situ)
- Turbine foundation backfilling following dismantling and removal of wind turbines (any excavated material, will be re-instated / foundations that protrude above ground level will be backfilled with soil -underground reinforced concrete remaining in-situ)
- Transport Route Accommodation Works

Any structural materials suitable for recycling will be disposed of in an appropriate manner. The financial costs of decommissioning, at current material values, will be more than met by the recycling value of the turbine components.

Prior to wind turbine removal, due consideration will be given to any potential impacts arising from these operations. Potential impacts are likely to be similar to that of the construction phase, to an equal or lesser extent. Some of the potential issues could include:

- Potential disturbance by the presence of cranes, HGVs, and personnel on-site
- Time of year and timescale (to be outside sensitive periods).

It is the intention that the Hydrogen Plant will continue operations indefinitely. The source of electricity for the Hydrogen Plant would change upon the decommissioning of the Wind Farm and be changed to one of the following options;

- Subject to planning consents, the repowering of Firlough Wind Farm.
- Reinforced electricity network with a corporate power purchase agreement with a green electricity producer.
- Connection to an offshore wind power generator off the west coast.

If these alternatives are not viable then the process equipment would be decommissioned; all plant, machinery and equipment will be emptied and dismantled to be sold or recycled or, where these are not possible, disposed of through a licenced waste contractor. If required, all machinery will be cleaned prior to removal and all necessary measures implemented to prevent the release of contaminants. All waste will be removed from the facility and recycled wherever possible, disposal operations will be controlled by licenced waste contractors. The buildings and infrastructure would be retained and repurposed.

The decommissioning phase for the Hydrogen Plant Site would be expected to last approximately three to six months, and any air quality impacts would be predicted to be imperceptible.

10.2.8 Mitigation Measures and Residual Effects

10.2.8.1 Construction Phase Mitigation

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

- Wind Farm Site and Hydrogen Plant Site access roads will be upgraded and built prior to the commencement of construction activities. These roads will be finished with graded aggregate which compacts, preventing dust.
- Approach roads and construction areas to and on the Wind Farm Site and Hydrogen Plant Site will be cleaned on a regular basis to prevent build-up of mud and prevent it from migrating around the sites and onto the public road network.
- Wheel wash facilities will be provided near the entrances to both sites to prevent mud/dirt being transferred from the site to the public road network.
- Public roads along the construction haul route will be inspected and cleaned daily. In the unlikely event that dirt/mud is identified on public roads, the road will be cleaned and the wheel wash facility will be investigated and the problem fixed to prevent this from happening again.
- During periods of dry and windy weather, there is potential for dust to become friable and cause nuisance to nearby residences and users of the local road network. This requires wetting material and ensuring water is supplied at the correct levels for the duration of the work activity. For example, weather will be monitored so that the need for damping down activities can be predicted. Water bowsers will be available to spray work areas (wind turbine area, Grid Connection Route and Interconnector Route) and haul roads to suppress dust migration.
- Vehicles delivering materials will be covered appropriately when transporting materials that could result in dust, e.g., crushed rock or sand.

- Exhaust emissions from vehicles operating within the sites, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the contractor by ensuring that emissions from vehicles are minimised through regular servicing of machinery
- Ready-mix concrete will be delivered to the sites and no batching of concrete will take place on either site. Only washing out of chutes will take place at the sites and this will be undertaken at designated concrete washout facilities.
- Speed restrictions on access roads will be implemented to reduce the likelihood of dust becoming airborne. Consideration should be given to how on-site speed limits are policed by the Site Foreman and toolbox talks should include this. Lower speed limits should be set for traffic on public roads also, to minimise nuisance to the general public.
- Stockpiling of materials will be carried out in such a way as to minimise their exposure to wind where possible. Stockpiles will be covered with geotextiles layering and damping down will be carried out when weather conditions require it.
- Earthworks and exposed areas/soil stockpiles will be re-vegetated to stabilise surfaces as soon as practicable.
- Methodology statements will be signed off by a suitably qualified Geotechnical Engineer. An independent, qualified Geotechnical Engineer will be contracted for the detailed design stage of the project and geotechnical services will be retained throughout the construction phase, including monitoring and supervision of construction activities on a regular basis.
- A complaints procedure will be implemented where complaints will be reported, logged and appropriate action taken.

10.2.8.2 Operational Phase Mitigation

As the operation of the Wind Farm will not have any direct negative impact but will have indirect positive impacts by displacing fossil fuels, mitigation measures are considered unnecessary.

Though no significant negative impacts have been identified for the Hydrogen Plant during operation, mitigation by design and health and safety has been a key consideration in the design of the Hydrogen Plant, and the approach has incorporated good practice principles such as inherently safer design and the hierarchy of controls. The Seveso III Directive (Directive 2012/18/EU), the main EU legislation dealing specifically with the control of onshore major accident hazards involving dangerous substances, along with the Chemical Act (Control of Major Accident Hazards involving Dangerous Substances) Regulations 2015 which implements the SEVESO directive, apply to the Hydrogen Plant. The ATEX Directive (Directive 1999/92/EC) which sets out a system of precautions and controls to be put in place where explosive atmospheres may be present due to flammable dusts vapours or gases. The ATEX Directive is transposed into Irish Legislation by Part 8 of the Safety, Health and Welfare at Work (General Application) Regulations 2007 and these regulations also apply to the Hydrogen Plant.

Design standards specific to hydrogen production facilities (NFPA 2, NFPA 55, ISO 22734, ISO 19880 and ISO 15916 as shown in **Chapter 2: Project Description Table 2.4**) have been used throughout the preliminary design phase. Regulations and separation distances required by industry good practice have been incorporated into the design. Site specific safety measures in accordance with COMAH, ATEX, Safety, Health and Welfare at Work Act and Regulations and other relevant standards and codes will be in place for the full life of operation. An outline Major Accident Prevention Policy has been prepared and is included in **Appendix 16.3.** An Emergency Response Plan (recommended, not required for lower-tier COMAH sites) will be produced for the plant. A risk management programme, ATEX Assessment and Safety Management System will be in place for the facility. A Quantitative Risk Assessment (QRA) has been undertaken for the Hydrogen Plant. The QRA was developed in accordance with the inputs, methodology and rulesets outlined in the Irish Health and Safety Authority (HSA) Guidance for Technical Land Use Planning Advice. The results of the analysis show that the proposed site of the Hydrogen Plant is within the tolerable risk region established within the HSA's Technical Land Use Planning Advice guidance.

Safety equipment installed at the Hydrogen Plant will include:

- Leak/fire detection + isolation/automatic shut-off
- Emergency stops
- Building ventilation (passive + active)
- Piping pressure/flow rate monitoring
- Impact sensors at dispensers
- Audible and visual alarms
- Fire protection and suppression equipment

The detection system in place at the Hydrogen Plant will be capable of detecting hydrogen gas or hydrogen fire and a Supervisory Control and Data Acquisition ("SCADA") system will monitor the facilities performance. Fire fighting systems will include alarms, water spray deluge systems, sprinkler systems, carbon dioxide suppression systems and mobile fire protection equipment.

Limiting the volume of hydrogen stored on site mitigates accidents. Should external factors limit the removal of hydrogen from the Hydrogen Plant Site for transportation, a shutdown system will stop production in order to stay within COMAH lower tier regulation volumes. To prevent loss of oxygen containment increasing fire risks, the oxygen systems will be physically separated from the hydrogen systems and stores of any combustible materials in line with good practice design standards.

All chemicals will be stored in a bunded area and will be subject to requirements of the Safety, Health and Welfare at Work (Chemical Agents) Regulations 2001 to 2021 (as amended) and compliance with the requirements of REACH, i.e., European Communities Regulation 1907/2006 for the Regulation, Evaluation, Authorisation and Restriction of Chemicals. Chemicals will be managed in accordance with European Chemicals Agency's Guidance for Downstream Users (2014). Final selection of bulk chemicals will be subject to an assessment of trace elements to ensure that they are within acceptable limits. Storage of large volumes of oils and other hazardous substances will have a secondary containment such as a bund to prevent hydrocarbon contamination to land/water. Waste oils and other chemicals, including oil rags/wipes will be disposed of as hazardous waste. Operational staff will receive training on the handling, containment, use, and disposal requirements for all potentially polluting products on the Hydrogen Plant Site.

10.2.8.3 Decommissioning Phase Mitigation

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

10.2.9 Cumulative Effects

There are many existing and approved developments within the vicinity of the Wind Farm Site and Hydrogen Plant Site as listed in **Appendix 2.3** of **Chapter 2: Development Description**.

Cumulative air impacts may arise if the construction, operational and maintenance period and decommissioning of these projects occur simultaneously with the construction of the Proposed Development. This could result in slight increased traffic and dust emissions. However, provided the mitigation measures as detailed in **Section 10.2.8** are implemented, there will be no significant cumulative effects on air quality due to dust or greenhouse gas emissions. There will be no net carbon dioxide (CO_2) emissions from operation of the Proposed Development.

The Proposed Development construction phase is a short-term activity, so the potential cumulative impact is predicted to be slight, negative, temporary/short-term, direct, medium probability given the distance of the Proposed Development to sensitive receptors.

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

In 2020, 42% of electricity came from renewable sources, with 86% coming from wind[16]. This energy displaced fossil fuel imports and improved Ireland's air quality. The target for renewable electricity in Ireland's Climate Action Plan 2023 is to generate 80% of electricity using renewable sources by 2030.

The cumulative effect with other Irish renewable generation is considered to be a change in the air quality effects of Ireland's energy supply, which is a **major, positive effect,** that is significant under the EIA Regulations and will contribute to Ireland's emission reduction targets.

10.2.10 Residual Impacts of the Development

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

During the operational phase of the Wind Farm, exhaust emissions will arise from occasional machinery use and Light-Good Vehicles (LGV) that will be required for occasional on-site maintenance works. The impact will be a long-term imperceptible negative.

The Hydrogen Plant production capacity will be scaled up to a maximum 80 MW, to meet demand for green hydrogen in the Irish market. Initially, as demand for green hydrogen builds, it is expected the majority of the 78 MW of renewable electricity generated by the Wind Farm will be exported to the national grid and contribute to the de-carbonisation of the Irish electricity network which is a significant positive effect on air quality. As the Hydrogen Plant is scaled up, it will consume larger volumes of the electricity generated by the Wind Farm in the production of green hydrogen. At 10 MW, it is expected that the Hydrogen Plant

[16] SEAI. (2021). ENERGY IN IRELAND. https://www.seai.ie/publications/Energy-in-Ireland-2021_Final.pdf Accessed 01/12/2022

will produce approximately 568 tonnes of green hydrogen per year, displacing approximately 84 diesel trucks, avoiding 6,235 tonnes of CO_2, 3,864 kg of NO_x and 84 kg of PM per year.

At full capacity of 80 MW, it will produce approximately 4,547 tonnes of green hydrogen per year. This avoids 49,883 tonnes of CO_2 per year by displacing approximately 669 diesel HGVs, avoiding 30,774 kg of NO_x and 669 kg of PM per year.

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

10.2.11 Summary of Significant Effects

This assessment has identified no potentially significant negative effects on air quality, given the mitigation measures embedded in the design which will be implemented in the Proposed Development. Significant indirect positive effects of the displacement of fossil fuels have been identified.

10.2.12 Statement of Significance

The Proposed Development has been assessed as having no significant negative effects on air quality during the construction, operation or decommissioning phases of the Development. Significant indirect positive effects of the displacement of fossil fuels have been identified.

10.3 CLIMATE CHANGE, CLIMATE ACTION PLAN AND GREENHOUSE GASES

The Climate Action Plan 2023[17] outlines actions to cut emissions and make Ireland a zero-carbon economy by 2050. The plan sets an ambitious 80% target for electricity production from renewable sources by 2030. It notes that electricity will play an important role in the

[17] Department of the Environment, Climate and Communications. (2023) Climate Action Plan 2023 https://www.gov.ie/en/publication/7bd8c-climate-action-plan-2023/#:~:text=The%20Climate%20Action%20Plan%202023,budgets%20and%20sectoral%20emissions%20ceilings./ Accessed 24/02/2023

decarbonisation of other sectors through electrification, including transport, heating, and industry.

Greenhouse gases can lead to increases in global temperatures known as 'global warming' or the 'greenhouse effect' which can influence climate change. There are a wide range of gases known as greenhouse gases. The most critical greenhouse gases are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). There are also other greenhouse gases known as F-Gases, man-made gases used in refrigeration and air conditioning appliances. Greenhouse gases produced by human activities are changing the composition of the earth's atmosphere. Human activities that produce greenhouse gases include carbon dioxide emissions through burning fossil fuels such as coal, oil and gas and peat.

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

- Rising sea-levels threatening land and particularly coastal infrastructure
- Extreme weather, including more intense storms and rainfall affecting our land, coastline and seas
- Further pressure on our water resources and food production systems with associated impacts on river and coastal ecosystems
- Greater political and security instability
- Displacement of population and climate refugees
- Heightened risk of the arrival of new pests and diseases
- Poorer water quality
- Changes in the timing of lifecycle events for plants and animals on land and in the oceans.[18]

Climate change means a significant change in the measures of climate, such as temperature, rainfall, or wind, lasting for an extended period – decades or longer. Earth's climate has changed naturally many times during the planet's existence. However, human activities are significantly contributing to climate change through greenhouse gas emissions. The global average temperatures have now increased by more than 1°C since pre-industrial times.

At the Paris climate conference (COP21) in 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. The agreement sets out a global action plan

[18] CAP23. https://www.gov.ie/en/publication/7bd8c-climate-action-plan-2023/

to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C above pre-industrial levels and to limit the increase to 1.5°C. Under the agreement, Governments also agreed on the need for global emissions to peak as soon as possible, recognising that this will take longer for developing countries and to undertake rapid reductions thereafter in accordance with the best available science.

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

The COP27 was held in Egypt in 2022 and focussed on adaption to climate change and preparing for its effects alongside climate change mitigation. The summit concluded with a historic decision to establish and operationalize a loss and damage fund.

The Intergovernmental Panel on Climate Change (IPCC) released their AR6 report[19] in April 2022. The report shows that human induced climate change is causing impacts of an extent and magnitude much larger than previously estimated. It highlights the widespread, dangerous disruptions caused in nature and shows how billions of people's lives are being impacted. It outlines how countries are falling behind on policies and actions needed to limit global temperature increases and achieve net zero emissions. Reducing carbon emissions by phasing out fossil fuels is stated as being urgently needed. Throughout the report, renewable energy such as wind is highlighted as an adaptation to displace fossils fuels, and so reduce emissions and mitigate climate effects. Renewable energy is also credited with benefits such as improving air quality, reducing the cost of electricity, improving wealth and development and increasing energy security. It is also recommended that increasing the diversity of energy generation with renewables reduces vulnerability to climate change and improves the resilience of the energy system.

The Climate Action Plan 2023 provides a detailed plan to achieve a 51% reduction in greenhouse gas emissions by 2030 and reach net zero by 2050. The Proposed Development will have a long-term positive impact on climate and green house gases by providing two sustainable renewable energy sources, a Wind Farm and a Hydrogen Plant. Should the project not be developed, fossil fuel power stations will be the primary alternative

[19] IPCC. (2022). AR6 Report. https://www.ipcc.ch/assessment-report/ar6/ Accessed 01/12/2022

to provide the required quantities of electricity and fossil based fuels will continue to be the main viable energy source of heavy transportation and industrial processes.

This will further contribute to greenhouse gas and other emissions. It will also hinder Ireland in its commitment to meet its target to increase electricity production from renewable sources and to reduce greenhouse gas emissions as agreed at the Paris climate conference (COP21) in 2015, the Glasgow Climate Pact (COP26) in November 2021 and the Egypt (COP27) in November 2022.

10.3.1 Relevant Legislation and Guidance

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

The Climate Action and Low Carbon Development (Amendment) Act 2021 commits Ireland to reach a legally binding target of net-zero emissions no later than 2050, and a cut of 51% by 2030 (compared to 2018 levels), and the Climate Action Plan 2023 outlines a set of actions to achieve this.

10.3.2 Assessment Methodology

This assessment of climate involved the following:

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

A Recently released Delegated Act supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin[20] notes that:

[20] EU. (2022) COMMISSION DELEGATED REGULATION (EU) …/... supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=PI_COM:Ares(2022)3836651

"*Renewable liquid and gaseous transport fuels of non-biological origin are important for increasing the share of renewable energy in sectors that are expected to rely on liquid or gaseous fuels in the long term*."

It states that:

"(*1*) *Articles 7 and 19 of Directive (EU) 2018/2001 provide sufficient assurances that the renewable properties of electricity used for the production of renewable hydrogen are claimed only once and only in one end-use sector. Article 7 of that Directive ensures that, when calculating the overall share of renewables in gross final energy consumption, renewable liquid and gaseous transport fuels of non-biological origin are not accounted because the renewable electricity used to produce them has already been accounted for*."

To assess the impacts of the Proposed Development, this chapter will lay out the effects of the renewable electricity generated by the Wind Farm and the renewable green hydrogen produced by the Hydrogen Plant. However, the contributions of only the renewable electricity generated by the Wind Farm will be counted for contribution purposes to ensure that the renewable energy produced by the Proposed Development is not counted twice.

The Hydrogen Plant production capacity will be scaled up to a maximum 80 MW, to meet demand for green hydrogen in the Irish market. An 80 MW electrolyser will produce a maximum of 31,200 kg of green hydrogen and consuming the whole output of the Wind Farm. However, based on the available wind data, this value will vary month to month as shown in **Table 10.3**, therefore hydrogen production per year has been more conservatively estimated at 4,547 tonnes (average 12.5 tonnes per day).

The smallest initial batch of electrolyser capacity will be 10 MW and will produce approximately 568 tonnes of green hydrogen per year, leaving 55 to 68 MW (based on a turbine range of between 5 and 6 MW) of installed capacity of the Wind Farm dispatching to the electricity grid.

10.3.3 Existing Climate

The Köppen climate classification divides regions of the globe based on seasonal precipitation and temperature patterns. The five main groups are tropical, dry, temperate, continental, and polar. The Irish climate is defined as a temperate oceanic climate on the Köppen climate classification system[21]. Ireland's climate is mild, moist and changeable with

[21] Britannica. https://www.britannica.com/science/Koppen-climate-classification/World-distribution-of-major-climatic-types, Accessed 01/12/2022

abundant rainfall and a lack of temperature extremes. The country generally receives cool summers and mild winters and it is considerably warmer than other areas on the same latitude. Ireland's land mass is warmed by the North Atlantic Current all year and as a result does not experience a great annual range of air temperatures.

Nationally, the mean air temperature is generally between nine and 11 degrees. The wettest months nationally are December and January and April being the driest month[22]. Annual rainfall totals on the West coast generally average between 1000 and 1400 mm, this compares to between 750 and 100 mm in the eastern half of the county. The prevailing wind direction is between South and West. Average wind speed ranges from 3 m/s in south Leinster to 8 m/s in the extreme North of the country[23].

For the purpose of the assessment of Climate Change, meteorological data from the nearest meteorological station to the Development, Belmullet monitoring station, over a period of 1981-2010 is shown in **Table 10.4**. This is the most recent available data, at the time of writing (December 2022), data used to populate the official standard normals tables for 1991-2020 is in the process of being quality assured and collated. Belmullet is located 68 km to the west of the development and is the closest Met Eireann climate station to the Development with the longest running data set.

The wettest months are October, December, January and November. May and April are usually the driest. July is the warmest month with a mean temperature of 15.3 °C.

The mean annual air temperature between 1981-2010 is 10.3 °C. Mean monthly temperatures ranged from 6.3 °C in January to 15 °C in august. Mean annual rainfall over this period was 1,244.8 mm, with a maximum monthly mean rainfall of 145.9 mm in October and a minimum monthly mean rainfall of 70.4 mm in May[24].

[22] Met Eireann https://www.met.ie/climate/what-we-measure/rainfall Accessed 02/12/2022
[23] Met Eireann. https://www.met.ie/climate/what-we-measure/wind Accessed 02/12/2022
[24]Met Eireann. 30 YEAR AVERAGES. https://www.met.ie/climate/30-year-averages, Accessed 01/12/2022

Table 10.4: Belmullet Meteorological Station Data Averages (1981- 2010)

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
TEMPERATURE (degrees Celsius)													
mean daily max	8.9	9.1	10.4	12.2	14.6	16.2	17.6	17.8	16.5	13.7	11.0	9.2	13.1
mean daily min	3.7	3.6	4.7	5.8	7.9	10.4	12.2	12.2	10.7	8.4	6.0	4.2	7.5
mean temperature	6.3	6.4	7.6	9.0	11.2	13.3	14.9	15.0	13.6	11.1	8.5	6.7	10.3
absolute max.	13.9	15.1	19.5	24.4	26.6	27.0	29.9	27.7	25.4	20.1	16.3	14.9	29.9
min. maximum	-1.1	0.7	3.1	6.3	8.0	11.3	12.5	12.1	11.6	7.4	3.4	0.9	-1.1
max. minimum	10.7	11.0	11.0	12.0	15.3	16.5	17.5	17.6	16.8	15.5	13.9	12.3	17.6
absolute min.	-8.1	-5.4	-5.7	-2.1	0.2	1.4	5.1	3.1	0.8	-1.7	-4.5	-7.6	-8.1
mean num. of days with air frost	4.0	3.8	1.2	0.4	0.0	0.0	0.0	0.0	0.0	0.1	1.1	3.5	14.1
mean num. of days with ground frost	10.6	10.0	6.5	5.4	1.7	0.1	0.0	0.0	0.4	2.0	5.6	10.0	52.3
mean 5cm soil	4.9	4.9	6.4	9.3	12.9	15.6	16.8	16.1	13.6	10.2	7.4	5.4	10.3
mean 10cm soil	5.3	5.3	6.6	9.0	12.3	14.9	16.2	15.8	13.7	10.7	7.9	5.9	10.3
mean 20cm soil	5.8	6.0	7.2	9.6	12.8	15.3	16.6	16.5	14.5	11.5	8.7	6.5	10.9
RELATIVE HUMIDITY (%)													
mean at 0900UTC	86.0	85.8	84.1	81.1	78.7	81.4	84.9	85.1	84.5	85.7	86.1	86.8	84.2
mean at 1500UTC	81.7	79.1	77.5	73.7	73.3	77.2	79.7	79.2	77.9	80.0	82.3	84.3	78.8
SUNSHINE (hours)													
mean daily duration	1.4	2.3	3.1	5.2	6.1	5.2	4.4	4.4	4.0	2.8	1.6	1.2	3.5
greatest daily duration	8.3	9.6	11.6	14.1	15.5	15.9	15.1	13.9	12.1	10.4	8.2	7.2	15.9
mean no. of days with no sun	10.3	6.0	5.9	2.7	2.0	2.8	3.5	3.2	3.7	5.5	8.3	10.8	64.8

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
RAINFALL (mm)													
mean monthly total	134.0	97.1	99.2	72.0	70.4	72.1	79.0	101.9	101.8	145.9	134.0	137.4	1244.8
greatest daily total	44.7	31.3	25.6	25.9	42.2	38.9	33.2	49.5	62.6	79.6	43.0	41.7	79.6
mean num. of days with >= 0.2 mm	23	20	22	18	17	17	20	20	20	23	23	23	246
mean num. of days with >= 1.0 mm	19	16	17	13	13	12	14	15	15	19	20	19	192
mean num. of days with >= 5.0 mm	10	7	7	4	4	4	5	6	6	10	10	9	82
WIND (knots)													
mean monthly speed	15.4	14.6	14.0	12.2	11.6	11.4	11.1	11.2	12.0	13.3	13.3	13.8	12.8
max. gust	94	93	88	75	66	63	67	56	73	73	80	93	94
max. mean 10-minute speed	55	60	58	43	42	45	45	40	50	52	47	59	60
mean num. of days with gales	7.0	4.8	3.1	1.4	0.9	0.2	0.2	0.4	1.5	2.6	3.1	4.4	29.6
WEATHER (mean no. of days with..)													
snow or sleet	4.5	4.2	3.1	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.9	3.0	17.3
snow lying at 0900UTC	0.4	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.6
hail	9.2	7.8	7.4	4.4	1.7	0.1	0.0	0.1	0.5	3.3	5.6	7.5	47.7
thunder	1.1	0.7	0.6	0.4	0.5	0.5	0.6	0.6	0.3	0.6	0.5	0.9	7.2
fog	1.0	0.4	0.9	1.4	1.4	1.7	2.9	1.9	1.2	0.7	0.9	0.7	15.1

10.3.4 Calculating Carbon Losses and Savings

10.3.4.1 Carbon Calculator

To assess the impact of the wind energy element of the Proposed Development on the climate, the carbon emitted or saved as a result of the Wind Farm was determined using a carbon calculator. The Scottish Government have produced an online carbon calculator which aims to assess, in a comprehensive and consistent way, the carbon impact of wind farm developments. This is done by comparing the carbon costs of wind farm developments with the carbon savings attributable to the wind farm. The carbon calculation takes into account the carbon released from a number of sources during the construction, operational and decommissioning stages. These include the effects of drainage works, forestry felling, losses associated with harvesting and transport of felled trees, changes in land use and wind turbine manufacture and construction. Also included in the assessment tool is the assessment of peat disturbance.

Assessments are also carried out to estimate the carbon saving over the lifetime of the wind farm, compared to electricity produced using fossil fuel. The assessment of carbon savings relates to the capacity of the wind farm over the number of years for which it is operational, site improvement works, (i.e., peatland improvement, habitat creation, etc.), forestry felling, and site restoration works, (i.e., removal of infrastructure and restoration of previous site conditions), when the wind farm will be decommissioned. However it does not factor in the potential re-use of turbine components. All metal components can be recycled, while there is limited potential for the recycling/reuse of the fibreglass blades.

The model also calculates the carbon savings associated with a wind farm against three comparators:

i. Coal fired Electricity Generation
ii. Grid mix of Electricity Generation
iii. Fossil fuel mix of Electricity Generation.

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

The completed worksheet, including the assumptions used in the model, is provided in **Appendix 10.1** of this EIAR. The model calculates the total carbon emissions associated with the wind energy element of the Development including manufacturing of the turbine technology, transport, construction of the Development and tree felling. The model, which is assessed for both the lower range (5 MW) and the higher range (6 MW) turbine options and the years taken for the Wind Farm Site to return to its original characteristics but does not factor in the potential re-use of turbine components. All metal components can be recycled, while there is limited potential for the recycling/reuse of the fibreglass blades. The model has also been used to assess the Hydrogen Plant carbon losses. The calculations include the access tracks, concrete and any peat removed from Hydrogen Plant element of the Proposed Development.

10.3.4.2 Carbon Losses

The potential carbon losses and savings taking into account peat removal, drainage, habitat improvement, forestry felling, concrete and site restoration were assessed for the Proposed Development using the Scottish Government Carbon Calculator. Site specific information was inserted into the worksheet where it was available. Otherwise, default values were used. The calculations include the turbines, areas of hardstanding, access tracks, and concrete required for the Wind Farm and Hydrogen Plant.

The main CO_2 losses the Proposed Development are summarised in **Table 10.5**.

Table 10.5: Carbon Losses

Origin of Losses	Total CO_2 Losses (tonnes CO_2 equivalent)	
	Lower Range Output	Higher Range Output
Turbine manufacture, construction and decommissioning	58,805	70,952
Losses due to Backup	49,196	59,035
Losses due to reduced carbon fixing potential	729	729
Losses from soil organic matter	27,680	27,680
Losses due to Dissolved Organic Carbon (DOC) and Particulate Organic Carbon (POC) leaching	7	7
Felling of Forestry	3,078	3,078
Total Expected Losses	139,496	161,482

The worksheet model calculated that the Proposed Development is expected to give rise to 139,107 tonnes of CO_2 equivalent losses at the lower range (5 MW) and 161,093 tonnes of CO_2 equivalent losses at the higher range (6 MW) over its 40 year life. Of this total figure, the proposed wind turbines directly account for 58,805 tonnes, or 42% at the lower range and 70,952 tonnes, or 44% at the higher range. Losses due to backup account for 49,196 tonnes, or 35% at the lower range and 59,035 tonnes or 36% at the higher range.

Losses from soil organic matter, reduced carbon fixing potential, DOC and POC leaching and the felling of forestry accounting for the remaining 20% or 27,680 tonnes at the lower range and 17% or 27,680 tonnes at the higher range. The figure 27,680 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 to choices, the other being Fen. The figure of 27,680 tonnes (lower and higher range of CO_2 arising from ground activities associated with the 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 main difference between a fen and a bog is that fens have greater water exchange and are less acidic, so their soil and water are richer in nutrients. Fens are often found near bogs and over time most fens become bogs. The habitat that will be impacted by the Wind Farm Site footprint comprises predominantly cutover bog and the Hydrogen Plant is 'Grey Brown Podzolics, Brown Earths' and some 'Basin Blanket Peats', with Limestone till subsoil rather than the acid bog assumed by the model 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 Wind Farm Site and habitats are restored on decommissioning of the Development after its expected 40 year useful life (the Hydrogen Plant is excluded from this). As a worst-case scenario, the model was also used to calculate the CO_2 losses from the Proposed Development if the hydrology and habitats of the Wind Farm 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. If repowering is undertaken, it will be offset by the carbon-neutral renewable energy that the new turbines would generate. The model is designed for wind farms, the Hydrogen Plant materials and excavations have been accounted for, however it does not take account of the offset potential of hydrogen.

10.3.4.3 Carbon Savings

The carbon calculator is pre-loaded with information specific to the CO_2 emissions from the United Kingdom's electricity generation plant, which is used to calculate emissions savings from proposed wind farm projects in the UK. Similar data was not available for the Irish electricity generation plant, and so the CO_2 emissions savings from the Proposed Development were calculated separately from the worksheet.

According to the model described above, the Development will give rise to total losses of between 139,496 tonnes (lower range) and 161,482 (higher range) tonnes of carbon dioxide.

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

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

where:

A = The maximum capacity of the wind energy element of the Development in MW

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

C = The number of hours in a year

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

For the purposes of this calculation, the rated capacity of the Wind Farm Site is assumed to be 65 MW at the lower range and 78 MW at the higher range. A load factor of 0.35 (or 35%) has been used for the 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 2021 and was published in October 2022 in an information paper published by the Commission for Regulation of Utilities(CRU) entitled "*Fuel Mix Disclosure and* CO_2 *Emissions, 2021*". The emission factor for electricity in Ireland in 2021 was 258g CO_2/kWh.

The calculations for carbon savings at the lower range is therefore as follows:

$$CO_2 \text{ (in tonnes)} = \frac{(65 \times 0.35 \times 8,760 \times 258)}{1000}$$

= 51,416.85 tonnes per annum

The calculations for carbon savings at the higher range is therefore as follows:

$$CO_2 \text{ (in tonnes)} = \frac{(78 \times 0.35 \times 8,760 \times 258)}{1000}$$

= 61,700.18 tonnes per annum

Based on this calculation, between 51,417 and 61,700 tonnes of carbon dioxide will be displaced per annum by the wind energy element of the Development when the total output of the Wind Farm is going to the electricity grid.

As noted previously areas cleared of forestry for the Wind Farm Site will be replaced by replanting at alternatives sites. A total of 5.83 ha 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 3,078 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.

Over the proposed 40 year lifetime of the wind farm, the Wind Farm, without the Hydrogen Plant could displace between 2,056,672 and 2,468,007 tonnes of carbon dioxide, displaced from traditional carbon-based electricity generation.

In order to quantify the benefits of the Hydrogen Plant and calculate the carbon savings of the hydrogen element, calculations were taken from a study analysing green hydrogen use in the haulage sector in Ireland[25]. The study found that a 42 MW electrolyser could provide hydrogen fuel for 1,000 HGVs enabling these to displace diesel HGVs, avoiding approximately 74,600 tonnes of CO_2 per year. Operating at the maximum capacity of 80 MW the Hydrogen Plant will produce a maximum of 31.2 tonnes of green hydrogen per day. However, based on the available wind data, this value will vary month to month as shown in **Table 10.3,** therefore hydrogen production per year has been more conservatively estimated at 4,547 tonnes (average 12.5 tonnes per day). Using the calculations on abatement in the haulage research paper, this avoids 49,883 tonnes of CO_2 per year by displacing approximately 669 diesel HGVs.

The Hydrogen Plant production capacity will be scaled up to the maximum 80 MW capacity, to meet demand for green hydrogen in the Irish market. The smallest initial batch of electrolyser capacity will be 10 MW and producing approximately 568 tonnes of green hydrogen per year and displacing approximately 84 diesel trucks, avoiding 6,235 tonnes of CO_2 per year. This 10 MW electrolyser at the Hydrogen Plant consumes 10 MW of the electricity produced by the Wind Farm, leaving 55 to 68 MW (based on a turbine range of between 5 and 6 MW) installed capacity of wind energy at the Wind Farm dispatching to the electrical grid. This will be phased up to an 80 MW electrolyser producing a maximum of 4,547 tonnes of hydrogen per year (average 12.5 tonnes per day) of green hydrogen and consuming the whole output of the Wind Farm.

[25] Laguipo, J. Forde, C. and Carton. J. (2022) Enabling the scale up of green hydrogen in Ireland by decarbonising the haulage sector. https://www.sciencedirect.com/science/article/pii/S0360319922026404

The anticipated savings during the period when renewable electricity generated at the Wind Farm is split between the electrical grid and hydrogen production have been modelled and are shown in **Table 10.6** for the lower installed capacity (5 MW per turbine) at the Wind Farm and **Table 10.7** for the higher installed capacity (6 MW per turbine) at the Wind Farm.

Table 10.6: Anticipated CO_2 savings from wind energy displacing fossil fuels in electricity production using the lower range (5 MW) turbines combined with green hydrogen used in the haulage industry to displace diesel HGVs, modelled for the phase up to the maximum electrolyser capacity.

Electrolyser installed capacity (MW)	Annual CO_2 saving from Green Hydrogen displacing Diesel HGVs (tonnes) figures from Ireland Haulage Sector Study[26]	Wind Farm installed Capacity (MW) being exported to grid	Annual CO_2 saving from Wind Farm (tonnes)	Total annual CO_2 displacement (tonnes)
0	0	65	51,417	51,416.82
10	6,235.32	55	43,507	49,741.86
20	12,470.64	45	35,596	48,066.90
30	18,705.95	35	27,686	46,391.93
40	24,941.27	25	19,776	44,716.97
50	31,176.59	15	11,865	43,042.01
60	37,411.91	5	3,955	41,367.05
65	40,529.57	0	0	40,529.57

Table 10.7: Anticipated CO_2 savings from wind energy displacing fossil fuels in electricity production using the higher range (6 MW) turbines combined with green hydrogen used in the haulage industry to displace diesel HGVs, modelled for the phase up to the maximum electrolyser capacity.

Electrolyser installed capacity (MW)	Annual CO_2 saving from Green Hydrogen displacing Diesel HGVs (tonnes) figures from Ireland Haulage Sector Study[27]	Wind Farm installed Capacity (MW) being exported to grid	Annual CO_2 saving from Wind Farm (tonnes)	Total annual CO_2 displacement (tonnes)
0	0	**78**	61,700	61,700
10	6,235.32	**68**	53,790	60,025.32
20	12,470.64	**58**	45,880	58,350.64
30	18,705.95	**48**	37,969	56,674.95
40	24,941.27	**38**	30,059	55,000.27
50	31,176.59	**28**	22,149	53,325.59
60	37,411.91	**18**	14,239	51,650.91
70	43,647.23	**8**	6,328	49,975.23

[26] Laguipo, J. Forde, C. and Carton. J. (2022) Enabling the scale up of green hydrogen in Ireland by decarbonising the haulage sector. https://www.sciencedirect.com/science/article/pii/S0360319922026404
[27] Laguipo, J. Forde, C. and Carton. J. (2022) Enabling the scale up of green hydrogen in Ireland by decarbonising the haulage sector. https://www.sciencedirect.com/science/article/pii/S0360319922026404

Electrolyser installed capacity (MW)	Annual CO_2 saving from Green Hydrogen displacing Diesel HGVs (tonnes) figures from Ireland Haulage Sector Study[27]	Wind Farm installed Capacity (MW) being exported to grid	Annual CO_2 saving from Wind Farm (tonnes)	Total annual CO_2 displacement (tonnes)
80	49,882.54	**0**	0	49,882.54

The rate at which the hydrogen market in Ireland matures is unknown, this could potentially dictate the period over which the Hydrogen Plant is scaled up from 10 MW to 80 MW. Over the 40 year operational life of the Wind Farm, the Hydrogen Plant and Wind Farm combined will displace between 1,621,183 and 2,468,000 tonnes of CO_2, assuming at least 10MW of hydrogen electrolyser capacity is installed. This is influenced by the size of the electrolyser (10 MW to 80 MW) and the selected turbine in the range (5 MW to 6 MW).

The offset of CO_2 of the Proposed Development decreases as capacity is added to the Hydrogen Plant. This is partly because of the current high carbon emissions factor of electricity due to the continued use of fossil fuels in electricity production, namely coal at Moneypoint. As the proportion of renewable energy on the grid in Ireland increases and fossil fuels are phased out, the emissions factor of electricity will reduce. Green hydrogen can be used to replace fossil fuels in hard to abate sectors, such as in the haulage transport and high heat industries. This enables Ireland to reach emissions reduction targets beyond electricity, which is needed to achieve the 2030 and 2050 targets. When displacing diesel vehicles, the green hydrogen also has further benefits of reducing sulphur Oxides (SO_x) and Nitrogen Oxides (NO_x).

Note, these calculations include the following assumptions and explanations; The calculations include using the green hydrogen produced in HGVs in the haulage industry only, i.e. not taking in to consideration that the green hydrogen could be used by multiple industries and sectors. In the lower range of turbine parameters the maximum Wind Farm installed capacity is 65 MW so this is the maximum installed electrolyser.

Based on the Scottish Government carbon calculator as presented above between 139,496 and 161,482 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 6-9% (lower to higher turbine range and electrolyser range) of the total amount of carbon dioxide emissions that will be offset by the Development.

The 139,496 (lower range) and 161,482 (higher range) tonnes of CO_2 that will be lost to the atmosphere due to changes in the peat environment and due to the construction and operation of the Proposed Development will be offset by the Wind Farm and Hydrogen Plant in between approximately 27 and 47 months of operation (or 2 to 4 years). This depends on the selected turbine and the installed capacity of the electrolyser.

10.3.5 DO NOTHING IMPACT

If the Proposed Development was not to proceed, greenhouse gas emissions, e.g., carbon dioxide, carbon monoxide and nitrogen oxides associated with construction and decommissioning works would not arise. However, the greenhouse gas savings that would arise from the operation of the Development would also be lost.

10.3.6 POTENTIAL IMPACTS OF THE DEVELOPMENT

10.3.6.1 Construction Phase

Greenhouse gas emissions, e.g., carbon dioxide (CO_2), carbon monoxide and nitrogen oxides are associated with vehicles and plant utilised for construction activities. The Institute of Air Quality Management document 'Guidance on the Assessment of Dust from Demolition and Construction' (IAQM, 2014)[28] states that site traffic and plant is unlikely to make a significant impact on climate. Based on the scale and temporary nature of the construction phase and the intermittent use of equipment, the potential impact on climate change from the proposed development is deemed to be short-term, negative and imperceptible in relation to Ireland's obligations under the EU 2030 target.

10.3.6.2 Operation Phase

There will be a small number of light vehicles accessing the Wind Farm during the operational phase for maintenance. This could lead to some localised dust being generated though this will be small and sporadic as only approximately one to two site visits per week will occur at the Proposed Development.

During the operational phase, the Hydrogen Plant will be manned and a small number of light vehicles will likely be used by staff to access the facility. Green hydrogen will be transported along the national roads from the Hydrogen Plant Site located near the N59. These vehicles will produce some localised dust being generated during the operational life of the Hydrogen Plant. It is anticipated that tube trailers, powered by zero emissions green hydrogen will be used to transport green hydrogen resulting in zero vehicle emissions however it is recognised that these may not be commercially available at that time, if this is the case then diesel vehicles will be used. These will produce emissions, including green house gases, when considered in the context of the offsetting of emissions due to the

[28]IAQM. (2014) https://iaqm.co.uk/text/guidance/construction-dust-2014.pdf

production of green hydrogen these are not likely to have a significant impact on climate change.

The Proposed Development is a renewable energy project in that it will generate energy from two renewable sources, wind energy and hydrogen. Green hydrogen will be produced at the Hydrogen Plant using electricity produced by the Wind Farm in an electrolyser. This energy generated will be in direct contrast to energy and the associated emission of greenhouse gases from electricity-generating stations dependent on fossil fuels, and from fossil fuel based energy displaced by green hydrogen in the transport, industry and heating sectors.

Currently fossil fuels are used to produce hydrogen in Ireland. Worldwide current production of hydrogen, mainly used in the chemical and petrochemical sectors, is responsible for more than 900 Mt of CO_2 emissions. The only atmospheric emission produced during normal operation of the electrolysis process when using renewable energy, is oxygen, which is not a greenhouse gas and will have no negative climate impacts.

In Ireland, in 2021, the transport sector was the second largest emitter of GHG emissions, producing 10.89 million tonnes of carbon dioxide equivalent (Mt CO_2eq), 17.7% of overall GHGs[29]. The SEIA's Energy in Ireland 2022[30] report noted that, though Ireland has committed to reducing its CO_2 emissions by 4.8% per annum from 2021- 2025 under the first carbon budget, energy related emissions were instead up by 5.4% in 2021. This is largely attributed to the rebound in transport emissions post Covid-19 restrictions; energy demand for transport rose by 7.1% from its significant suppression in 2020. The transport sector emitted 12.0 MtCO_2 in 2021 and accounted for 34% of Ireland's total energy emissions with 95.5% of transport energy demand coming from fossil fuels.

There are approximately 2,215,127 Heavy-goods vehicles (HGVs) in Ireland[31], almost all diesel fuelled, these produce around 20% of road transport emissions[32]. The haulage industry is considered a hard to decarbonise industry, hydrogen fuel cell electric vehicles offer a solution. Switching to 10 hydrogen heavy duty vehicles is equivalent to decarbonising

[29] EPA. (2022). Latest Emissions Data https://www.epa.ie/our-services/monitoring--assessment/climate-change/ghg/latest-emissions-data/ Accessed 03/03/23
[30] SEAI. (2022). Energy in Ireland. https://www.seai.ie/publications/Energy-in-Ireland-2022.pdf
[31] ACEA. (2022). Report – Vehicles in use, Europe 2022. https://www.acea.auto/files/ACEA-report-vehicles-in-use-europe-2022.pdf
[32] EPA. (2020). Final GHG emissions report. https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/Irelands-Final-Greenhouse-Gas-Emissions-report-1990-2020_finalv1.1.pdf

approximately 400 passenger cars[33], therefore introducing even a small number of zero emission heavy duty vehicles has a large effect on overall transport emissions.

Ireland's renewable energy in transport target (RES-T) under REDII is 14% by 2030, the renewable energy share in 2021 was 4.3%. This indicates that there is a strong justification for the decarbonisation of the transportation sector, which could be assisted by the Proposed Development with the production of green hydrogen.

Operating at the maximum capacity of 80 MW the Hydrogen Plant will produce a maximum of 31,200 kg of green hydrogen per day. However, based on the available wind data, this value will vary month to month as shown in **Table 10.3**, therefore hydrogen production per year has been more conservatively estimated at 4,547 tonnes (average 12.5 tonnes per day). Using the calculations on abatement in the haulage research paper, this avoids 49,883 tonnes of CO_2 per year by displacing approximately 669 diesel HGVs.

The emissions limit for Diesel HGVs in Europe is 0.46 NO_x g per km and 0.01 PM g per km[34]. Driving 100,000 km per year, this totals 46 kg NO_x per year and 1 kg of PM per year per HGV. By replacing 669 diesel HGVs with green hydrogen, the 80 MW electrolyser gives a saving of 30,774 kg of NO_x and 669 kg of PM per year.

The Hydrogen Plant production capacity will be scaled up from a minimum of 10 MW, producing approximately 568 tonnes of green hydrogen per year and displacing approximately 84 diesel trucks, avoiding 6,235 tonnes of CO_2, 3,864 kg of NO_x and 84 kg of PM per year.

When combined with the renewable electricity from the Wind Farm, the Proposed Development, at the lower turbine range (5 MW), will avoid between 40,530 and 49,742 tonnes of CO_2 per year. At the higher turbine range (6 MW) this is between 49,883 and 60,025 tonnes of CO_2 per year. Both turbine ranges assume a minimum 10 MW and maximum 80MW of installed electrolyser capacity.

This assists Ireland in achieving the Climate Action and Low Carbon Development (Amendment) Act 2021 the legally binding target of net-zero emissions no later than 2050, and a cut of 51% by 2030 (compared to 2018 levels). It contributes to the Climate Action

[33] Lao, J., Song, H., Wang. C., Zhou, Y. and Wang, J. (2021). (2022). Reducing atmospheric pollutant and greenhouse gas emissions of heavy duty trucks by substituting diesel with hydrogen in Beijing-Tianjin-Hebei-Shandong region, China. https://www.sciencedirect.com/science/article/abs/pii/S0360319920335722
[34] ICCT. (2016) https://theicct.org/sites/default/files/publications/ICCT_Euro6-VI_briefing_jun2016.pdf

Plan 2023's 80% renewable electricity target by 2030, it's target of having green hydrogen in production by 2030 and it's zero emissions gas targets. It also helps towards the European Hydrogen Strategy's target of achieving 40 GW of renewable hydrogen electrolysers by 2030 with production of up to 10 million tonnes of renewable hydrogen. As more renewable energy is added to the national grid, the carbon factor of electricity will reduce in the future. However, heavy goods transport is a hard to abate sector. By producing green hydrogen, the Proposed Development provides a renewable fuel to assist this sector in making cuts to emissions.

10.3.6.3 Decommissioning Phase

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

10.3.7 MITIGATION MEASURES

10.3.7.1 Construction Phase

The main potential impact during the construction phase of the Development will be from emissions from construction vehicles. All construction vehicles and plant will be maintained in good operational order while on-site, thereby minimising any emissions that arise.

10.3.7.2 Operation Phase

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

10.3.7.3 Decommissioning Phase

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

10.3.8 Cumulative Effects

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

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

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

The use of renewable energy displaces the use of fossil fuels thereby avoiding CO_2 emissions and reducing the amount of imported fossil fuels. According to the SEIA's Energy in Ireland 2022[35] report, 180 MW of wind energy capacity was added to the Irish electrical grid in 2020. Renewable energy in 2021 provided 36.4% of electricity. Wind accounted for 84% of renewable electricity generated in 2021. The estimated amount of CO_2 avoided through the use of renewable energy was 6.2 Mt CO_2 in 2021, with 4.0 Mt CO_2 avoided by wind energy.

The EU Hydrogen Strategy includes an ambitious plan to achieve 6 GW of renewable hydrogen electrolysers by 2024, and 40 GW by 2030 with production of up to 10 million tonnes of renewable hydrogen. From 2030 onwards, it sets out that renewable hydrogen will be deployed at a large scale across all hard-to-decarbonise sectors.

The strategy states:

"Hydrogen can be used as a feedstock, a fuel or an energy carrier and storage, and has many possible applications across industry, transport, power and buildings sectors. Most importantly, it does not emit CO_2 and almost no air pollution when used. It thus offers a solution to decarbonise industrial processes and economic sectors where reducing carbon emissions is both urgent and hard to achieve. All this makes hydrogen essential to support the EU's commitment to reach carbon neutrality by 2050 and for the global effort to implement the Paris Agreement while working towards zero pollution."

In the European Commission's strategic vision for a climate-neutral EU (2018)[36], the share of hydrogen in Europe's energy mix is projected to grow from the current less than 2%, to 13-14% by 2050.

[35] SEAI. (2022). Energy in Ireland. https://www.seai.ie/publications/Energy-in-Ireland-2022.pdf

[36] European Commission. (2018). A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0773 Accessed 03/07/2023

In the European Parliament EU Hydrogen Policy report[37], hydrogen is stated to be: *"Expected to play a key role in a future climate-neutral economy, enabling emission-free transport, heating and industrial processes as well as inter-seasonal energy storage."*

When produced with renewable energy, hydrogen is identified as being an emissions free energy carrier.

The cumulative effect with other Irish and European renewable energy generation is considered to be a fundamental change in the climate effects of Ireland and the EU's energy supply, which is a long term significant, positive effect on Climate Change, that is significant under the EIA Regulations.

10.3.9 RESIDUAL IMPACTS OF THE DEVELOPMENT

10.3.9.1 Construction Phase

There will be a short-term imperceptible negative impact on climate change as a result of greenhouse gas emissions from manufacturing of equipment and infrastructure for the Wind Farm and the Hydrogen Plant and transportation of same to each of the sites.

10.3.9.2 Operational Phase

It is considered that the Proposed Development will have an overall positive impact in terms of emissions reductions and climate change. It will assist Ireland in meeting the binding renewable energy target for the EU of 32% by 2030 and assist in meeting Ireland's renewable energy in transport target (RES-T) of 14% by 2030, which needs to increase from 4.3% in 2021.

Also, it will aid in increasing the onshore wind capacity, as per the Climate Action Plan 2023 and contribute to the EU Hydrogen Strategy's target to achieve 40 GW of renewable hydrogen electrolysers by 2030.

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

[37] European Parliament. (2021). EU hydrogen policy Hydrogen as an energy carrier for a climate-neutral economy. https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/689332/EPRS_BRI(2021)689332_EN.pdf Accessed 02/12/2022

10.3.9.3 Decommissioning Phase

Any impacts and consequential effects that occur during the decommissioning phase are similar to that which occur during the construction phase, albeit of less impact.

10.3.10 SUMMARY OF SIGNIFICANT EFFECTS

This assessment has identified no potential negative significant effects on climate, given the mitigation measures embedded in the design and recommended for the implementation of the Proposed Development.

10.3.11 STATEMENT OF SIGNIFICANCE

The Proposed Development has been assessed as having the potential to result in a short-term imperceptible, negative impact on climate during construction. There will be long-term moderate positive indirect impact on climate as a result of reduced greenhouse gas emissions in the electricity generation, transport and industry sectors during the operational phase.

Potential cumulative impact of the Proposed Development and other renewable energy developments on climate was assessed as having a long-term, significant, positive indirect impact on the climate.