5. POPULATION AND HUMAN HEALTH

5.1 Introduction

This section of the Environmental Impact Assessment Report (EIAR) identifies, describes and assesses the potential effects of the Proposed Project on population and human health and has been completed in accordance with the EIA guidance and legislation set out in Chapter 1: Introduction. The full description of the Proposed Project is provided in Chapter 4 of this EIAR.

As detailed in Section 1.1.1 in Chapter 1, for the purposes of this EIAR, the various project components are described and assessed using the following references: 'Proposed Project', 'Proposed Wind Farm ', 'Proposed Grid Connection' and the 'Site'.

One of the principal concerns on the development process is that human beings, as individuals or communities, should experience no significant diminution of their quality of life from the direct, indirect or cumulative effects arising from the construction, operation and decommissioning of a development. Ultimately, all the effects of a development impinge on human beings, directly and indirectly, positively and negatively. The key issues examined in this chapter of the EIAR include population, human health, employment and economic activity, land use, residential amenity (including visual amenity, shadow flicker and noise), community facilities and services, tourism, property values, traffic and health and safety.

5.1.1 Statement of Authority

This section of the EIAR has been prepared by Niamh McHugh and Keelin Bourke, and reviewed by Órla Murphy and Sean Creedon, all of MKO. Niamh is an Environmental Scientist who has been working with MKO since June 2021. Niamh possesses a BSc (Hons) in Environmental Science from the National University of Ireland, Galway. Niamh has been involved in the compilation and production of a number of EIARs, mainly in the field of Renewables. Keelin is a Graduate Environmental Scientist with MKO having joined the company in September 2023. Keelin holds a BSc (Hons) in Environmental Science from University College Cork and an MSc (Dist) in Environmental Engineering from Trinity College Dublin. Prior to taking up her position with MKO, Keelin worked as an Environmental Health and Safey Officer in an EPA licensed Waste Transfer Station in Cork City. Keelin's current key strengths and areas of expertise are in environmental surveying, report writing and environmental mapping. Since joining MKO, Keelin has become a member of the MKO Environmental Renewables Team which work on produce high quality Environmental Impact Assessment Reports for a variety of Renewable Energy clients. The chapter has been reviewed by Órla Murphy and Sean Creedon of MKO. Órla is a Senior Environmental Scientist with over 8 years' experience in the environmental sector where she has acted as Project Manager for a number of EIAR applications for wind energy developments, compiling numerous EIAR chapters including chapters on Population and Human Health. Órla holds a BSc. in Geography and MSc. in Environmental Protection and Management. Sean is an Associate Director in the Environment Team and has over 22 years' experience in program and project development, holds an MSc from NUI Galway and a Diploma in Project Management from Institute of Project Management Ireland. He oversees a team of highly skilled environmental professionals working on EIAR for large-and medium scale Renewable Energy infrastructure. Sean has directed and overseen multiple renewable energy projects across wind, solar, battery and hydrogen as well as a range of thermal and other energy related developments. He has worked on the planning and environmental impact elements within all stages of wind farm project delivery.

5.2 Assessment Methodology

5.2.1 Population

A desk-based assessment using sources and guidelines referenced in 5.2.2 below was undertaken to examine relevant information pertaining to the population impact assessment. Information on population statistics, employment and social data for the relevant District Electoral Divisions (DEDs) were obtained from the Central Statistics Office (CSO) for census years 2016 and 2022. Fáilte Ireland's EIAR Guidelines for the Consideration of Tourism and Tourism Related Projects was also considered in this assessment. See section 5.3 below.

The Population Study Area for this assessment mainly focuses on the (DEDs within which the Proposed Wind Farm site is within and adjacent to, namely Annaghdown, Killower, Cummer, and Claretuam, but it also refers to county and national statistics.

5.2.2 Human Health

This human health analysis section was assessed using guidelines set out in section 5.1.2 above.

The World Health Organisation's (WHO) defines health as:

> "*A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*".[4]

5.2.2.1 National Guidance

The EPA 2022 EIAR Guidelines advise that "*in an EIAR, the assessment of impacts on population and human health should refer to the assessments of those factors under which human health effects might occur, as addressed elsewhere in this EIAR e.g., under the environmental factors of air, water, soil etc.*" Environmental Impacts from the Proposed Project which may also have an impact on population and human health are discussed in this chapter but addressed in more detail in the following chapters: Chapter 8 Land Soil and Geology, Chapter 9 Hydrology and Hydrogeology, Chapter 10 Air Quality, Chapter 11 Climate, Chapter 12 Noise and Vibration, Chapter 14 Landscape and Visual, Chapter 15 Material Assets (including Traffic and Transport).

As referenced in the Department of Housing, Planning and Local Government (2018) *Guidelines for Planning Authorities and An Bord Pleanála*, (taken from the European Commission's Environmental Impact Assessment of Projects: Guidance on the Preparation of the Environmental Impact Assessment Report (2017)), human health is, "*a very broad factor that would be highly project dependent.*" The report continues:

> '* *The notion of human health should be considered in the context of the other factors in Article 3(1) of the EIA Directive and thus environmentally related health issues (such as health effects caused by the release of toxic substances to the environment, health risks arising from major hazards associated with the Project, effects caused by changes in disease vectors caused by the Project, changes in living conditions, effects on vulnerable groups, exposure to traffic noise or air pollutants) are obvious aspects to study. In addition, these would concern the commissioning, operation, and decommissioning of a Project in relation to workers on the Project and surrounding population.*'

The EIAR Guidance (EPA, 2022) also states that "*while no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU, the same term was used in 3.3.6 the SEA Directive (2001/42/EC). The Commission's SEA Implementation Guidance states 'The notion of human health should be considered in the context of the other issues mentioned in paragraph* *(f)*" of the Directive, where paragraph f lists environmental factors such as soils, water, landscape, air etc. The Guidelines state that this approach is '*consistent with the approach set out in the 2002 EPA Guidelines where health was considered through assessment of the environmental pathways through which it could be affected, such as air, water or soil*'. The EIAR Guidelines (EPA, 2022)note that the above approach follows the 2002 EPA guidelines already in place which details the following:

> *'The evaluation of effects on these pathways is carried out by reference to accepted standards (usually international) of safety in dose, exposure or risk. These standards are in turn based upon medical and scientific investigation of the direct effects on health of the individual substance, effect or risk. This practice of reliance upon limits, doses and thresholds for environmental pathways, such as air, water or soil, provides robust and reliable health protectors [protection criteria] for analysis relating to the environment'.*

5.2.2.2 IEMA Guidance 2017

The Institute for Environmental Management and Assessment (IEMA) published 'Health In Environmental Impact Assessment: A Primer for a Proportionate Assessment' in 2017 examining what a proportionate assessment of the impacts on health should be in Environmental Impact Assessments. The document states that Health Impact Assessment (HIA) and EIA are separate processes.

> *'HIA is defined as a combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, plan, programme or project on both the health of a population and the distribution of those effects within the population. HIA identifies appropriate actions to manage those effects… […] … HIA can inform EIA practice in relation to population and human health but conducting a HIA will not necessarily meet the EIA population and human health requirement. By the same token, conducting an EIA will not automatically meet the requirements of a HIA.'*

The Primer Assessment Report acknowledges that *'disproportionate burdens maybe placed on developers if HIA is applied as a proxy for the consideration of population and human health in every future UK EIA'.* The focus of EIA should be on predicting health and wellbeing outcomes, rather than focusing on changes in determinants of health e.g., expected changes in noise levels. Determining the significance of impacts on population and human health should include a professional judgement, scientific literature; consultation responses; comparison with baseline conditions; local health priorities; and national/international regulatory standards and guidelines. The primer report refers to the WHO 2014 which provides and overview of health in different types of assessment:

> *"The health sector, by crafting and promoting HIA, can be regarded as contributing to fragmentation among impact assessments. Health issues can, and need to, be included [in impact assessment] irrespective of levels of integration. At the same time, from a civic society perspective, it would be unacceptable for HIA to weaken other impact assessments. A prudent attitude suggests optimizing the coverage of health along all three avenues:*
>
> - *better consideration of health in existing impact assessments other than HIA;*
> - *dedicated HIA;*
> - *and integrated forms of impact assessment."*

As such, the WHO does not support a stand-alone HIA unless it could be demonstrated to be of advantage over an EIAR. Therefore, given that this human health assessment is part of the EIAR; there is no stand-alone HIA.

5.2.2.3 EIA Significance Matrix for Human Health, IEMA Guidance 2022

The IEMA Working Group 2022 published *Determining Significance For Human Health In Environmental Impact Assessment* in response to gaps and inconsistencies across existing guidance documents as to how health is assessed in EIA, particularly with regard to significance. The aim of this report is to assist and streamline discussions for consultants producing the assessments and for the decision makers who are reviewing the assessments. The report states that an EIA must identify, describe and assess the direct and indirect significant effects in an appropriate manner of a proposed development on human health. It must include the information that may reasonably be required for reaching a reasoned conclusion on the significant effects, taking into account current knowledge and methods of assessment.

5.2.3 Shadow Flicker

5.2.3.1 Background

Shadow flicker is an effect that occurs when rotating wind turbine blades cast shadows over a window in a nearby property. Shadow flicker is an indoor phenomenon, which may be experienced by an occupant sitting in an enclosed room when sunlight reaching the window is momentarily interrupted by a shadow of a wind turbine's blade. Outside in the open, light reaches a viewer (person) from a much less focused source than it would through a window of an enclosed room, and therefore shadow flicker assessments are typically undertaken for the nearby adjacent properties around a proposed wind farm site.

The frequency of occurrence and the strength of any potential shadow flicker effect depends on several factors, each of which is outlined below.

1. ***Whether the sunlight is direct and unobstructed or diffused by clouds:***

If the sun is not shining, shadow flicker cannot occur. Reduced visibility conditions such as clouds, haze, and fog greatly reduce the chance of shadow flicker occurring.

Cloud amounts are reported as the number of eights (okta) of the sky covered. Irish skies are completely covered by cloud (8 oktas) for over 50% of the time. The mean cloud amount for each hour is between five and six okta. This is due to Ireland's geographical position off the northwest of Europe, close to the path of Atlantic low-pressure systems which tend to keep the country in humid, cloudy airflows for much of the time. A study at 12 stations over a 25-year period showed that the mean cloud amount was at a minimum in April and maximum in July. Cloud amounts were less at night than during the day, with the mean minimum occurring roughly between 2100 and 0100 GMT and the mean maximum occurring between 1000 and 1500 GMT at most stations. (*Source: Met Éireann, www.met.ie*)

2. ***The presence of intervening obstructions between the turbine and the observer:***

For shadow flicker to occur, the windows of a potentially affected property must have direct visibility of a wind turbine, with no physical obstructions such as buildings, trees and hedgerows, hills or other structures located on the intervening land between the window and the turbine.

Any obstacles such as trees or buildings located between a property and the wind turbine will reduce or eliminate the occurrence and/or intensity of the shadow flicker.

3. ***How high the sun is in the sky at a given time:***

At distances of greater than approximately 500m between a turbine and a receptor, shadow flicker generally occurs only at sunrise or sunset when the shadow cast by the turbine is longer. The Guidelines (2006)iterates that at distances greater than ten rotor diameters from a turbine, the potential for shadow flicker is very low.

Figure 5-1 illustrates the shadow cast by a turbine at various times during the day; the red shading represents the area where shadow flicker may occur. When the sun is high in the sky, the length of the shadow cast by the turbine is significantly shorter.

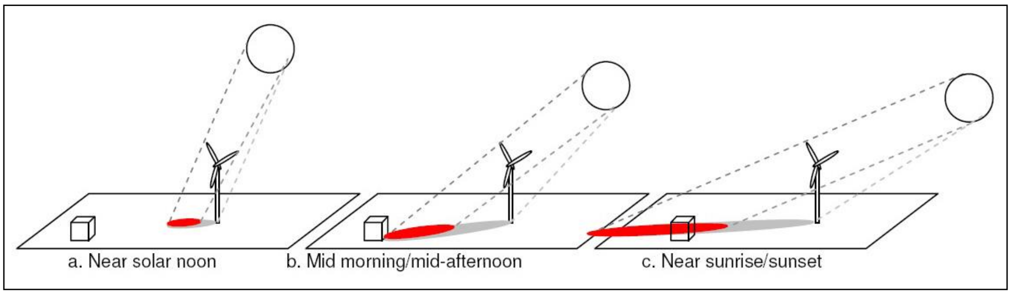


Figure 5-1 Shadow-Prone Area as Function of Time of Day (Source: Shadow Flicker Report, Helimax Energy, Dec 2008)

4. *Distance and bearing, i.e. where the property is located relative to a turbine and the sun:*

The further a property is from the turbine the less pronounced the effect will be. There are several reasons for this: there are fewer times when the sun is low enough to cast a long shadow; when the sun is low it is more likely to be obscured by either cloud on the horizon or intervening buildings and vegetation; and, the centre of the rotor's shadow passes more quickly over the land reducing the duration of the effect.

At a distance, the turbine blades do not cover the sun but only partly mask it, substantially weakening the shadow. This impact occurs first with the shadow from the blade tip, the tips being thinner in section than the rest of the blade. The shadows from the tips extend the furthest and so only a very weak impact is observed at distance from the turbines. (Source: Update of Shadow Flicker Evidence Base, UK Department of Energy and Climate Change, 2010).

5. *Property usage and occupancy:*

Where shadow flicker is predicted to occur at a specific location, this does not imply that it will be witnessed. Potential occupants of a property may be sleeping or occupying a room on another side of the property that is not subject to shadow flicker, or completely absent from the location during the time of shadow flicker events. As shadow flicker usually occurs only when the sun is at a low angle in the sky, i.e. very early in the morning after sunrise or late in the evening before sunset, even if there is a bedroom on the side of the property affected, the shadow flicker may not be witnessed if curtains or blinds in the bedroom are closed. It should be noted, that the below assessment considers a worst-case assessment as detailed in Section 5.7.4.3 below.

6. *Wind direction, i.e. position of the turbine blades:*

The direction of wind turbine blades changes according to wind direction, as the turbine rotor turns to face the wind. In order to cast a shadow, the turbine blades must be facing directly toward or away from the sun, so they are moving across the source of the light relative to the observer. This is demonstrated in Figure 5-2 below.

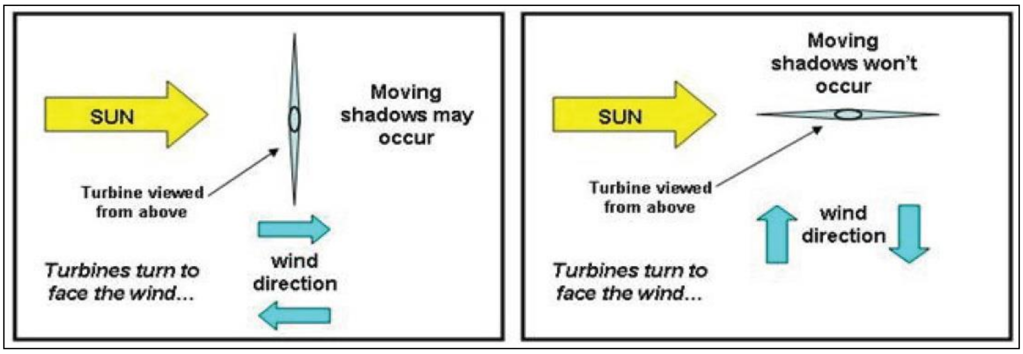


Figure 5-2 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environment Power LLC)

7. ***Rotation of turbine blades:***

Shadow flicker occurs only if there is sufficient wind for the turbine blades to be continually rotating. Wind turbines begin operating at a specific wind speed referred to as the 'cut-in speed', i.e. the speed at which the turbine produces a net power output, and they cease operating at a specific 'cut-out speed'. Therefore, even during the sunlight hours when shadow flicker has been predicted to occur, if the turbine blades are not turning due to insufficient wind speed, then no shadow flicker will occur.

5.2.3.2 Guidance

The current guidance for shadow flicker in Ireland is derived from the '*Wind Energy Development Guidelines for Planning Authorities 2006*' (DoEHLG), and the '*Best Practice Guidelines for the Irish Wind Energy Industry*' (Irish Wind Energy Association, 2012).

The Guidelines set out a threshold of 30 hours per year or 30 minutes per day of shadow flicker at dwellings within 500 metres of a proposed turbine location. As detailed in the Guidelines, there is a low probability of any shadow flicker effects occurring beyond 10 rotor diameters. Therefore, a study area of 10 rotor diameters was selected based on the low probability of effects beyond 10 rotor diameters as outlined in the Guidelines. In this case, the maximum potential rotor diameter proposed for this project is 163m. As such, the shadow flicker study area in this case is 1.63km. A significant minimum separation distance of 768m from third-party dwellings has been achieved with the project design. There are 243 no. properties located within 1.63km (i.e., the shadow flicker study area of ten times the maximum rotor diameter, 10 x 163m = 1.63km as per the 2006 DoEHLG guidelines) of the proposed turbines, of which 242 are inhabited dwellings, 1 is an uninhabited derelict building.

The Guidelines state that the shadow flicker lasts for only a short period of time and occurs only during certain specific combined circumstances, as follows:

- the sun is shining and is at a low angle in the sky, i.e. just after dawn and before sunset, **and**
- the turbine is located directly between the sun and the affected property, **and**
- there is enough wind energy to ensure that the turbine blades are moving, **and**
- the turbine blades are positioned so as to cast a shadow on the receptor.

The Guidelines are currently under review. The DoEHLG released the '*Draft Revised Wind Energy Development Guidelines*' in December 2019 (draft Guidelines) which was released for public consultation. The draft Guidelines recommend local planning authorities and/or An Bord Pleanála impose conditions to ensure that:

> *"no existing dwelling or other affected property will experience shadow flicker as a result of the wind energy development subject of the planning application and the wind energy development shall be installed and operated in accordance with the shadow flicker study*

> *submitted to accompany the planning application, including any mitigation measures required."*

The draft Guidelines are based on the recommendations set out in the '*Proposed Revisions to Wind Energy Development Guidelines 2006 – Targeted Review'* (December 2013) and the '*Review of the Wind Energy Development Guidelines 2006 – Preferred Draft Approach'* (June 2017). The assessment herein is based on compliance with the Guidelines to ensure that no existing dwelling or other affected property will experience more than 30 minutes per day or 30 hours per year of shadow flicker as a result of the wind energy development. In the event that the draft Guidelines are adopted, lower thresholds of shadow flicker will be adhered to on the site in accordance with any limits set out in that guidance.

5.2.3.3 Shadow Flicker Prediction Methodology

Shadow flicker occurs only under certain, combined circumstances, as detailed above. Where shadow flicker does occur, it is generally short-lived. The Guidelines state that careful site selection, design and planning, and good use of relevant software can help avoid the possibility of shadow flicker, all of which have been employed at the site of the Proposed Project. Proper siting of wind turbines is key in eliminating shadow flicker.

The occurrence of shadow flicker can be precisely predicted using specialist computer software programmes specifically developed for the wind energy industry, such as WindFarm (ReSoft) or WindFarmer (DNV.GL) or AWS OpenWind. The computer modelling of the occurrence and magnitude of shadow flicker is made possible by the fact that the sun rises and sets in the same position in the sky on every day each year.

Any potential effect can be precisely modelled to give the start and end time (accurate to the second) of any incidence of shadow flicker, at any location, on any day or all days of the year when it might occur. Where a shadow flicker impact is predicted to occur, the total maximum daily and annual durations can be predicted, along with the total number of days. Any incidence of predicted shadow flicker can be attributed to a particular turbine or group of turbines to allow effective mitigation strategies to be planned and proposed as detailed further below.

For the purposes of this shadow flicker assessment, the software package WindFarm Version 5.0.2.2 has been used to predict the level of shadow flicker associated with the Proposed Project. WindFarm is a commercially available software tool that enables developers to analyse, design and optimise proposed wind farms. It allows proposed turbine layouts to be optimised for maximum energy yield whilst taking account of environmental, planning and engineering constraints.

5.2.3.4 Turbine Dimensions

Planning permissions is being sought for a turbine of the following dimensions:

- Tip Height: 185 metres
- Hub Height: 103.5 metres
- Rotor Diameter: 163 metres

With the benefit of the mitigation measures outlined in Section 5.10.3.2.7, all turbines installed onsite will comply with the Guidelines, to ensure there is no shadow flicker occurrences in excess of 30 minutes per day or 30 hours per year at any property within the 1.63km shadow flicker study area as a result of the Proposed Wind Farm. This will be achieved through the use of turbine control software throughout the entire operational period of the Proposed Wind Farm. Any references to the turbine dimensions in this shadow flicker assessment should be considered in the context of the above.

5.2.3.5 Shadow Flicker Study Area

At the outset of the Proposed Project, during the constraints mapping process detailed in Chapter 3 of this EIAR, all sensitive receptors within c.3km of the area suitable for siting wind turbines within the EIAR Site Boundary were identified and mapped. This included all occupied and unoccupied dwellings. In addition, a planning history search to identify properties that may have been granted planning permission, but not yet been constructed, was carried out. Any property with a valid planning permission for a dwelling house was also added to the sensitive receptors' dataset.

The study area for the shadow flicker assessment is 10 times rotor diameter from each turbine as detailed in Section 5.2.3.2 above. The Guidelines note that, at distances greater than 10 times the rotor diameter of a proposed turbine, the potential for shadow flicker is very low, and therefore the shadow flicker study area is set at 1.63km from the proposed turbines. All inhabitable dwellings within 1.63km of the proposed turbines has been considered as part of the following shadow flicker assessment. A significant minimum separation distance of above 768m from any third-party dwelling has been achieved with the Proposed Project design, thus exceeding the necessary setback distance. There are 243 no. properties located within the shadow flicker study area as detailed above, of which 23 no. properties are involved and one is a derelict property. The shadow flicker study area and sensitive receptor locations are shown in Figure 5-6.

It is important to note that shadow flicker effects occur only in certain weather conditions, when a turbine is located between the sun and the sensitive receptor location. Because of this, there will be many sensitive receptors located to the south of the turbines that will not experience any shadow flicker effects.

5.2.3.6 Assumptions and Limitations

Due to the latitude of Ireland and the UK, shadow flicker effects are only possible at properties 130 degrees either side to the north as turbines do not cast shadows on their southern side (ODPM Annual Report and Accounts 2004: Housing, Planning, Local Government and the Regions Committee; Planning Policy Statement 22; the Guidelines). As such properties located outside of this potential shadow flicker zone will not be impacted. However, in this assessment, all 236 no. properties within 360 degrees of the Proposed Project within the Shadow Flicker Study Area were assessed for shadow flicker impact.

At each property, shadow flicker calculations were carried out based on 4 no. notional windows facing north, east, south and west, labelled Windows 1, 2, 3 and 4 respectively. The degrees from north value for each window is:

- Window 1: 0 degrees from North
- Window 2: 90 degrees from North
- Window 3: 180 degrees from North
- Window 4: 270 degrees from North

Each window measures one-metre-high by one-metre-wide, and tilt angle is assumed to be zero. The centre height of each window is assumed to be two metres above ground level and no screening due to trees or other buildings or vegetation is assumed. It was not considered necessary or practical to measure the dimensions of every window on every property in the Shadow Flicker Study Area . While the actual size of a window will marginally influence the incidence and duration of any potential shadow flicker impact, with larger windows resulting in slightly longer shadow flicker durations, any incidences or durations or shadow flicker can be countered by the measures outlined in Section 5.9.3.4 below.

The use of computer models to predict the amount of shadow flicker that will occur is known to produce an over-estimate of possible impact, referred to as the *'worst-case impact'*, due to the following limitations:

- The sun is assumed to be shining during all daylight hours such that a noticeable shadow is cast. This will not occur in reality.
- The wind is always assumed to be within the operating range of the turbines such that the turbine rotor is turning at all times, thus enabling a periodic shadow flicker. Wind turbines only begin operating at a specific 'cut-in speed', and cease operating at a specific 'cut-out speed'. In periods where the wind is blowing at medium to high speeds, the probability of there being clear or partially clear skies where the sun is shining and could cast a shadow, is low.
- The wind turbines are assumed to be available to operate, i.e. turned on at all times. In reality, turbines may be switched off during maintenance or for other technical or environmental reasons.
- The turbine rotor is considered (as a sphere) to present its maximum aspect to observers in all directions. In reality, the wind direction and relative position of the turbine rotor would result in a changing aspect being presented by the turbine. The rotor will actually present as ellipses of varying sizes to observers from different directions. The time taken for the sun to pass across the sky behind a highly elliptical rotor aspect will be shorter than the modelled maximum aspect.

The total annual shadow flicker calculated for each property assumes 100% sunshine during daytime hours, as referred to above. However, weather data for this region shows that the sun shines on average for 26.46% of the daylight hours per year. This percentage is based on Met Éireann data recorded at Birr weather station over the 30-year period from 1979-2008 (www.met.ie). The Met Éireann weather station at Birr, Co. Offaly, which is located approximately 115 kilometres to the southeast of the Site, is the nearest weather and climate monitoring station to the Proposed Project site that has meteorological data recorded for the 30-year period from 1979-2008. The Met Éireann weather station in Claremorris is located closer to the Proposed Project, however this weather station only has data for the 30-year average period from 1971-2000, which has been deemed an inappropriate timescale to determine weather in the existing environment. The actual sunshine hours at the Proposed Project site and therefore the percentage of time shadow flicker could actually occur is 26.46% of daylight hours. Where the annual shadow flicker is calculated for each property, it is corrected for the regional average of 26.46% sunshine, to give an accurate annual average shadow flicker prediction.

Tables 5-8, 5-9 and 5-10 below outlines whether a shadow flicker mitigation strategy is required for any property within the Shadow Flicker Study Area which may be impacted by shadow flicker.

5.3 Population

5.3.1 Receiving Environment

The socio-economic study of the receiving environment included an examination of the population and employment characteristics of the area. The relevant methodology pertaining to the population and human health assessment relates to the assessment of desk-based data sourced from the following locations. Information regarding population and general socio-economic data were sourced from the Central Statistics Office (CSO), the Galway County Development Plan 2022-2028, Fáilte Ireland and any other literature pertinent to the area. The study included an examination of the population and employment characteristics of the area. This information was sourced from the Census of Ireland 2022, which is the most recent census for which a complete dataset is available, also the Census of Ireland 2016, the Census of Agriculture 2010 and from the CSO website (www.cso.ie). Census information is divided into State, Provincial, County, Major Town, District Electoral Division (DED) level.

The Proposed Project is located 9km southwest of Tuam and 10km north of Claregalway, adjacent to the N83 National Road in Co. Galway, as shown in Figure 4-1 of this EIAR.

Current land-use on the Proposed Wind Farm comprises small scale agriculture. Current land-use along the Proposed Grid Connection underground cabling route comprises public road corridor. Land-use in the wider landscape of the Site comprises a mix of agriculture, quarries, residential and one-off housing.

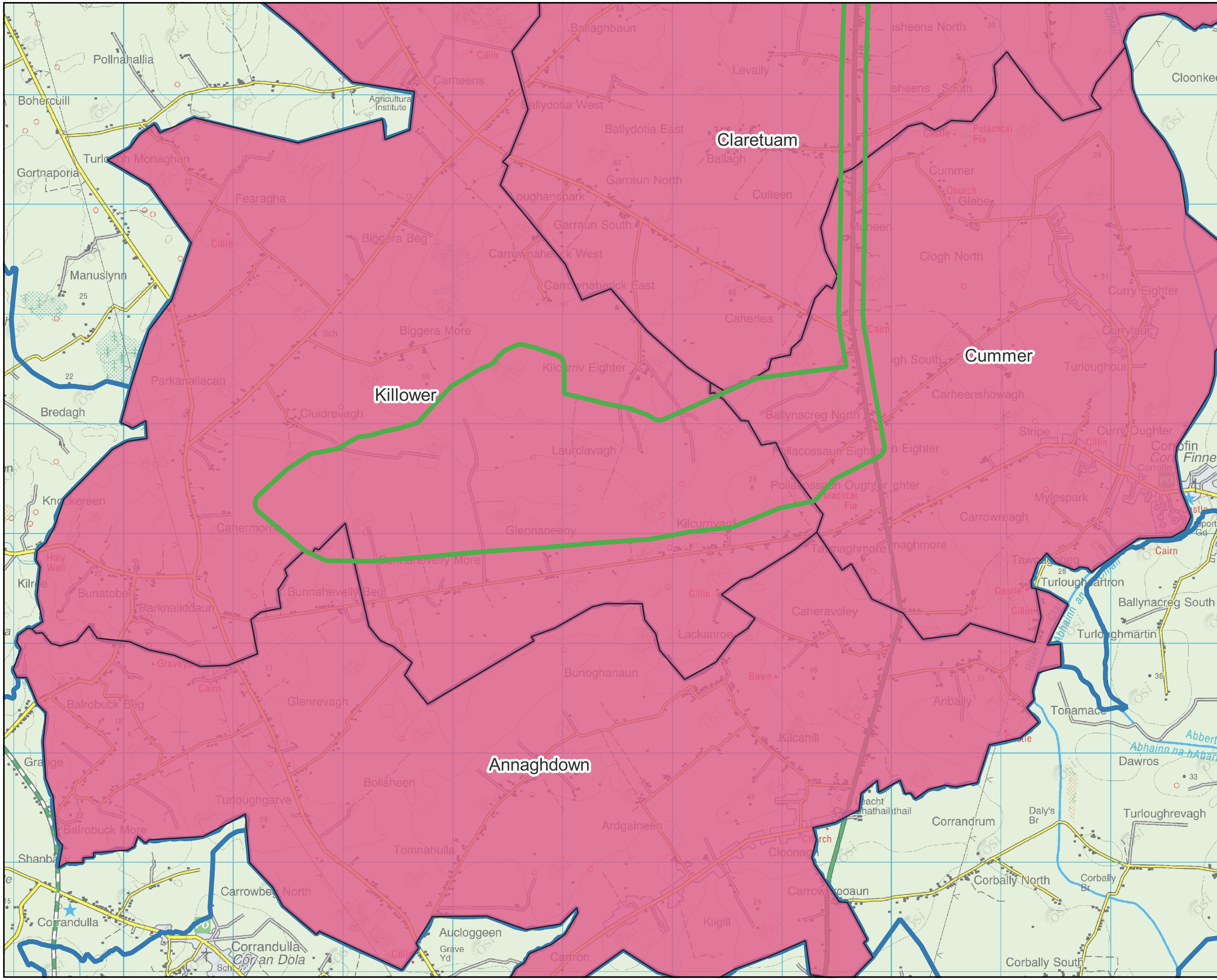
In order to assess the population in the vicinity of the Proposed Wind Farm, the Population Study Area for the Population section of this EIAR was defined in terms of the District Electoral Divisions (DEDs) where the Proposed Wind Farm is located, and where the relevant, nearby DEDs which may be affected by the Proposed Wind Farm. The Proposed Wind Farm is located within 4 no. DEDs, Annaghdown, Killower, Cummer, and Claretuam, as seen in Figure 5-3. All 4 no of these DEDs will collectively be referred to hereafter as the Population Study Area for this chapter. The DEDs which fall within the area of the turbine delivery route have not been considered in this assessment as there are only minor works being proposed in Galway City to facilitate the delivery route. It was also decided to omit DEDs from this study which only supported Proposed Grid Connection infrastructure and did not border the Proposed Wind Farm, as due to the short term and temporary nature of the works, no significant effects on the local population are anticipated.

The Population Study Area has a population of 4,437 persons as of 2016 and 4,668 persons in 2022 and comprises a total land area of 100.2 km^2 (Source: CSO Census of Population 2016 and 2022).

There are 80 no. sensitive receptors located within 1 kilometre of the proposed turbine locations with 9 no. of those sensitive receptors belonging to the landowners who form part of the Proposed Wind Farm. Of the 80 no. sensitive receptors located within 1 kilometres of the proposed turbines, all are inhabitable dwellings. The closest sensitive receptor is located approximately 767m from the nearest turbine (T6).

For the shadow flicker assessment, which is further detailed in Section 5.2.3.5 above, the Shadow Flicker Study Area is defined as ten times rotor diameter from each turbine. The Shadow Flicker Study Area for this assessment is 1.63 kilometres based on a rotor diameter of 163 metres and is further detailed in Section 5.2.3.5 above.

For the purposes of the population baseline assessment, the Proposed Wind Farm will be examined primarily from a population perspective due to the reasons outlined above. Where the Proposed Wind Farm and the Proposed Grid Connection are required to be considered separately, this is identified within the baseline assessment.



Map Legend

- EIAR Site Boundary
- Population Study Area
- District Electoral Divisions

Drawing Title	Population Study Area
Project Title	Laurclavagh Renewable Energy Development
Drawn By: KB	Checked By: OM
Project No.: 210627	Drawing No.: Figure 5-3
Scale: 1:45,000	Date: 2024-02-13

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5.3.2 Population Trends

In the period between the 2016 and the 2022 Census, the population of Ireland increased by 8.1%. During this time the population of Co. Galway grew by 7.8%

Table 5-1 Population 2016 - 2022 (Source: CSO)

Area	Population Change		% Population Change
	2016	2022	2016-2022
State	4,761,865	5,149,139	8.1%
Co. Galway	179,390	193,323	7.8%
Population Study Area	4,473	4,668	4.4%

In the same period, the population of the Study Area grew by 4.4%. When this is examined in closer detail, can be seen that the population of all 4 no. DEDs grew in the period between the 2016 and 2022 Census'. Claretuam grew in population size by the largest amount, seeing a population growth of 6.9%, with Annaghdown growing by 5.8%, Killower growing by 3.8% and Cummer growing marginally by 0.8%.

5.3.3 Population Density

The population densities recorded within the State, County Galway and the Population Study Area during the 2016 and 2022 Census are shown in Table 5-2.

Table 5-2 Population Density in 2016 and 2022 (Source CSO)

Area	Population Density (Persons per square kilometre)	
	2016	2022
State	67.8	73.3
Co Galway	29.2	31.4
Population Study Area	44.6	46.6

In the same period, the population density of the study area grew from 44.6 persons per square kilometre, to 46.6 persons per square kilometre. When these figures are examined on a closer level, it can be seen that the population density of Annaghdown rose from 61.0 to 64.5 persons per square kilometre, the population density of Claretuam rose from 36.1 to 38.6 persons per square kilometre, the population density of Killower rose from 27.1 to 28.1 persons per square kilometre; and the population density of Cummer rose slightly from 74.3 to 74.8 persons per square kilometre.

5.3.4 Household Statistics

The number of households and average household size recorded within the State, County Galway, and the Population Study Area during the 2016 and 2022 Censuses are shown in Table 5-3.

Table 5-3 Number of Household and Average Household Size 2016 – 2022 (Source: CSO)

Area	2016		2022	
	No. of Households	Avg. Size (persons)	No. of Households	Avg. Size (persons)
State	1,702,289	2.75	1,841,152	2.74
County Galway	63040	2.81	68,021	2.81
Population Study Area	1,436	3.1	1,535	3.06

In the same period, the average household size was recorded for the Population Study Area as decreasing marginally from 3.1 persons per household, to 3.06 persons per household. When the figures are examined on an individual DED level, it can be seen that the average household size decreased all 4 no. DED which make up the Population Study Area. The average persons per household in Cummer decreased by 4%, decreased in Cummer by 1.9%, decreased 1.4% in Annaghdown and decreased by 0.3% in Claretuam in the period between 2016 and 2022.

5.3.5 Age Structure

Table 5-4 presents the population percentages of the State, County Galway, and the Population Study Area within different age groups as defined by the Central Statistics Office during the 2022 Census. This data is also displayed in Figure 5-4.

Table 5-4 Population per Age Category in 2022 (Source: CSO)

Area	Age Category				
	0 - 14	15 – 24	25 - 44	45 - 64	65 +
State	19.7%	12.5%	27.6%	25.1%	15.1%
County Galway	21.0%	11.6%	24.1%	26.7%	16.6%
Population Study Area	21.5%	13.0%	23.3%	28.2%	14.0%

The proportion of the Population Study Area population is broadly similar to those recorded at national and county levels for most categories. For the Population Study Area, the highest population percentage occurs within the 45-64 age category, while the 25-44 age category is behind at 28.2% and 23.3% respectively.

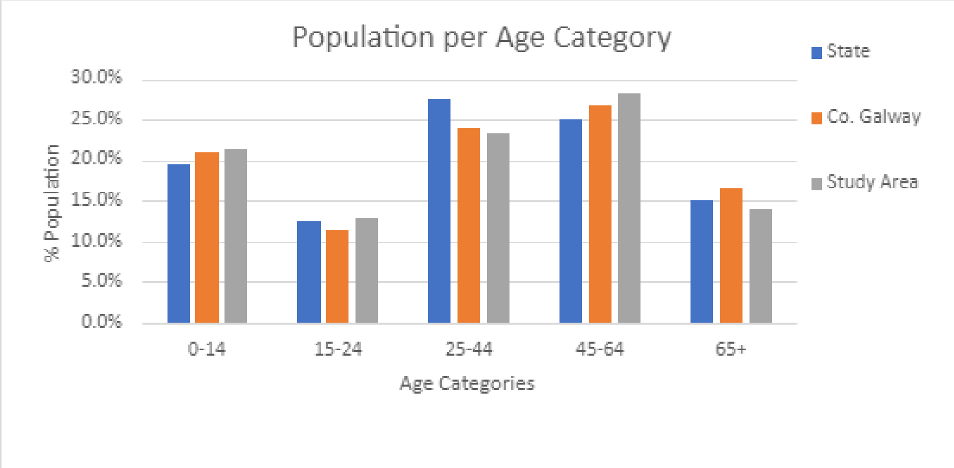

Figure 5-4 Population per Age Category in 2022 (Source: CSO)

5.3.6 Employment an Economic Activity

5.3.6.1 Economic Status of the Population Study Area

The labour force consists of those who are able to work, i.e. those who are aged 15+, out of full-time education and not performing duties that prevent them from working. In 2022, there were 2,531,099 persons in the labour force in the State. Table 5-5 shows the percentage of the total population aged 15+ who were in the labour force in the State during the 2022 Census. This figure is further broken down into the percentages that were at work or unemployed. It also shows the percentage of the total population aged 15+ who were not in the labour force, i.e., those who were students, retired, unable to work or performing home duties. In Census 2022, for the first time, two categories of unemployment detail were included, Long-term Unemployment and Short-term Unemployment, for the purpose of this assessment, both categories have been grouped into one Unemployment group.

Table 5-5 Economic Status of the Total Population Aged 15+ in 2022 (Source: CSO)

Status		State	County Galway	Population Study Area
% of population aged 15+ who are in the labour force		61.2%	60.6%	62.1%
% of which are:	At work	91.7%	92.8%	95.0%
	First time job seeker	1.4%	1.1%	0.4%
	Unemployed	7.0%	6.2%	4.6%
% of population aged 15+ who are not in the labour force		38.8%	39.4%	37.9%
% of which are:	Student	28.6%	27.7%	33.5%
	Home duties	17.0%	16.8%	16.9%
	Retired	41.0%	43.0%	37.9%

Status		State	County Galway	Population Study Area
	Unable to work	11.8%	10.8%	10.4%
	Other	1.7%	1.7%	1.3%

Overall, the principal economic status of those living in the Population Study Area is broadly similar to that recorded at State and County level. During the 2022 Census, the percentage of people over the age of 15 who were in the labour force was similar at both state and county level, but slightly higher in the Population Study Area at 62.1% of the population. Of those who were not in the labour force during the 2016 Census, the highest percentage of the Population Study Area population were 'Retired' individuals, similar to state and county populations.

5.3.6.2 Employment by Socio Economic Group

Socio-economic grouping divides the population into categories depending on the level of skill or educational attainment required. The 'Higher Professional' category includes scientists, engineers, solicitors, town planners and psychologists. The 'Lower Professional' category includes teachers, lab technicians, nurses, journalists, actors and driving instructors. Skilled occupations are divided into manual skilled such as bricklayers and building contractors; semi-skilled such as roofers and gardeners; and unskilled, which includes construction labourers, refuse collectors and window cleaners. Figure 5-3 shows the percentages of those employed in each socio-economic group in the State, County Galway, and the Population Study Area during 2022.

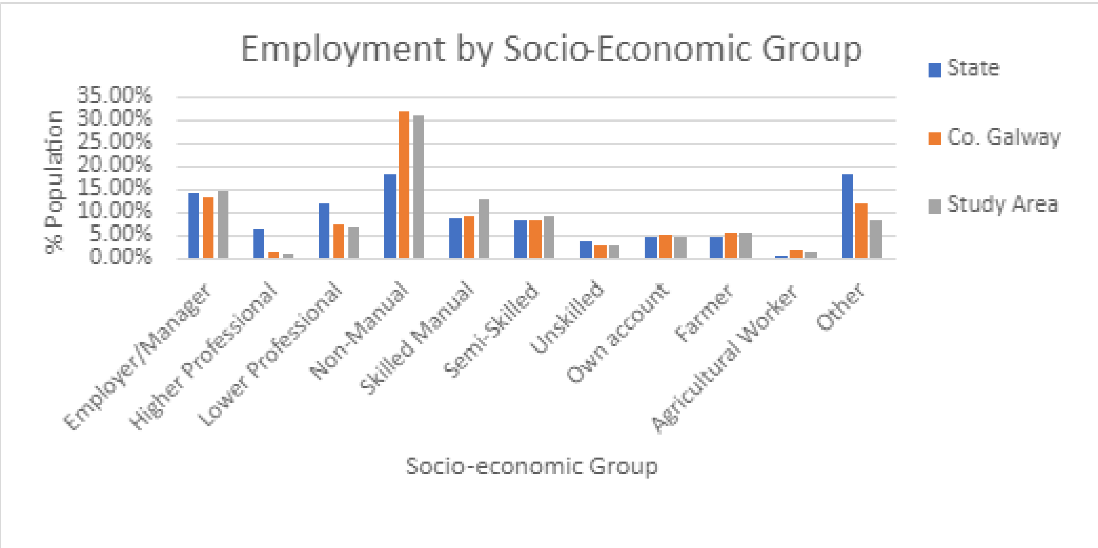

Figure 5-3 Employment by Socio-Economic Group in 2022 (Source CSO)

The highest level of employment within the Population Study Area was recorded in the 'Non-Manual' category, at 31.1% of all workers. The levels of employment within the Employer/Manager, Skilled Manual, Semi-Skilled, Unskilled, and Farmer categories are either higher than or level with the figures recorded at State level. On the other hand, the figures recorded at Higher Professional, Lower Professional, Own Account, Agricultural Worker and Other were lower than National figures. While employment in the categories of Agricultural Worker, and Non-Manual were higher than County Level but less than figures recorded at State level.

The CSO employment figures grouped by socio-economic status includes the entire population for the Population Study Area, County and State in their respective categories. As such, the socio-economic category of 'Other' is skewed to include those who are not in the labour force.

5.3.6.3 Employment and Investment Potential in the Irish Wind Energy Industry

5.3.6.3.1 *Background*

A report entitled '*Jobs and Investment in Irish Wind Energy – Powering Ireland's Economy'* was published in 2009 by Deloitte, in conjunction with the Irish Wind Energy Association (IWEA). This report focused on the ability of the Irish wind energy industry to create investment and jobs. In terms of the overall economic benefit to be obtained from wind energy, the report states in its introduction:

> *"Ireland is fortunate to enjoy one of the best wind resources in the world. Developing this resource will reduce and stabilise energy prices in Ireland and boost our long-term competitiveness as an economy. It will also significantly reduce our dependence on imported fossil fuels."*

More recently, a report published in 2014 by Siemens entitled '*An Enterprising Wind - An economic analysis of the job creation potential of the wind sector in Ireland*', also in conjunction with the Irish Wind Energy Association (IWEA), concluded that, *'a major programme of investment in wind could have a sizeable positive effect on the labour market, resulting in substantial growth in employment.'* The report considers the three potential types of direct employment created, as a result of increased investment in wind energy, to be:

- Wind Energy Industry Employment:
- Installation
- Development
- Planning
- Operation and Maintenance
- Investor activity
- Electricity Grid Network Employment
- Potential Wind Turbine Manufacturing Employment

The Sustainable Energy Authority of Ireland[1] demonstrates in their '*Wind Energy Roadmap 2011-2050*', that '*the wind energy resource represents a significant value to Ireland by 2050. This value is presented in terms of its ability to contribute to our indigenous energy needs, the benefits of enhanced employment creation and investment potential, and the ability to significantly abate carbon emissions to 2050.'*

5.3.6.3.2 *Energy Targets*

The Climate Action Plan 2023 (CAP 2023) was launched in December 2022. Following on from Climate Action Plans 2019 and 2021, CAP 2023 sets out the roadmap to deliver on Ireland's climate ambition. It aligns with the legally binding economy-wide carbon budgets and sectoral ceilings that were agreed by Government in July 2022 following the Climate Action and Low Carbon Development (Amendment) Act 2021, which commits Ireland to a *legally binding target of net-zero greenhouse gas emissions no later than 2050, and a reduction of 51% by 2030.* CAP 2023 sets out indicative ranges of emissions reductions for each sector of the economy.

Further information on energy and climate change targets is detailed in Chapter 11 of this EIAR.

[1] *SEAI (2019), https://www.seai.ie/publications/Wind_Energy_Roadmap_2011-2050.pdf*

5.3.6.3.3 *Employment Potential*

The 2014 report *"An Enterprising Wind: An economic analysis of the job creation potential of the wind sector in Ireland"* published by the Irish Wind Energy Association (IWEA) predicted that the wind energy sector in Ireland would result in 6,659 direct jobs in a scenario where 4GW capacity is achieved by 2020. This figure of 6,659 is broken down further; 5,596 of these jobs are associated directly with the construction and installation of windfarms, while the remaining 1,063 jobs are associated with the national grid. Under this scenario this contributes 1.66 direct jobs per Megawatt (MW) of wind capacity throughout the various stages of installation. According to Wind Energy Ireland, the installed wind capacity in Ireland is over 4.3GW as of February 2021, which would support employment during the last decade. Ireland needs to achieve a total of 9GW of onshore wind by 2030 which will further support further employment.

The Sustainable Energy Authority of Ireland[2] estimates, in their '*Wind Energy Roadmap 2011-2050*', note that '*Onshore and offshore wind could create 20,000 direct installation and O&M jobs by 2040'.* Furthermore, '*wind energy resource represents a significant value to Ireland by 2050. This value is presented in terms of its ability to contribute to our indigenous energy needs, the benefits of enhanced employment creation and investment potential, and the ability to significantly abate carbon emissions to 2050'.*

The 2014 report '*The Value of Wind Energy to Ireland*', published by Pőyry, stated that growth of the wind sector in Ireland could support 23,850 jobs (construction and operational phases) by 2030. The report states that if Ireland instead chooses to not develop any more wind, then by 2030 the country will be reliant on natural gas for most of our electricity generation, at a cost of €671 million per annum in fuel import costs.

Internationally, a report issued by WindEurope in September 2017, entitled '*Wind energy in Europe: Scenarios for 2030'* details various scenarios in Europe in respect to the EU target for renewable energy. According to WindEurope's High Scenario, which assumes favourable market and policy conditions including the achievement of a 35% EU renewable energy target (slightly higher than the 32% EU target for renewables), '*397 GW of wind energy capacity would be installed in the EU by 2030, 298.5 GW onshore and 99 GW offshore. In this scenario, the wind energy industry would invest €351bn by 2030, and it would create 716,000 jobs'.*

A new report published by MaREI, the SFI Research Centre for Energy, Climate and Marine, hosted by University College Cork[3] (March 2021) details that in order to meet the government target of net-zero carbon emissions by 2050, at least 25,000 jobs will be created in the development of onshore and offshore wind to meet our zero carbon targets.

A more recent report which was issued by WindEurope in February 2022, titled '*Wind Energy in Europe: 2021 Statistics and the Outlook for 2022-2026'* details various scenarios in Europe in respect to the EU target for renewable energy. According to WindEurope's report, '*Europe installed 17GW (11 GW in the EU-27) of new wind capacity in 2021. This is not even half of what the EU should be building to be on track to deliver its 2030 Climate Energy Goals.*' The report continued on to state that '*We expect Europe to install 116 GW of new wind farms over the period from 2022-2026. Three quarters of these new capacity additions will be onshore wind.*' The report also states that '*The European Commission modelling shows that we need at least 79 GW offshore wind but National Government have pledged to build at least 92 GW offshore wind capacity by 2030.'*

As of May 2022, there were 5,585 Megawatts (MW) of wind energy capacity installed on the island of Ireland[4]. Of this, 4,309 MW was installed in the Republic of Ireland. The majority of the Republic of

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[2] *SEAI (2019), https://www.seai.ie/publications/Wind_Energy_Roadmap_2011-2050.pdf*
[3] *https://www.marei.ie/our-climate-neutral-future-zeroby50/*
[4] *Wind Energy Ireland – Facts and Stats, https://windenergyireland.com/about-wind/facts-stats*

Ireland's installed wind energy capacity is located in Counties Donegal, Galway, Cork, Clare and Kerry, contributing to employment potential on the Island of Ireland.

5.3.6.3.4 Economic Value

A 2019 report by Baringa, '*Wind for a Euro: Cost-benefit analysis of wind energy in Ireland 2000-2020'*, has analysed the financial impact for end consumers of the deployment of wind generation in Ireland over the period 2000-2020. The report calculates how the costs and benefits for consumers would have differed if no wind farms had been built. The analysis indicated that the deployment of 4.1 GW of wind generation capacity in Ireland between 2000 and 2020 (2018-2020 results being projective) will result in a total net cost to consumers, over 20 years, of €0.1bn (€63 million to be exact), which equates to a cost of less than €1 per person per year since 2000. Further cost benefit analysis noted that wind energy has delivered €2.3 billion in savings in the wholesale electricity market. As such, the economic benefit of renewable energy to consumers is greater than what would have been if Ireland did not invest in wind power. This corresponds with the Deloitte report which indicates that more wind energy feeding into the national grid will result in lower and more stable energy costs for consumers.

Furthermore, in May 2020, IWEA released its 70by30 Implementation Plan Reports which further details the savings that can be made from the continuation of onshore wind. The report, entitled '*Saving Money - 70 by 30 Implementation Plan'*, notes that '*Baringa calculated previously that if onshore wind in Ireland can be delivered at €60/MWh, on average, between 2020 and 2030, then the 70 per cent renewable electricity target set out in the Climate Action Plan will actually be cost neutral for the consumer. If we can achieve prices under €60/MWh then Ireland's electricity consumers will be saving money'.*

The Proposed Project will, if consent is granted, contribute to the economic value that renewable energy brings to the country.

5.3.7 Land-Use

Current land use on the Proposed Wind Farm comprises small scale agriculture. Current use along the Proposed Grid Connection underground cabling route comprises of public road corridor, discontinuous urban fabric and agriculture. The predominant surrounding land use within the Population Study Area is also farmland and one-off rural housing.

The total area of farmland within the DEDs around the Proposed Project site measures approximately 10,506 hectares, comprising approximately 77.6% of the Population Study Area land mass, according to the CSO Census of Agriculture 2010. There are 406 no. farms located within the Population Study Area, with an average farm size of 25.8 hectares.

Table 5-6 Farm Size and Classification within the Population Study Area in 2010 (Source: CSO)

Characteristic	Value
Size of Population Study Area	10,020 ha
Total Area Farmed within Population Study Area	8426 ha
Farmland as % of Population Study Area	84%
Breakdown of Farmed Land	Area (Hectares)
Pasture	5,171
Silage	2,031

Rough Grazing	809
Hay	454
Crops	140
Cereals	74
Potatoes	1

5.3.8 Services

The Proposed Wind Farm is located approximately 9km southwest of Tuam, and 10km north of Claregalway, Co. Galway. It is proposed to access the Proposed Wind Farm via a temporary access off the N82 National Road, which connects to an the L61461 Local Road which leads into the east of the Proposed Wind Farm. The Proposed Wind Farm is served by a number of existing agricultural roads and tracks.

Tuam town centre is located approximately 3.6km north of the Proposed Grid Connection underground cabling route terminus at Cloon 110kV substation.

The main services for the Population Study Area are located within Tuam, which is located approximately 9km northeast of the Proposed Wind Farm, which is classified as a County town. Other settlement centres within the wider region which provide retail, recreational, educational, and religious services include Claregalway, 10 kilometres to the south of the Proposed Wind Farm, and Corofin, 2.8 kilometres to the east of the Proposed Wind Farm.

5.3.8.1 Education

The nearest Primary School to the Proposed Project is Castlehackett National School which is located roughly 1.3km northwest of the Proposed Project at its closest point.

The nearest Secondary School is St Jarlath's College, which is located approximately 1.8km north/northeast of the Proposed Project at its closest point.

The nearest Third Level institution to the Proposed Project is Atlantic Technological University (Galway Campus) which is located approximately 21km south of the Proposed Project at its closest point.

5.3.8.2 Access and Public Transport

The site of the Proposed Project will be accessed via the N83 National Road which runs along the eastern boundary of the Site in a north – south direction connecting Tuam to Galway City. There are also a number of private and public bus routes that service the area via the N83. The Bus Éireann Galway – Castlerea service (Route 249) travels twice daily on this route. The local private bus company Burkes Bus travels from Galway City to Tuam (Tuam – Galway – Tuam Route) 11 times daily and has multiple stops along the N83, directly adjacent to the Proposed Project.

5.3.8.3 Amenities and Community Facilities

Most of the amenities and community facilities, including sports clubs, and recreational facilities are available in the nearby settlements of Claregalway, and Corofin. The town of Tuam and the city of Galway also offer a large selection of amenities and community facilities. There are a number of GAA clubs surrounding the Proposed Wind Farm and the Proposed Grid Connection, some of which are the Claregalway GAA Football Club, Belclare GAA Pitch ad Annaghdown GAA Club.

The varied environment of this area of County Galway provides many opportunities for walking, cycling and playing golf. Knockma Hill is located approximately 2.4.2km north of the Proposed Wind Farm proposed turbines and provides opportunities for walking and running along its trail. Although this is not a waymarked walking trail, it is popular among locals. Tuam Golf Club is located approximately 1.2km west of the proposed underground cabling route at its closest point, just before it enters the existing 110kV Cloon Substation.

Community Benefit proposals, which would enhance local amenities and community facilities are described in Chapter 4: Description of the Proposed Project.

5.4 Tourism

For the purposes of this section, the Proposed Wind Farm is considered solely in relation to the tourism baseline assessment. Due to the temporary nature of the works and any potential effects associated with the Proposed Grid Connection underground cabling route, it has been screened out from the tourism assessment that follows.

5.4.1 Tourism and Revenue

Tourism is one of the major contributors to the national economy and is a significant source of full time and seasonal employment. During 2019, total tourism revenue generated in Ireland was approximately €9.5 billion, an increase on the €9.1 billion revenue recorded in 2018. Overseas tourist visits to Ireland in 2018 grew by 6.5% to 9.6 million (‘*Tourism Facts 2019*, Fáilte Ireland, March 2021).

Ireland is divided into seven tourism regions. Table 5-6 shows the total revenue and breakdown of overseas tourist numbers to each region in Ireland during 2018 (‘*Tourism Facts 2019*, Fáilte Ireland, March 2021).

Table 5-7 Overseas Tourists Revenue and Numbers 2019 (Source: Fáilte Ireland)

Region	Total Revenue (€m)	Total Number of Overseas Tourists (000s)
Dublin	€2,210m	6,644
Mid-East/Midlands	€348m	954
South-East	€261m	945
South-West	€970m	2,335
Mid-West	€472m	1,432
West	**€653m**	**1,943**
Border	€259m	768
Total	€5,173 m	15,021

The Proposed Project is located within the West Region. According to ‘*Regional Tourism Performance in 2019’* (Fáilte Ireland, March 2021), the West Region, which comprises the counties Galway, Mayo and Roscommon, benefitted from approximately 12.9% of the overseas visitors who came to Ireland in 2019 and approximately 12.6% of the associated tourism income generated in Ireland in 2019.

Although the data from 2019 is not available, Table 5-8 presents the most recent breakdown of overseas tourist numbers and revenue to the West Region during 2017 (‘*2017 Topline Tourism Performance by Region,* Fáilte Ireland, August 2018). As can be observed in Table 5-8, Co. Galway hosted 1,673,000 no. tourists in 2017, which was the largest share of those who visited the West Region and had tourism revenue at €589 million.

Table 5-8 Overseas Tourism during 2017 (Source: Fáilte Ireland)

Region	Total Revenue (€m)	Total Number of Overseas Tourists (000s)
Galway	**589**	**1,673**
Mayo	78	324
Roscommon	27	54

In October 2023, Failte Ireland released their *Key Tourism Facts 2022* in which details of domestic tourism in 2022 were included. The report states that, in 2022, holidays accounted for 50% of all domestic trips with a per diem spend of €100. The report detailed the performance of each region on the revenue collected from domestic tourists. The results of this are detailed below in Table 5-9.

Table 5-9 Domestic Tourism Revenue by Region

Region	Estimated Expenditure (€m)
Mid East/ Midlands	395
Dublin	419
South East	381
South West	665
Mid West	261
West	**459**
Border	350

The Proposed Project falls within the West region, which received an estimated €459 million from domestic tourism in 2022, which was the second highest earning region in this period. The West region comprises the counties of Galway, Mayo and Roscommon. Tourism is one of Ireland’s, and the West region’s most important industries, contributing to the economic and social fabric of the island. It is a leading creator of jobs and revenue, and one of the few sectors that has the potential to significantly benefit remote rural areas.

5.4.2 Tourist Attractions

There are no key identified tourist attractions pertaining specifically to the site of the Proposed Project (either the Proposed Wind Farm or the Proposed Grid Connection).

Key tourist attractions within County Galway include Galway City, Connemara National Park, mountain ranges including the Maamturks, the Twelve Bens, and the Mweelrea mountains.

Many additional tourist attractions are found in Tuam, Claregalway and Galway City.

The Discover Ireland website (www.discoverireland.ie) lists the following attractions with the vicinity of the Proposed Project:

- **Knockma Hill** is located approximately 2.7km north of the Proposed Project and poses opportunities for walking through the partially wooded area. The cairn at the summit of Knockma Hill is thought to be the burial place of Queen Maeve, and the wooded areas also host a number of floral species characteristic of areas such as the Burren.
- **Lough Corrib** is located approximately 4km west of the Proposed Project at its closest point. Lough Corrib is the largest lake in the Republic of Ireland and is famed for its beauty. Lough Corrib attracts large volumes of tourists yearly who partake in various boat tours, sightseeing trips and various water sports activities, such as kayaking and canoeing.
- **Castle Ellen House** was built originally by the Lambert Family in 1810 and is situated on 33 acres of land approximately 14.7km southeast of the Proposed Project. Castle Ellen is now a popular location for visitors to stay in overnight as it is available to book on AirBnB.
- **Galway City** is located approximately 16 kilometres south/southwest of the Proposed Project at its closest point. Galway city hosts a number of tourist attractions including the following:
    - Walking tours of the historic city
    - Bus tours of the historic city
    - The Latin Quarter
    - Beaches and amusements at Salthill
    - Druid Theatre
    - Galway Atlantaquaria
    - Pearse Stadium
- **Wildlands Galway** is an indoor and outdoor adventure centre located approximately 16km southwest of the Proposed Project. Wildlands offers activities for visitors of all age groups and offers accommodation in sustainably built log cabins. Wildlands has become a very popular tourist destination since its opening in 2020.

5.4.3 Tourist Attitudes to Wind Farms

5.4.3.1 Scottish Tourism Study 2021

BiGGAR Economics undertook an independent study in 2021, entitled '*Wind Farms & Tourism Trends in Scotland: Evidence from 44 Wind Farms*' to understand the relationship, if any, that exists between the development of onshore wind and the sustainable tourism sector in Scotland. In recent years, the onshore wind sector and sustainable tourism sector have grown significantly in Scotland. However, it could be argued that if there was any relationship between the growth of onshore wind energy and tourism, it would be at a more local level. This study therefore considered the evidence at a local authority level and in the immediate vicinity of constructed wind farms.

Since 2009, the onshore wind sector has expanded considerably in Scotland. Employment in tourism-related sectors in Scotland also grew during the years since 2009, an overall increase of 20%.

Analysis of the rates of change in the number of onshore wind turbines and in tourism-related employment in local authority areas, found that there is no correlation between the two factors. This applies to whether the analysis covers the decade between 2009 – 2019, or the more recent 2015 to 2019 period.

The research also analysed trends in tourism employment within the immediate vicinity of wind farm developments. This included 16 no. wind farms with a capacity of at least 10MW that became operational between 2015 and 2019. Analysis of trends in tourism employment in the locality of these wind farms (study areas were based on a 15km radius) found that 11 of these 16 areas had experienced more growth in tourism employment than for Scotland as a whole. For 12 of the 16 wind farms, trends in tourism employment in the locality had outperformed the local authority area in which they were based.

The research also re-examined 28 wind farms constructed between 2009 and 2015 that had been analysed in a previous study published in 2017, finding that the localities in which they were based had outperformed Scotland and their local authority areas in the majority of cases. Moreover, the analysis, found that in the seven areas which had underperformed their local authority areas in the 2017 study, four had done better than their local authorities in the 2015 to 2019 period.

This research analysed trends in tourism employment in the localities of 44 no. wind farms developed in recent years, providing a substantial evidence base. The study found no relationship between tourism employment and wind farm development, at the level of the Scottish economy, across local authority areas, not in the locality of the wind farm sites.

5.4.3.2 Fáilte Ireland Surveys 2007 and 2012

In 2007, Fáilte Ireland in association with the Northern Ireland Tourist Board carried out a survey of domestic and overseas holidaymakers to Ireland in order to determine their attitudes to wind farms. The purpose of the survey was to assess whether the development of wind farms impacts on the enjoyment of the Irish scenery by holidaymakers. The survey involved face-to-face interviews with 1,300 tourists (25% domestic and 75% overseas). The results of the survey are presented in the Fáilte Ireland Newsletter 2008/No.3 entitled 'Visitor Attitudes on the Environment: Wind Farms'.

The Fáilte Ireland survey results indicate that most visitors are broadly positive towards the idea of building wind farms in Ireland. There exists a sizeable minority (one in seven) however who are negative towards wind farms in any context. In terms of awareness of wind farms, the findings of the survey include the following:

- Almost half of those surveyed had seen at least one wind farm on their holiday to Ireland. Of these, two thirds had seen up to two wind farms during their holiday.
- Typically, wind farms are encountered in the landscape while driving or being driven (74%), while few have experienced a wind farm up close.
- Of the wind farms viewed, most contained less than ten turbines and 15% had less than five turbines.

Regarding the perceived impact of wind farms on sightseeing, the Fáilte Ireland report states:

> *"Despite the fact that almost half of the tourists interviewed had seen at least one wind farm on their holiday, most felt that their presence did not detract from the quality of their sightseeing, with the largest proportion (45%) saying that the presence of the wind farm had a positive impact on their enjoyment of sightseeing, with 15% claiming that they had a negative impact."*

In assessing the perceived impact of wind farms on beauty, visitors were asked to rate the beauty of five different landscapes types: Coastal, Mountain, Farmland, Bogland and Urban Industrial, and then rate on a scale of 1-5 the potential impact of a wind farm being sited in each landscape. The survey found that each potential wind farm must be assessed on its own merits. Overall however, in looking at wind farm developments in different landscape types, the numbers claiming a positive impact on the landscape due to wind farms were greater than those claiming a negative impact, in all cases.

Regarding the perceived impact of wind farms on future visits to the area, the Fáilte Ireland survey states:

> *"Almost three quarters of respondents claim that potentially greater numbers of wind farms would either have no impact on their likelihood to visit or have a strong or fairly strong*

> *positive impact on future visits to the island of Ireland. Of those who feel that a potentially greater number of wind farms would positively impact on their likelihood to visit, the key driver is their support for renewable energy and potential decreased carbon emissions."*

The report goes on to state that while there is a generally positive disposition among tourists towards wind development in Ireland, it is important also to take account of the views of the one in seven tourists who are negatively disposed towards wind farms. This requires good planning on the part of the wind farm developer as well as the Local Authority. Good planning has been an integral component of the Proposed Project throughout the site design and assessment processes. Reference has been made to the '*Planning Guidelines on Wind Energy Development 2006'* and the '*Draft Revised Wind Energy Development Guidelines December 2019'* in addition to WEI (previously IWEA) best practice guidance, throughout all stages, including pre-planning consultation and scoping.

The 2007 survey findings are further upheld by a more recent report carried out by Fáilte Ireland on tourism attitudes to wind farms in 2012. The results of the updated study were published in the 'Fáilte Ireland Newsletter 2012/No.1 entitled 'Visitor Attitudes on the Environment: Wind Farms – Update on 2007 Research'. The updated survey found that of 1,000 domestic and foreign tourists who holidayed in Ireland during 2012, over half of tourists said that they had seen a wind turbine while travelling around the country. Of this number of tourists, 21% claimed wind turbines had a negative impact on the landscape. However, 32% said that it enhanced the surrounding landscape, while 47% said that it made no difference to the landscape. Almost three quarters of respondents claim that potentially greater numbers of wind farms would either have no impact on their likelihood to visit or have a strong or fairly strong positive impact on future visits to the island of Ireland.

Further details regarding the general public perception of wind energy, including those living in the vicinity of a wind farm, are presented in Section 5.4 below.

5.5 Public Perception of Wind Energy

5.5.1 Sustainable Energy Ireland Survey 2003

5.5.1.1 Background

The results of a national survey entitled '*Attitudes Towards the Development of Wind Farms in Ireland'* were published by the Sustainable Energy Authority of Ireland (SEAI) in 2003 and updated in 2017 – see Section 5.4.1.3 below. A catchment area survey was also carried out by SEAI (formerly SEI) in order to focus specifically on people living with a wind farm in their locality or in areas where wind farms are planned.

5.5.1.2 2003 Findings

The SEAI survey published in 2003, found that the overall attitude to wind farms is very positive, with 84% of respondents rating it positively or very positively. One percent rates it negatively and 14% had no opinion either way. Approximately two thirds of respondents (67%) were found to be positively disposed to having a wind farm in their locality. Where negative attitudes were voiced towards wind farms, the visual effect of the turbines on the landscape was the strongest influence. The report also notes however that the findings obtained within wind farm catchment areas showed that effect on the landscape is not a major concern for those living near an existing wind farm.

With regards to the economic and environmental effects of wind farm development, the national survey reveals that attitudes towards wind energy are influenced by a perception that wind is an attractive source of energy:

> *"Over 8 in 10 recognise wind as a non-polluting source of energy, while a similar number believe it can make a significant contribution to Ireland's energy requirements."*

The study reveals uncertainty among respondents with regards to the issues of noise levels, local benefits and the reliability or otherwise of wind power as an energy source. It goes on to state however that the finding that people who have seen wind farms rate these economic and environmental factors more favourably is a further indication that some experience of the structures tends to translate into positive attitudes towards wind energy.

Similar to the national survey, the surveys of those living within the vicinity of a wind farm also found that the findings are generally positive towards wind farms. Perceptions of the effect of the development on the locality were generally positive, with some three-quarters of interviewees believing it had impacted positively.

In areas where a wind farm development had been granted planning permission but was not yet under construction, three quarters of the interviewees expressed themselves in favour of the wind farm being built in their area. Four per cent were against the development. The reasons cited by those who expressed themselves in favour of the wind farm included the fact that wind energy is clean (78%), it would provide local jobs (44%), it would help develop the area (32%) and that it would add to the landscape (13%). Those with direct experience of a wind farm in the locality are generally impressed with it as an additional feature in the landscape. The report states:

> *"It is particularly encouraging that those with experience of wind turbines are most favourable to their development and that wind farms are not solely seen as good in theory, but are also seen as beneficial when they are actually built."*

Few of those living in proximity either to an existing wind farm or one for which permission has been granted believe that the development damages the locality, either in terms of damage to tourism potential or to wildlife. The survey found that there is a clear preference for larger turbines in smaller numbers over smaller turbines in larger numbers.

5.5.1.3 Survey Update 2017

Additionally, a survey carried out by Interactions in October 2017, published by the SEAI, show 47% of Irish adults polled said they were strongly in favour of wind power in Ireland while a further 38% favour it. Overall, this is a 4% increase in favourable attitudes towards wind power compared with similar research in 2013.

The SEAI survey found that the overall attitude to wind farms is very positive, with 84% of respondents in favour of the use of wind energy in Ireland. Approximately two thirds of respondents (70%) would prefer to power their home with renewable energy over fossil fuels, and 45% would be in favour of a wind farm development in their area.

The survey also captured the perceived benefits of wind power among the public. Of those surveyed three quarters selected good for the environment and reduced Carbon Dioxide emissions while fewer people, just over two in three, cited cheaper electricity.

5.5.1.4 Conclusions

The main findings of the SEAI survey in 2017 indicate that the overall attitude to wind farms is "almost entirely positive". The study highlights that two-thirds of Irish adults are either very favourable or fairly favourable to having a wind farm built in their locality, with little evidence of a "Not In My Back Yard" (NIMBY) effect. The final section of the 2017 report states:

> *"The overwhelming indication from this study is that wind energy enjoys great support and, more specifically, that the development of wind farms is supported and welcomed. The single most powerful indicator of this is to be found among those living in proximity to an existing wind farm: over 60% would be in favour of a second wind farm or an extension of the existing one. This represents a strong vote in favour of wind farm developments – especially important since it is voiced by those who know from direct experience about the impact of such developments on their communities."*

5.5.2 Public Perceptions of Wind Power in Scotland and Ireland Survey 2005

5.5.2.1 Background

A survey of the public perception of wind power in Scotland and Ireland was carried out in 2003/2004 by researchers at the School of Geography & Geosciences, University of St. Andrews, Fife and The Macaulay Institute, Aberdeen ('*Green on Green: Public Perceptions of Wind Power in Scotland and Ireland*', Journal of Environmental Planning and Management, November 2005). The aims of the study were to ascertain the extent to which people support or oppose wind power, to investigate the reasons for these attitudes and to establish how public attitudes relate to factors such as personal experience of operational wind farms and their proximity to them.

5.5.2.2 Study Area

Surveys were carried out at two localities in the Scottish Borders region, one surrounding an existing wind farm and one around a site at which a wind farm had received planning permission but had not yet been built. Surveys were also carried out in Ireland, at two sites in Counties Cork and Kerry, each of which had two wind farms in proximity to each other.

5.5.2.3 Findings

The survey of public attitudes at both the Scottish and Irish study sites concluded that large majorities of people are strongly in favour of their local wind farm, their personal experience having engendered positive attitudes. Attitudes towards the concept of wind energy were described as "overwhelmingly positive" at both study sites in Scotland, while the Irish survey results showed almost full support for renewable energy and 92% support for the development of wind energy in Ireland.

The results of the survey were found to agree with the findings of previous research, which show that positive attitudes to wind power increase through time and with proximity to wind farms. With regards to the NIMBY effect, the report states that where NIMBY-ism does occur, it is much more pronounced in relation to proposed wind farms than actual wind farms. The Scottish survey found that while positive attitudes towards wind power were observed among those living in proximity to both the proposed and existing wind farm sites, people around the proposed site were less convinced than those living in proximity to the existing site. Retrospective questioning regarding pre- and post-construction attitudes at the existing site found that attitudes remained unchanged for 65% of respondents. Of the 24% of people who altered their attitudes following experience of the wind farm, all but one became more positive. The report states:

> *"These results support earlier work which has found that opposition to wind farms arises in part from exaggerated perceptions of likely impact, and that the experience of living near a wind farm frequently dispels these fears. Prior to construction, locals typically expect the landscape impacts to be negative, whereas, once in operation, many people regard them as an attractive addition."*

The reasons that people gave for their positive attitude to the local wind farm were predominantly of a global kind, i.e. environmental protection and the promotion of renewable energy, together with opposition to a reliance on fossil fuels and nuclear power. Problems that are often cited as negative effects of wind farms, such as interference with telecommunications and shadow flicker were not mentioned at either site. With regards to those who changed to a more positive attitude following construction of the wind farm, the reasons given were that the wind farm is *"not unattractive (62%), that there was no noise (15%), that community funding had been forthcoming (15%) and that it could be a tourist attraction (8%)".*

The findings of the Irish survey reinforce those obtained at the Scottish sites with regards to the increase in positive attitudes to wind power through time and proximity to wind farms. The survey of public attitudes at the sites in Cork and Kerry found that the highest levels of support for wind power were recorded in the innermost study zone (0 – 5 kilometres from a point in between the pair of wind farms). The data also suggests that *"those who see the wind farms most often are most accepting of the visual impact".* The report also states that a previous Irish survey found that most of those with direct experience of wind farms do not consider that they have had any adverse effect on the scenic beauty of the area, or on wildlife, tourism or property values. Overall, the study data reveals *"a clear pattern of public attitudes becoming significantly more positive following personal experience of operational wind farms".*

With regards to wind farm size, the report notes that it is evident from this and previous research that wind farms with small numbers of large turbines are generally preferred to those with large numbers of smaller turbines.

5.5.2.4 Conclusions

The overall conclusions drawn from the survey findings and from the authors' review of previous studies show that local people become more favourable towards wind farms after construction, that the degree of acceptance increases with proximity to them, and that the NIMBY effect does not adequately explain variations in public attitudes due to the degree of subjectivity involved.

5.5.3 IWEA Interactions Opinion Poll on Wind Energy

Published in January 2020, IWEA undertook a national opinion poll on Wind Energy November 2019 with the objective to "*measure and track public perceptions and attitudes around wind energy amongst Irish adults*." Between November 20th – 30, a nationally represented sample of 1,019 adults and a booster sample of 200 rural residents participated in an online survey. The 2019 results indicate that 79% of both the nationally represented sample and rural sample strongly favour or favour wind power while 16% of both samples neither favour or oppose it. Amongst those in favour of wind power, the majority cited environmental and climate concerns as their main reasons for supporting such developments. Other reasons cited for supporting wind energy developments include: "economic benefits," "reliable/efficient," "positive experience with wind energy" and recognise it as a "safe resource." When questioned about wind developments in their local area, 55% of nationally represented sample favour or tend to favour such proposals and 51% of the rural population reported the same. Reasons cited for supporting wind developments in their local area include: "good for the environment," "social responsibility," "create jobs," "good for the community."

The IWEA November 2019 survey follows previous national opinion polls on wind energy undertaken in October 2017 and November 2018. The 2019 survey results are consistent with the 2017 and 2018 figures and thus indicate that approximately 4 out of 5 Irish adults have continued to support for wind energy in recent years.

5.5.4 Wind Energy Ireland Public Attitudes Monitor

Published in December 2022, IWEA undertook a national opinion poll on Wind Energy in Q4 of 2022 with the objective '*to measures & track the perceptions and attitudes around wind energy amongst Irish adults*'. Between November 23rd and December 8th 2022, a nationally represented sample of 1,017 and a booster samples of 201 rural dwellers participated in the survey. The 2022 results indicate that 80% of the nationally representative sample and 85% of the rural sample strongly favour or favour wind power. Almost half (45%) of those surveyed ranked cheaper electricity as the top wind energy benefit. Amongst rural residents, the percentage of people producing negative feedback is reducing year on year. Nationally, 58% of people said that they would be in favour of a wind farm in their area, which is the highest number in favour since tracking began. Amongst rural residents, just 1 in 10 people registered being opposed to having a wind farm in their local area.

The IWEA December 2022 survey follows previous national opinion polls on wind energy undertaken by IWEA in November 2019 and November 2018. The 2022 survey results are consistent with the 2019 and 2018 figures and thus indicate that 4 out of 5 Irish adults have continued to support wind energy in recent years.

5.6 Health Effects of Wind Farms

5.6.1 Introduction

The 2022 Census of Ireland as carried out by the Central Statistics Office provides the general health conditions of the population of the DEDs which make up the Population Study Area for the Proposed Project. The vast majority of those within the Population Study Area marked their general health as being 'very good' across all DEDs. It is not anticipated that the general health of the population of the Population Study Area be altered due to the Proposed Project.

5.6.2 Health Impact Studies

While there are anecdotal reports of negative health effects on people who live very close to wind turbines, peer-reviewed research has not supported these statements. There is currently no published credible scientific evidence to positively link wind turbines with adverse health effects. The main publications supporting the view that there is no evidence of any direct link between wind turbines and health are summarised below.

1. ***'Wind Turbine Sound and Health Effects – An Expert Panel Review',*** *American Wind Energy Association and Canadian Wind Energy Association, December 2009*

This expert panel undertook extensive review, analysis and discussion of the large body of peer-reviewed literature on sound and health effects in general, and on sound produced by wind turbines in particular. The panel assessed the plausible biological effects of exposure to wind turbine sound. Following review, analysis, and discussion of current knowledge, the panel reached consensus on the following conclusions:

- "There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects.
- The ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans.
- The sounds emitted by wind turbines are not unique. There is no reason to believe, based on the levels and frequencies of the sounds and the panel's experience with sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences."

The report found, amongst other things, that:

- "Wind Turbine Syndrome" symptoms are the same as those seen in the general population due to stresses of daily life. They include headaches, insomnia, anxiety, dizziness, etc.
- Low frequency and very low-frequency 'infrasound' produced by wind turbines are the same as those produced by vehicular traffic and home appliances, even by the beating of people's hearts. Such 'infrasounds' are not special and convey no risk factors;
- The power of suggestion, as conveyed by news media coverage of perceived 'wind-turbine sickness', might have triggered 'anticipatory fear' in those close to turbine installations."

2. ***'Wind Turbine Syndrome – An independent review of the state of knowledge about the alleged health condition',*** *Expert Panel on behalf of Renewable UK, July 2010*

This report consists of three reviews carried out by independent experts to update and understand the available knowledge of the science relating to infrasound generated by wind turbines. This report was prepared following the publication of a book entitled '*Wind Turbine Syndrome'*, in 2009 by Dr. Pierpont, which received significant media attention at the time. The report discusses the methodology and assessment carried out in the 2009 publication and assessed the impact of low-frequency noise from wind turbines on humans. The independent review found that:

- "The scientific and epidemiological methodology and conclusions drawn (in the 2009 book) are fundamentally flawed;
- The scientific and audiological assumptions presented by Dr Pierpont relating infrasound to WTD are wrong; and
- Noise from Wind Turbines cannot contribute to the symptoms reported by Dr. Pierpont's respondents by the mechanisms proposed."

Accordingly, the consistent and scientifically robust conclusion remains that there is no evidence to demonstrate any significant health effects in humans arising from noise at the levels of that generated by wind turbines.

3. ***'The Health Effects of 72 Hours of Simulated Wind Turbine Infrasound: A Double-Blind Randomized Crossover Study in Noise-Sensitive Health Adults'*** *Woolcock Institute for Medical Research, New South Wales Australia*

The purpose of this study was to examine the potential health effects of audible sound and inaudible infrasound has on noise sensitive adults over a period of 72 hours. Sufferers of wind turbine syndrome (WTS) have attributed their ill-health and particularly their sleep disturbance to the signature of infrasound. On this basis, the objectives of the study were to test the effects of 72 hours of infrasound exposure on human physiology, particularly sleep. The results of the study are outlined below:

- All staff and participants were asked whether they were able to differentiate in any way between infrasound and sham infrasound (the control), and none of them were able to.
- The study found that 72 hours of the simulated wind turbine infrasound (~90dB pk re 20 µPa) in controlled laboratory conditions did not worsen any measure of sleep quality compared with the same speakers being present but not generating infrasound (sham infrasound).
- The study found no evidence of that 72 hours of exposure to a sound level of ~90dB pk re 20 µPa of simulated wind turbine infrasound in double-blind conditions perturbed any physiological or psychological variable.
- None of the participants in the study who were exposed to infrasound developed what could be described as Wind Turbine Syndrome.

- This study suggests that the infrasound component of Wind Turbine Syndrome is unlikely to be a cause of any ill-health or sleep disruption, although this observation should be independently replicated.

4. ***'A Rapid Review of the Evidence',*** *Australian Government National Health and Medical Research Council (NHMRC) Wind Turbines & Health, July 2010*

The purpose of this paper was to review evidence from current literature on the issue of wind turbines and potential effects on human health and to validate the finding of the 'Wind Turbine Sound and Health Effects - An Expert Panel Review' (see Item 2 above) that:

- "There are no direct pathological effects from wind farms and that any potential impact on humans can be minimised by following existing planning guidelines."
- There is currently no published scientific evidence to positively link wind turbines with adverse health effects.
- 'This review of the available evidence, including journal articles, surveys, literature reviews and government reports, supports the statement that: There are no direct pathological effects from wind farms and that any potential impact on humans can be minimised by following existing planning guidelines."

5. ***'Position Statement on Health and Wind Turbines',*** *Climate and Health Alliance, February 2012*

The Climate and Health Alliance (CAHA) was established in August 2010 and is a coalition of health care stakeholders who wish to see the threat to human health from climate change and ecological degradation addressed through prompt policy action. In its Position Statement in February 2012, CAHA states that:

> *"To date, there is no credible peer reviewed scientific evidence that demonstrates a direct causal link between wind turbines and adverse health impacts in people living in proximity to them. There is no evidence for any adverse health effects from wind turbine shadow flicker or electromagnetic frequency. There is no evidence in the peer reviewed published scientific literature that suggests that there are any adverse health effects from infrasound (a component of low frequency sound) at the low levels that may be emitted by wind turbines."*

The Position Statement explores human perceptions of wind energy and notes that some people may be predisposed to some form of negative perception that itself may cause annoyance. It states that:

> *"Fear and anxious anticipation of potential negative impacts of wind farms can also contribute to stress responses, and result in physical and psychological stress symptoms... Local concerns about wind farms can be related to perceived threats from changes to their place and can be considered a form of "place-protection action", recognised in psychological research about the importance of place and people's sense of identity."*

CAHA notes the existence of *"misinformation about wind power"* and, in particular, states that:

> *"Some of the anxiety and concern in the community stems originally from a self-published book by an anti-wind farm activist in the United States which invented a syndrome, the so-called "wind turbine syndrome". This is not a recognised medical syndrome in any international index of disease, nor has this publication been subjected to peer review."*

CAHA notes that:

> *"Large scale commercial wind farms however have been in operation internationally for many decades, often in close proximity to thousands of people, and there has been no evidence of any significant rise in disease rates."*

This, it states, contrasts with the health effects of fossil fuel energy generation.

6. ***'Wind Turbine Health Impact Study -Report of Independent Expert Panel' –*** *Massachusetts Departments of Environmental Protection and Public Health (2012)*

An expert panel was established with the objective to, inter alia, evaluate information from peer-reviewed scientific studies, other reports, popular media and public comments and to assess the magnitude and frequency of any potential effects and risks to human health associated with the design and operation of wind energy turbines. In its final report, the expert panel set out its conclusions under several headings, including noise and shadow flicker.

In relation to noise, the panel concluded that there was limited or no evidence to indicate any causal link between noise from wind turbines and health effects, including the following conclusions:

> *"There is no evidence for a set of health effects, from exposure to wind turbines that could be characterized as a "Wind Turbine Syndrome."*
>
> *The strongest epidemiological study suggests that there is not an association between noise from wind turbines and measures of psychological distress or mental health problems. There were two smaller, weaker, studies: one did note an association, one did not. Therefore, we conclude the weight of the evidence suggests no association between noise from wind turbines and measures of psychological distress or mental health problems.*
>
> *None of the limited epidemiological evidence reviewed suggests an association between noise from wind turbines and pain and stiffness, diabetes, high blood pressure, tinnitus, hearing impairment, cardiovascular disease, and headache/migraine."*

In relation to shadow flicker, the expert panel found the following:

> *"Scientific evidence suggests that shadow flicker does not pose a risk for eliciting seizures as a result of photic stimulation.*
>
> *There is limited scientific evidence of an association between annoyance from prolonged shadow flicker (exceeding 30 minutes per day) and potential transitory cognitive and physical health effects."*

7. ***Wind Turbines and Health, A Critical Review of the Scientific Literature,*** *Massachusetts Institute of Technology (Journal of Occupational and Environmental Medicine Vol. 56, Number 11, November 2014)*

This review assessed the peer-reviewed literature regarding evaluations of potential health effects among people living in the vicinity of wind turbines. The review posed a number of questions around the effect of turbines on human health, with the aim of determining if stress, annoyance or sleep disturbance occur as a result of living in proximity to wind turbines, and whether specific aspects of wind turbine noise have unique potential health effects. The review concluded the following with regard to the above questions:

- Measurements of low-frequency sound, infrasound, tonal sound emission, and amplitude-modulated sound show that infrasound is emitted by wind turbines. The levels of infrasound at customary distances to homes are typically well below audibility thresholds.
- No cohort or case–control studies were located in this updated review of the peer-reviewed literature. Nevertheless, among the cross-sectional studies of better quality, no clear or consistent association is seen between wind turbine noise and any reported disease or other indicator of harm to human health.

- Components of wind turbine sound, including infrasound and low frequency sound, have not been shown to present unique health risks to people living near wind turbines.
- Annoyance associated with living near wind turbines is a complex phenomenon related to personal factors. Noise from turbines plays a minor role in comparison with other factors in leading people to report annoyance in the context of wind turbines.

A further 25 reviews of the scientific evidence that universally conclude that exposure to wind farms and the sound emanating from wind farms does not trigger adverse health effects, were compiled in September 2015 by Professor Simon Chapman, of the School of Public Health and Sydney University Medical School, Australia, and is included as Appendix 5-1 of this EIAR. Another recent publication by Chapman and Crichton (2017) entitled '*Wind turbine syndrome; A communicated disease'* critically discusses why certain health effects might often be incorrectly attributed to wind turbines.

8. ***Position Paper on Wind Turbines and Public Health:*** *HSE Public Health Medicine Environment and Health Group, February 2017*

The Health Service Executive (HSE) position paper on wind turbines and public health was published in February 2017 to address the rise in wind farm development and concerns regarding potential effects on public health. The paper discusses previous observations and case studies which describe a broad range of health effects that are associated with wind turbine noise, shadow flicker and electromagnetic radiation.

A number of comprehensive reviews conducted in recent years to examine whether these health effects are proven has highlighted the lack of published and high-quality scientific evidence to support adverse effects of wind turbines on health.

The HSE position paper determines that current scientific evidence on adverse effects of wind farms on health is weak or absent. Further research and investigative processes are required at a larger scale in order to be more informative for identifying potential health effects of exposure to wind turbine effects. They advise developers on making use of the Draft Wind Energy Development Guidelines (2006), as a means of setting noise limits and set back distances from the nearest dwellings.

9. ***Environmental Noise Guidelines for the European Region:*** *World Health Organisation Regional Office for Europe, 2018.*

The WHO Environmental Noise Guidelines provide recommendations for protecting human health from exposure to environmental noise originating from various sources such as transportation noise, wind turbine noise and leisure noise. The Guideline Development Group (GDG) defined priority health outcomes and from this were able to produce guideline exposure levels for noise exposure.

For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB Lden. The GDG recognise the potential for increased risk of annoyance at levels below this value but cannot determine whether this increase risk can impact health. Wind turbine noise above this level is associated with adverse health effects.

The GDG points out that evidence on health effects from wind turbine noise (apart from annoyance) is either absent or rated low/very low quality. Furthermore, public perception towards wind turbines are hard to differentiate from reported effects related to noise and the two may be inextricably linked. The GDG also recognises that the percentage of people exposed to noise from wind turbines is far lower than other sources such as road traffic and state that any benefit from specifically reducing population exposure to wind turbine noise in all situations remains unclear.

That being said, the GDG recommends renewable energy policies include provisions to ensure noise levels from wind farm developments do not rise above the guideline values for average noise exposure. The GDG also provides a conditional recommendation for the implementation of suitable measures to reduce noise exposure, however, it states that no evidence is available to facilitate the recommendation of one type of intervention over another.

10. ***Infrasound Does Not Explain Symptoms Related to Wind Turbines:*** *Finnish Government's Analysis, Assessment and Research Activities (VN TEAS), 2020*

The study targeted to adverse health effects of wind turbine infrasound and was funded by the Finnish Government's Analysis, Assessment and Research Activities (VN TEAS).

It was found that the low-frequency, inaudible sounds made by wind turbines are not damaging to human health despite fears that they cause unpleasant symptoms. The project, which was carried out over two years, examined the impact of low-frequency—or infrasound—emissions which cannot be picked up by the human ear.

People in many countries have blamed the infrasound waves for symptoms ranging from headaches and nausea to tinnitus and cardiovascular problems, researchers said.

Interviews, sound recordings and laboratory tests were used to explore possible health effects on people living within 20 kilometres (12 miles) of the generators.

The report notes:

> *'...the behavioral findings of the current study suggest that wind turbine infrasound cannot be reliably perceived and it does not result in increased annoyance. Participants that showed health effects did not show signs of increased infrasound sensitivity and did not rate wind turbine sounds more annoying.*

As a result:

> *'These findings do not support the hypothesis that infrasound is the element in turbine sound that causes annoyance. Instead, they suggest that people who have health symptoms which they associate with wind turbine sound are not likely to have these symptoms because they perceive turbine sound more annoying than controls, at least in laboratory settings. It is more likely that these symptoms are triggered by other factors such as symptom expectancy'.*

5.6.3 Turbine Safety

Turbines pose no threat to the health and safety of the general public. The Department of the Environment, Heritage and Local Government (DoEHLG)'s '*Wind Energy Development Guidelines for Planning Authorities 2006*' (referred to as the Guidelines) and the '*Draft Revised Wind Energy Development Guidelines'* (December 2019) (referred to as the draft Guidelines) (iterate that there are no specific safety considerations in relation to the operation of wind turbines. Fencing or other restrictions are not necessary for safety considerations and should be kept to a minimum. People or animals can safely walk up to the base of the turbines.

The Guidelines and the draft Guidelines state that there is a very remote possibility of injury to people from flying fragments of ice or from a damaged blade. Modern turbine blades are composite structures with no bolts or separate components; therefore, danger is minimised. Furthermore, the proposed wind turbines will be fitted with anti-vibration sensors which will detect any imbalance caused by icing of the blades. These sensors will cause the turbine to wait until the blades have been de-iced prior to beginning operation. As such, turbines are designed in such a way that ice throw/projection is not a significant risk. Furthermore, the Site (and the State) falls within the International Energy Agency (IEA) Ice Class 1 Category, which correlates to a *Low* icing frequency.

Turbine blades are manufactured of glass reinforced plastic which will prevent any likelihood of an increase in lightning strikes within the Site or the local area. Lightning protection conduits will be integral to the construction of the turbines. Lightning conduction cables, encased in protection conduits, will follow the electrical cable run, from the nacelle to the base of the turbine. The conduction cables will be earthed adjacent to the turbine base. The earthing system will be installed during the construction of the turbine foundations.

The International Electrotechnical Commission (IEC) is a global organization that develops and publishes international standards for electrical and electronic technologies. One of the areas where the IEC has played a significant role is in the standardization of wind turbines. The IEC has developed a series of standards specifically for wind turbines, which cover various aspects such as design, testing, and performance. The IEC 61400-1 "Wind turbines – Part 1: Design requirements" provides guidelines and requirements for the design of wind turbines, including considerations for environmental conditions[3]. This standard covers a range of conditions that wind turbines may encounter, including those related to icing. It sets out criteria for the structural design, safety systems, and other aspects to ensure that wind turbines can operate safely and effectively in various environments.[4] As such, the Proposed Project, and like those across Ireland and in many other countries, is generally designed and assessed according to international standards, with the IEC standards being frequently employed in this process. Additionally, regulatory entities and energy authorities at the national level, such as the SEAI, often refer to and align their guidance with internationally recognized standards, including those established by the IEC, such as IEC 61400-1 for wind turbines. In conclusion, the Proposed Project adheres to the criteria specified in both the IEC 61400-1 design requirements and the SEAI guidance.

Turbine blades are manufactured of fiberglass and wood which will prevent any likelihood of an increase in lightning strikes within the site of the Proposed Project or the local area. Lightning protection conduits will be integral to the construction of the turbines. Lightning conduction cables, encased in protection conduits, will follow the electrical cable run, from the nacelle to the base of the turbine. The conduction cables will be earthed adjacent to the turbine base. The earthing system will be installed during the construction of the turbine foundations.

5.6.4 Electromagnetic Interference

The provision of underground electric cables of the capacity proposed is common practice throughout the country and installation to the required specification does not give rise to any specific health concerns.

The extremely low frequency (ELF) electric and magnetic fields (EMF) associated with the operation of the proposed cables fully comply with the international guidelines for ELF-EMF set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), a formal advisory agency to the World Health Organisation, as well as the EU guidelines for human exposure to EMF. Accordingly, there will be no operational impact on properties (residential or other uses) as the ICNIRP guidelines will not be exceeded at any distances even directly above the cables.

The ESB document 'EMF & You' (ESB, 2017)[5] provides further practical information on EMF.

Further details on the potential effects of electromagnetic interference to telecommunications and aviation are presented in Chapter 14: Material Assets.

5.6.5 Assessment of Effects on Human Health

As set out in the Department of Housing, Planning, Community and Local Government '*Key Issues Consultation Paper on the Transposition of the EIA Directive 2017*' and the guidance listed in Section 1.3.3 of Chapter 1: Introduction, the consideration of the effects on populations and on human health

[5] *EMF & You: Information about Electric & Magnetic Fields and the electricity network in Ireland Available at: https://esb.ie/docs/default-source/default-document-library/emf-public-information_booklet_v9.pdf?sfvrsn=0.*

should focus on health issues and environmental hazards arising from the other environmental factors, for example water contamination, air pollution, noise, accidents, disasters.

Chapter 5: Population and Human Health (including Shadow Flicker), Chapter 8: Land, Soils and Geology, Chapter 9: Water, Chapter 10: Air Quality and Chapter 11: Climate, Chapter 12: Noise and Vibration and Chapter 15: Material Assets (Traffic and Transport) provide an assessment of the effects of the Proposed Project on these areas of consideration. There is the potential for negative effects on human health during the wind farm construction phase related to potential emissions to air of dust, potential emissions to land and water of hydrocarbons, release of potentially silt-laden runoff into watercourses and noise emissions.

The proposed site design and mitigation measures outlined in Chapter 8 and Chapter 9 ensures that the potential for effects on the water environment are not significant. No effects on local water supplies are anticipated.

As set out in Chapter 9, potential health effects are associated with negative effects on public and private water supplies and potential flooding. There are no mapped public or group water scheme groundwater protection zones in the area of the Proposed Project site. The Proposed Wind Farm is located within the Group Water Schemes (GWSs) of Caherlea, Cluide – Cahermorris, and Cahermorris Glenreevagh. Chapter 9 provides details on potential impacts to these GWSs.

The detailed Flood Risk Assessment in Appendix 9-1 has also shown that the risk of the Proposed Project contributing to flooding is very low.

A wind farm is not a recognised source of pollution. It is not an activity which requires Environmental Protection Agency licensing under the Environmental Protection Agency Act 1992, as amended. As such, a wind farm is not considered to have ongoing significant emissions to environmental media and the subsequent potential for human health effects.

The Proposed Project is for the development of a renewable energy project, a wind farm, capable of offsetting carbon emissions associated with the burning of fossil fuels. During the operational stage the Proposed Wind Farm will have a long term, significant, positive effect on air quality as set out in Chapter 10 which will contribute to positive effects on human health.

The provision of aviation lighting on permitted turbines is a standard and accepted part of any wind farm development. This is a safety requirement of the Irish Aviation Authority (IAA). The standard lighting required by the IAA are medium intensity lights. Such lighting is designed specifically for aviation safety and is not intended to be overbearing or dominant when viewed from the ground thus striking a reasonable balance between aviation safety and visual effect. The IAA generally only confirm lighting arrangements required for wind farm developments once a consent is in place.

It is considered that aviation lighting on the proposed turbines will have no significant effect on human health, beyond increasing aircraft safety in the context of the Proposed Project. The applicant will continue its engagement with IAA as required in relation to aviation lighting.

The assessments show that the residual effects are not significant and do not have the potential to cause negative health effects for human beings. On this basis, the potential for negative health effects associated with the Proposed Project is imperceptible.

5.6.6 Vulnerability of the Project to Natural Disasters and Major Accidents

As outlined in Section 5.6.2 above, a wind farm is not a recognised source of pollution. Should a major accident or natural disaster occur, the potential sources of pollution onsite during the construction, operational and decommissioning phases, are limited. Sources of pollution with the potential to cause significant environmental pollution and associated negative effects on health, such as bulk storage of hydrocarbons or chemicals, storage of wastes etc., are limited.

In the context of the Proposed Project site, there is limited potential for significant natural disasters to occur. Ireland is a geologically stable country with a mild temperate climate. The potential natural disasters that may occur are therefore limited to peat instability, flooding and fire. The risk of flooding and potential for contamination of groundwater and drinking water due to the construction of the Proposed Project is addressed in Chapter 9: Hydrology and Hydrogeology, with the risk being limited due to the proposed mitigation measures and site drainage plan, meaning there is limited risk to human health. It is considered that the risk of significant fire occurring, affecting the Proposed Wind Farm and causing the wind farm to have significant environmental effects is limited and therefore a significant effect on human health is similarly limited. As outlined in Chapter 8 of this EIAR, due to the soils upon which the Proposed Wind Farm is not underlain by any peat soils, so there is no risk of peat instability. There are peat soils mapped and observed along the Proposed Grid Connection underground cabling route, however, due to the nature of the proposed works and the fact that the underground cable is to be located fully within the road corridor, there is no risk of peat instability along the Proposed Grid Connection underground cabling route either. As described earlier, there are no significant sources of pollution in the wind farm with the potential to cause environmental or health effects. Also, the spacing of the turbines and distance of turbines from any properties limits the potential for effects on human health. The issue of turbine safety is addressed in Section 5.5.2.

Major industrial accidents involving dangerous substances pose a significant threat to humans and the environment; such accidents can give rise to serious injury to people or serious damage to the environment, both on and off the site of the accident. The Site is not regulated under the Control of Major Accident Hazards Involving Dangerous Substances Regulations i.e. SEVESO sites and so there are no potential effects from this source. A Major Accidents and Natural Disasters assessment is included as Chapter 16.

5.7 Property Values

In the absence of any Irish studies on the effect of wind farms on property values, this section provides a summary of the largest and most recent studies from the UK, Scotland and the United States.

A study was commissioned by RenewableUK and carried out by the Centre for Economics and Business Research (Cebr) in March 2014. Its main conclusions are:

- Overall, the analysis found that the county-wide property market drives local house prices, not the presence or absence of wind farms.
- The econometric analysis established that construction of wind farms at the five sites examined across England and Wales has not had a detectable negative impact on house price growth within a five-kilometre radius of the sites.

A relatively new study issued in October 2016 '*Impact of wind Turbines on House Prices in Scotland*' (2016) was published by Climate Exchange. Climate Exchange is Scotland's independent centre of expertise on climate change which exists to support the Scottish Governments policy development on climate and the transition to a low carbon economy. A copy of the report is included as Appendix 5-2 of this EIAR.

The report presents the main findings of a research project estimating the impact on house prices from wind farm developments. It is based on analysis of over 500,000 property sales in Scotland between 1990 and 2014. The key findings from the study are:

- No evidence of a consistent negative effect on house prices: Across a very wide range of analyses, including results that replicate and improve on the approach used by

Gibbons (2014[6]), we do not find a consistent negative effect of wind turbines or wind farms when averaging across the entire sample of Scottish wind turbines and their surrounding houses. Most results either show no significant effect on the change in price of properties within 2km or 3km or find the effect to be positive.

- Results vary across areas: The results vary across different regions of Scotland. Our data does not provide sufficient information to enable us to rigorously measure and test the underlying causes of these differences, which may be interconnected and complex.

Although there have been no empirical studies carried out in Ireland on the effects of wind farms on property prices, the literature described above demonstrates that at an international level, wind farms have not impacted property values in the local areas. It is a reasonable assumption based on the available international literature, that the provision of a wind farm at the proposed location would not impact on the property values in the area.

The largest study of the impact of wind farms on property values has been carried out in the United States. '*The Impact of Wind Power Projects on Residential Property Values in the United States: A multi-Site Hedonic Analysis*', December 2009, was carried out by the Lawrence Berkley National Laboratory (LBNL) for the U.S Department of Energy. This study collected data on almost 7,500 sales of single-family homes situated within ten miles of 24 existing wind farms in nine different American states over a period of approximately ten years. The conclusions of the study are drawn from eight different pricing models including repeat sales and volume sales models. Each of the homes included in the study was visited to demonstrate the degree to which the wind facility was visible at the time of the sale, and the conclusions of the report state that "*The result is the most comprehensive and data rich analysis to date on the potential impacts of wind energy projects on nearby property values.*"

The main conclusion of this study (as detailed on Page XVII) is as follows:

> *"Based on the data and analysis presented in this report, no evidence is found that home prices surrounding wind facilities are consistently, measurably, and significantly affected by either the view of wind facilities or the distance of the home to those facilities. Although the analysis cannot dismiss the possibility that individual or small numbers of homes have been or could be negatively impacted, if these impacts do exist, they are either too small and/or too infrequent to result in any widespread and consistent statistically observable impact.*"

This study has been recently updated by LBNL who published a further paper entitled '*A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States*', in August 2013. This study analysed more than 50,000 home sales near 67 wind farms in 27 counties across nine U.S. states, yet was unable to uncover any effects to nearby home property values. The homes were all within 10 miles of the wind energy facilities - about 1,100 homes were within 1 mile, with 331 within half a mile. The report is therefore based on a very large sample and represents an extremely robust assessment of the effects of wind farm development on property prices. It concludes that:

> *"Across all model Specifications, we find no statistical evidence that home prices near wind turbines were affected in either the post-construction or post announcement/pre-construction periods."*

Both LBNL studies note that their results do not mean that there will never be a case of an individual home whose value goes down due to its proximity to a wind farm – however if these situations do exist, they are considered to be statistically insignificant. Therefore, although there have been claims of significant property value effects near operating wind turbines that regularly surface in the press or in

[6] *Stephen Gibbons, 2014. "Gone with the Wind: Valuing the Visual Impacts of Wind Turbines through House Prices," SERC Discussion Papers 0159, Spatial Economics Research Centre, LSE.*

local communities, strong evidence to support those claims has failed to materialise in all the major U.S. studies conducted thus far.

5.8 Residential Amenity

Residential amenity relates to the human experience of one's home, derived from the general environment and atmosphere associated with the residence. The quality of residential amenity is influenced by a combination of factors, including site setting and local character, land-use activities in the area and the relative degree of peace and tranquillity experienced in the residence.

As noted previously, the current land-use for the Proposed Project site is small-scale agricultural practices, predominantly livestock grazing, pasture and sileage. The closest occupied third-party dwelling to the Proposed Project is located 768m from T1. In addition, an assessment of roadside screening was also carried out for all national roads within 5km of the proposed turbine locations, with both the methodology and findings being presented in Chapter 13 of this EIAR.

When considering the amenity of residents in the context of a proposed wind farm, there are four main potential effects of relevance: 1) Shadow Flicker, 2) Noise, and 3) Visual Amenity and 4) Telecommunications. Shadow flicker and noise are quantifiable aspects of residential amenity while visual amenity is more subjective. Detailed shadow flicker and noise modelling have been completed as part of this EIAR (Section 5.7 above refers to shadow flicker modelling, Chapter 12 addresses noise). A comprehensive landscape and visual impact assessment has also been carried out, as presented in Chapter 14 of this EIAR. Effects on human beings during the construction, operational and decommissioning phases of the Proposed Project is assessed in relation to each of these key issues and other environmental factors such as noise, traffic and dust; see Effects in Section 5.9 below. The impact on residential amenity is then derived from an overall judgement of the combination of effects due to shadow flicker, changes to land-use and visual amenity, noise, traffic, dust and general disturbance

Drawing Title
Shadow Flicker Assessment Area

Project Title
Laurclavagh Renewable Energy Development

Drawn By	Checked By
NMc	ÓM
Project No. ******	Drawing No. ******
Scale NTS	Date **/**/****

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5.9 Shadow Flicker Assessment Results

5.9.1 Daily and Annual Shadow Flicker

The WindFarm computer software (version number 5.0.2.2) was used to model the predicted daily and annual shadow flicker levels in significant detail, identifying the predicted daily start and end times, maximum daily duration and the individual turbines predicted to give rise to shadow flicker.

The model results assume worst-case conditions, including;

- 100% sunshine during all daylight hours throughout the year,
- An absence of any screening (vegetation or other buildings),
- That the sun is behind the turbine blades,
- That the turbine blades are facing the property, and
- That the turbine blades are moving.

The maximum daily shadow flicker model assumes that daylight hours consist of 100% sunshine. This is a conservative assumption which represents a worst-case scenario. Following the detail provided above on sunshine hours, a sunshine factor of 26.46% has been applied to the annual shadow flicker results as detailed above. Taking this information into consideration, the predicted shadow flicker which is estimated to occur at nearby sensitive receptors is presented in Table 5-10.

The predicted maximum daily and annual shadow flicker levels are then considered in the context of the Guidelines' recommendation of committing to less than 30 minutes of shadow flicker per day, or less than 30 hours of shadow flicker per year. If there is any predicted exceedance of shadow flicker at any property, the turbines that contribute to the exceedance are also identified, with mitigation measures required for these contributing turbines.

A total of 243 no. residential buildings have been included in the shadow flicker assessment, the results of which are presented in Table 5-10 below.

Table 5-10 Maximum Potential Daily & Annual Shadow Flicker – Proposed Laurclavagh Renewable Energy Development

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H001	536831	742784	Dwelling*	768	T06	00:31:48	25:27:36	6:44:11	T03	No	No
H002	534804	742372	Dwelling	768	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H003	537425	742687	Dwelling	831	T07	00:00:00	0:00:00	0:00:00	N/A	No	No
H004	534778	742366	Dwelling	771	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H005	534752	742365	Dwelling	771	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H006	534837	742373	Dwelling	771	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H007	534721	742364	Dwelling	771	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H008	534872	742376	Dwelling	774	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H009	539187	745019	Dwelling	1514	T08	00:25:48	14:49:12	3:55:16	N/A	No	No
H010	539603	744322	Dwelling	1421	T08	00:28:48	14:03:00	3:43:03	N/A	No	No
H011	539162	745038	Dwelling	1515	T08	00:22:48	11:16:12	2:58:55	N/A	No	No
H012	537892	742837	Dwelling	856	T07	00:35:24	30:21:00	8:01:48	T06	Yes	Yes
H013	539272	744974	Dwelling	1532	T08	00:27:36	21:49:48	5:46:33	N/A	No	No
H014	533928	743226	Dwelling	796	T01	00:48:36	57:07:48	15:06:56	1 T0	Yes	Yes
H015	539247	744993	Dwelling	1531	T08	00:27:00	19:26:24	5:08:37	N/A	No	No
H016	537213	742676	Dwelling	855	T07	00:00:00	0:00:00	0:00:00	N/A	No	No
H017	535078	742418	Dwelling*	802	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H018	539026	743502	Dwelling*	808	T08	00:51:00	81:43:12	21:37:18	T08	No	No
H019	535612	742519	Dwelling	810	T03	00:39:36	36:36:00	9:41:01	T01	Yes	Yes
H020	538458	743018	Dwelling	810	T08	00:35:24	34:58:12	9:15:09	T07	Yes	Yes
H021	534571	743983	Dwelling	817	T02	00:48:00	60:01:48	15:52:59	T02, T03	Yes	Yes

**Participating Landowner*

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H022	535258	742518	Dwelling*	819	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H023	538998	745126	Dwelling	1502	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H024	536822	745187	Dwelling	822	T04	00:34:12	17:52:48	4:43:51	T04	Yes	Yes
H025	535966	742579	Dwelling*	824	T03	00:31:12	22:24:36	5:55:46	T01	No	No
H026	534936	742335	Dwelling*	829	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H027	537780	744471	Dwelling	829	T08	01:16:48	127:18:36	33:41:03	T04, T06, T08	Yes	Yes
H028	537992	742880	Dwelling	889	T07	00:33:36	39:57:36	10:34:22	T06	Yes	Yes
H029	539144	743566	Dwelling	899	T08	00:45:00	43:39:00	11:32:57	T08	Yes	Yes
H030	539627	744173	Dwelling	1398	T08	00:28:48	13:49:48	3:39:33	N/A	No	No
H031	534522	742325	Dwelling	834	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H032	539077	743532	Dwelling	845	T08	00:48:00	60:11:24	15:55:31	T08	Yes	Yes
H033	538020	742887	Dwelling	904	T07	00:33:00	39:59:24	10:34:50	T06	Yes	Yes
H034	539641	744493	Dwelling	1525	T08	00:27:00	13:08:24	3:28:36	N/A	No	No
H035	534497	742317	Dwelling	848	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H036	539091	745127	Dwelling	1549	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H037	534568	744081	Dwelling	850	T02	00:46:12	58:51:36	15:34:24	T02, T03	Yes	Yes
H038	539131	745117	Dwelling	1562	T08	00:08:24	1:21:00	0:21:26	N/A	No	No
H039	539633	744549	Dwelling	1544	T08	00:27:00	13:16:12	3:30:40	N/A	No	No
H040	539614	744613	Dwelling	1560	T08	00:27:00	13:46:12	3:38:36	N/A	No	No
H041	539518	743850	Dwelling	1241	T08	00:32:24	17:29:24	4:37:39	T08	Yes	Yes
H042	539109	743527	Dwelling	877	T08	00:46:48	53:03:36	14:02:20	T08	Yes	Yes

**Participating Landowner*

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H043	539667	744393	Dwelling	1507	T08	00:27:36	12:41:24	3:21:27	N/A	No	No
H044	535312	744638	Dwelling	862	T02	00:30:36	33:40:12	8:54:31	T04	Yes	Yes
H045	536743	745247	Dwelling	863	T04	00:00:00	0:00:00	0:00:00	N/A	No	No
H046	538052	742893	Dwelling	923	T07	00:32:24	38:40:12	10:13:53	T06	Yes	Yes
H047	535260	744639	Dwelling	868	T02	00:30:00	31:06:36	8:13:52	N/A	No	No
H048	536810	745241	Dwelling	871	T04	00:19:48	5:55:12	1:33:59	N/A	No	No
H049	539542	743856	Dwelling	1265	T08	00:31:48	16:49:12	4:27:01	T08	Yes	Yes
H050	536074	742581	Dwelling	873	T03	00:28:48	40:26:24	10:41:59	N/A	No	No
H051	539677	744205	Dwelling	1454	T08	00:28:12	12:48:36	3:23:22	N/A	No	No
H052	535892	742495	Dwelling	876	T03	00:31:48	37:09:00	9:49:45	T01	Yes	Yes
H053	534737	742257	Dwelling	878	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H054	534516	744024	Dwelling	881	T02	00:44:24	53:15:36	14:05:30	T02, T03	Yes	Yes
H055	535916	742496	Dwelling	883	T03	00:31:48	32:47:24	8:40:32	T01	Yes	Yes
H056	539433	743702	Dwelling	1160	T08	00:34:48	21:09:36	5:35:55	T08	Yes	Yes
H057	536771	742673	Dwelling	885	T06	00:32:24	39:55:12	10:33:44	T03	Yes	Yes
H058	534252	742383	Dwelling	885	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H059	535938	742501	Dwelling	886	T03	00:31:12	28:26:24	7:31:29	T01	Yes	Yes
H060	537587	744368	Dwelling*	879	T07	01:08:24	132:17:24	35:00:06	T04, T05, T06, T08	No	No
H061	534535	744104	Dwelling	889	T02	00:44:24	54:56:24	14:32:10	T02, T03	Yes	Yes
H062	538438	742931	Dwelling	891	T08	00:35:24	45:31:12	12:02:38	T07	Yes	Yes
H063	535361	744672	Dwelling	895	T02	00:31:48	36:45:00	9:43:24	T04	Yes	Yes

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H064	539698	744213	Dwelling*	1477	T08	00:27:36	12:30:00	3:18:26	N/A	No	No
H065	538328	742913	Dwelling	896	T08	00:39:36	59:46:48	15:49:00	T06, T07	Yes	Yes
H066	535551	742435	Dwelling	897	T03	00:20:24	8:40:48	2:17:48	N/A	No	No
H067	535496	744664	Dwelling	897	T02	00:35:24	48:31:48	12:50:25	T04, T05	Yes	Yes
H068	538371	742913	Dwelling	900	T08	00:40:12	60:06:36	15:54:15	T06, T07	Yes	Yes
H069	538258	742908	Dwelling	900	T08	00:39:36	56:24:00	14:55:21	T06, T07	Yes	Yes
H070	538294	742907	Dwelling	901	T08	00:39:08	57:58:12	15:20:16	T06, T07	Yes	Yes
H071	536119	742575	Dwelling	902	T03	00:28:12	35:25:48	9:22:27	N/A	No	No
H072	535236	742396	Dwelling	902	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H073	535516	742431	Dwelling	904	T03	00:09:36	2:03:36	0:32:42	N/A	No	No
H074	535988	742501	Dwelling	904	T03	00:30:06	23:55:12	6:19:44	T01	Yes	Yes
H075	537657	744465	Dwelling	904	T08	01:13:48	132:42:00	35:06:37	T04, T05, T06, T08	Yes	Yes
H076	538806	745233	Dwelling	1520	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H077	534502	744070	Dwelling	909	T02	00:43:12	51:36:36	13:39:19	T02, T03	Yes	Yes
H079	536887	742636	Dwelling	913	T06	00:30:00	31:31:12	8:20:23	N/A	No	No
H080	535531	744675	Dwelling	914	T02	00:36:00	54:37:12	14:27:06	T04, T05	Yes	Yes
H081	536920	742635	Dwelling	914	T06	00:29:24	26:10:12	6:55:27	N/A	No	No
H082	536863	742635	Dwelling	915	T06	00:30:36	34:37:12	9:09:36	T03	Yes	Yes
H083	536026	742507	Dwelling	915	T03	00:29:24	21:15:36	5:37:30	N/A	No	No
H085	536829	742628	Dwelling	923	T06	00:31:12	36:55:48	9:46:16	T03	Yes	Yes
H086	535507	742406	Dwelling	930	T03	00:00:00	0:00:00	0:00:00	N/A	No	No

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H087	538134	742888	Dwelling	931	T08	00:31:12	41:39:36	11:01:21	T06, T07	Yes	Yes
H088	534470	744044	Dwelling	931	T02	00:42:36	48:37:12	12:51:51	T02, T03	Yes	Yes
H089	535711	744697	Dwelling	938	T04	00:42:00	66:15:36	17:31:53	T04, T05	Yes	Yes
H090	535477	742402	Dwelling	939	T03	00:00:00	0:00:00	0:00:00	N/A	No	No
H091	538803	745272	Dwelling	1555	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H092	539725	744089	Dwelling	1474	T08	00:27:36	12:10:48	3:13:21	N/A	No	No
H093	537662	744530	Dwelling*	949	T08	01:10:12	117:24:00	31:03:43	T04, T05, T06, T08	No	No
H094	538517	742888	Dwelling	951	T08	00:33:00	40:28:12	10:42:28	T07	Yes	Yes
H095	538333	742854	Dwelling	956	T08	00:37:12	51:46:48	13:42:00	T06, T07	Yes	Yes
H096	539655	743876	Dwelling	1379	T08	00:29:24	14:10:12	3:44:57	N/A	No	No
H097	538782	745285	Dwelling	1561	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H098	538388	742854	Dwelling	960	T08	00:36:00	38:01:48	10:03:44	T07	Yes	Yes
H099	538288	742847	Dwelling	961	T08	00:36:00	47:59:24	12:41:50	T06, T07	Yes	Yes
H101	539770	744213	Dwelling	1546	T08	00:26:24	11:22:48	3:00:39	N/A	No	No
H102	534470	744160	Dwelling*	971	T02	00:40:48	48:25:48	12:48:50	T02	No	No
H103	538677	745291	Dwelling	1536	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H104	537590	744497	Dwelling	974	T08	01:06:00	121:14:24	32:04:41	T04, T05, T06, T08	Yes	Yes
H105	536282	742610	Dwelling	975	T03	00:18:00	7:42:00	2:02:14	N/A	No	No
H106	538751	745304	Dwelling	1569	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H107	538689	742919	Dwelling	979	T08	00:29:24	21:07:12	5:35:17	N/A	No	No
H108	539717	743955	Dwelling	1446	T08	00:28:12	12:43:48	3:22:05	N/A	No	No

**Participating Landowner*

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H109	539770	744128	Dwelling	1526	T08	00:27:00	11:32:24	3:03:12	N/A	No	No
H110	539733	743991	Dwelling	1466	T08	00:27:36	12:20:24	3:15:54	N/A	No	No
H111	539698	743896	Dwelling*	1423	T08	00:28:12	13:16:48	3:30:49	N/A	No	No
H112	535587	744747	Dwelling	996	T02	00:37:12	57:33:36	15:13:46	T04, T05	Yes	Yes
H113	539775	744043	Dwelling	1515	T08	00:27:00	11:36:36	3:04:19	N/A	No	No
H114	538704	745330	Dwelling	1580	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H115	536597	742582	Dwelling	1012	T06	00:31:48	20:27:36	5:24:48	T03	Yes	Yes
H116	538240	742797	Dwelling	1012	T08	00:28:48	36:11:24	9:34:31	N/A	No	No
H117	537709	744645	Dwelling*	1012	T08	01:04:12	85:24:36	22:35:53	T04, T08	No	No
H118	538903	742990	Dwelling	1029	T08	00:25:48	13:23:24	3:32:34	N/A	No	No
H119	538819	742931	Dwelling	1030	T08	00:27:00	16:02:24	4:14:38	N/A	No	No
H120	539563	745030	Dwelling	1773	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H122	538579	745343	Dwelling	1564	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H123	539822	744043	Dwelling	1562	T08	00:26:24	11:00:36	2:54:47	N/A	No	No
H124	533785	743625	Dwelling	1055	T01	00:38:24	38:16:12	10:07:32	T01	Yes	Yes
H125	539566	745064	Dwelling	1799	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H127	539854	744078	Dwelling	1599	T08	00:25:48	10:29:24	2:46:32	N/A	No	No
H128	538989	743003	Dwelling*	1074	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H129	533863	743786	Dwelling*	1075	T01	00:38:24	44:46:48	11:50:53	T01	Yes	Yes
H130	539830	743980	Dwelling	1562	T08	00:26:24	10:57:36	2:53:59	N/A	No	No
H131	534166	742206	Dwelling	1081	T01	00:00:00	0:00:00	0:00:00	N/A	No	No

**Participating Landowner*

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H132	533637	743177	Dwelling*	1083	T01	00:36:36	22:49:48	6:02:26	T01	No	No
H134	539020	743011	Dwelling*	1089	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H135	533728	742667	Dwelling	1096	T01	00:38:24	48:53:24	12:56:08	T01	Yes	Yes
H136	539887	744106	Dwelling	1636	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H137	534382	744289	Dwelling	1106	T02	00:36:36	41:38:24	11:01:02	T02, T03	Yes	Yes
H138	534020	742278	Dwelling	1106	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H139	533617	743028	Dwelling	1107	T01	00:36:00	23:15:00	6:09:06	T01	Yes	Yes
H140	533979	742303	Dwelling	1113	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H141	533618	743316	Dwelling	1116	T01	00:35:24	21:00:00	5:33:22	T01	Yes	Yes
H142	533599	743112	Dwelling	1120	T01	00:35:24	21:46:48	5:45:45	T01	Yes	Yes
H144	533599	743170	Dwelling	1121	T01	00:35:24	21:23:24	5:39:34	T01	Yes	Yes
H145	536530	745520	Dwelling	1126	T04	00:00:00	0:00:00	0:00:00	N/A	No	No
H146	533611	743349	Dwelling	1128	T01	00:35:24	20:36:36	5:27:11	T01	Yes	Yes
H147	533949	742304	Dwelling	1133	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H148	539092	743017	Dwelling	1135	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H149	537632	744866	Dwelling	1135	T04	00:35:24	55:16:12	14:37:25	T04, T05, T08	Yes	Yes
H150	533584	743199	Dwelling	1137	T01	00:35:24	20:38:24	5:27:40	T01	Yes	Yes
H151	533586	743235	Dwelling	1137	T01	00:34:48	20:27:36	5:24:48	T01	Yes	Yes
H152	533604	743378	Dwelling	1141	T01	00:34:48	20:15:36	5:21:38	T01	Yes	Yes
H154	536622	745544	Dwelling	1148	T04	00:00:00	0:00:00	0:00:00	N/A	No	No
H156	533921	742304	Dwelling	1152	T01	00:00:00	0:00:00	0:00:00	N/A	No	No

**Participating Landowner*

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H157	539122	743022	Dwelling	1153	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H158	533573	743264	Dwelling	1153	T01	00:34:48	19:50:24	5:14:58	T01	Yes	Yes
H159	534716	744734	Dwelling	1155	T02	00:31:48	24:57:00	6:36:05	T02	Yes	Yes
H161	533564	743298	Dwelling	1166	T01	00:34:12	19:17:24	5:06:14	T01	Yes	Yes
H163	533888	742307	Dwelling	1173	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H164	537629	744975	Dwelling	1182	T04	00:34:48	22:01:48	5:49:44	T04	Yes	Yes
H165	539175	743036	Dwelling	1183	T08	00:14:24	4:24:36	1:10:01	N/A	No	No
H167	539200	743055	Dwelling	1190	T08	00:24:00	11:43:48	3:06:13	N/A	No	No
H168	533578	743493	Dwelling	1196	T01	00:33:36	19:04:48	5:02:54	T01	Yes	Yes
H170	534530	744637	Dwelling	1197	T02	00:34:48	40:00:36	10:35:10	T02	Yes	Yes
H171	539221	743067	Dwelling*	1199	T08	00:30:00	17:25:48	4:36:42	N/A	No	No
H172	533546	743398	Dwelling	1202	T01	00:33:36	18:17:24	4:50:21	T01	Yes	Yes
H174	537716	744877	Dwelling	1208	T08	00:33:00	19:20:24	5:07:01	T04	Yes	Yes
H175	534560	744687	Dwelling	1213	T02	00:33:00	36:55:48	9:46:16	T02	Yes	Yes
H176	534542	744674	Dwelling	1215	T02	00:33:00	38:02:24	10:03:53	T02	Yes	Yes
H177	533770	742365	Dwelling	1222	T01	00:24:36	12:01:48	3:10:59	N/A	No	No
H178	533840	742285	Dwelling	1223	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H179	534013	744141	Dwelling	1229	T01	00:29:24	35:07:12	9:17:32	N/A	No	No
H180	533993	744128	Dwelling	1230	T01	00:30:13	37:43:12	9:58:48	T01	Yes	Yes
H181	534032	744158	Dwelling	1232	T01	00:29:24	32:15:36	8:32:08	N/A	No	No
H182	533948	744103	Dwelling	1238	T01	00:31:12	42:15:00	11:10:43	T01	Yes	Yes

**Participating Landowner*

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H183	534712	744835	Dwelling	1242	T02	00:27:00	13:45:36	3:38:26	N/A	No	No
H185	534625	744780	Dwelling	1245	T02	00:30:36	25:28:12	6:44:20	T02	Yes	Yes
H187	533798	743973	Dwelling*	1245	T01	00:34:12	44:59:24	11:54:13	T01	Yes	Yes
H188	539049	742826	Dwelling	1249	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H189	539166	742918	Dwelling	1257	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H193	539214	742953	Dwelling	1268	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H194	539195	742931	Dwelling	1269	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H195	533848	744062	Dwelling	1272	T01	00:32:24	47:01:12	12:26:27	T01	Yes	Yes
H196	533541	743625	Dwelling	1276	T01	00:31:48	17:40:12	4:40:31	T01	Yes	Yes
H197	539241	742966	Dwelling	1279	T08	00:09:36	2:25:12	0:38:25	N/A	No	No
H198	534504	744729	Dwelling	1282	T02	00:32:24	34:38:24	9:09:55	T02	Yes	Yes
H199	534474	744704	Dwelling	1284	T02	00:33:00	35:58:12	9:31:01	T02	Yes	Yes
H200	533501	743547	Dwelling	1286	T01	00:31:12	16:50:24	4:27:20	T01	Yes	Yes
H201	533689	743905	Dwelling	1286	T01	00:32:24	23:27:00	6:12:16	T01	Yes	Yes
H202	533709	743933	Dwelling	1287	T01	00:33:00	24:48:36	6:33:52	T01	Yes	Yes
H204	533667	743882	Dwelling	1290	T01	00:32:24	20:04:48	5:18:46	T01	Yes	Yes
H205	534366	744598	Dwelling	1291	T02	00:33:00	26:16:48	6:57:12	T02	Yes	Yes
H206	534206	744356	Dwelling*	1293	T02	00:31:48	18:06:36	4:47:30	T02	Yes	Yes
H207	534554	744787	Dwelling	1293	T02	00:30:11	28:17:24	7:29:06	T02	Yes	Yes
H208	538268	745507	Dwelling	1699	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H210	534328	744568	Dwelling	1302	T02	00:32:24	23:29:24	6:12:54	T02	Yes	Yes

**Participating Landowner*

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H212	533817	742183	Dwelling	1311	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H214	534010	744242	Dwelling	1315	T01	00:28:48	24:31:48	6:29:25	N/A	No	No
H215	539312	742994	Dwelling	1316	T08	00:28:12	16:13:48	4:17:39	N/A	No	No
H216	533482	742681	Dwelling	1318	T01	00:31:48	21:29:24	5:41:09	T01	Yes	Yes
H217	535535	742011	Dwelling	1321	T03	00:00:00	0:00:00	0:00:00	N/A	No	No
H218	536698	745716	Dwelling	1324	T04	00:00:00	0:00:00	0:00:00	N/A	No	No
H219	534090	744301	Dwelling*	1325	T01	00:30:00	15:13:48	4:01:47	N/A	No	No
H220	536792	745709	Dwelling	1327	T04	00:00:00	0:00:00	0:00:00	N/A	No	No
H221	534942	745046	Dwelling	1337	T02	00:00:00	0:00:00	0:00:00	N/A	No	No
H222	536721	745733	Dwelling	1343	T04	00:00:00	0:00:00	0:00:00	N/A	No	No
H223	539350	743000	Dwelling	1342	T08	00:31:12	21:47:24	5:45:55	T08	Yes	Yes
H224	535539	741987	Dwelling	1345	T03	00:00:00	0:00:00	0:00:00	N/A	No	No
H225	534865	745036	Dwelling	1354	T02	00:00:00	0:00:00	0:00:00	N/A	No	No
H226	534141	744375	Dwelling*	1360	T02	00:30:16	16:22:48	4:20:02	T02	No	No
H227	536741	745748	Dwelling	1359	T04	00:00:00	0:00:00	0:00:00	N/A	No	No
H228	534730	744982	Dwelling	1361	T02	00:00:00	0:00:00	0:00:00	N/A	No	No
H229	539837	743432	Dwelling	1604	T08	00:25:48	11:59:24	3:10:20	N/A	No	No
H230	533506	743760	Dwelling*	1365	T01	00:30:15	16:48:00	4:26:42	T01	No	No
H232	533525	743817	Dwelling*	1375	T01	00:30:12	17:11:24	4:32:53	T01	No	No
H233	533401	742687	Dwelling	1392	T01	00:30:04	18:07:48	4:47:49	T01	Yes	Yes
H234	535547	741933	Dwelling	1398	T03	00:00:00	0:00:00	0:00:00	N/A	No	No

**Participating Landowner*

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H235	539554	743143	Dwelling	1439	T08	00:30:00	25:47:24	6:49:25	N/A	No	No
H236	539534	743127	Dwelling	1429	T08	00:30:08	30:04:12	7:57:22	T08	Yes	Yes
H237	539649	743204	Dwelling	1498	T08	00:28:12	18:15:36	4:49:53	N/A	No	No
H239	535005	745151	Dwelling	1420	T02	00:00:00	0:00:00	0:00:00	N/A	No	No
H240	539504	743061	Dwelling	1436	T08	00:30:36	35:03:00	9:16:25	T08	Yes	Yes
H241	534050	741858	Dwelling	1442	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H243	539780	743252	Dwelling	1602	T08	00:26:24	13:51:00	3:39:52	N/A	No	No
H244	539729	743174	Dwelling	1583	T08	00:27:00	15:51:00	4:11:37	N/A	No	No
H245	534459	741678	Dwelling	1480	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H246	539753	743180	Dwelling	1603	T08	00:26:24	15:05:24	3:59:33	N/A	No	No
H247	539780	743192	Dwelling	1623	T08	00:26:24	14:15:36	3:46:23	N/A	No	No
H249	534940	745216	Dwelling**	1500	T02	00:00:00	0:00:00	0:00:00	N/A	No	No
H251	533564	744110	Dwelling	1512	T01	00:28:48	20:47:24	5:30:02	N/A	No	No
H252	534062	741772	Dwelling	1513	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H253	533272	742680	Dwelling	1517	T01	00:27:36	14:26:24	3:49:14	N/A	No	No
H254	534043	741775	Dwelling	1519	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H257	533568	744145	Dwelling	1531	T01	00:28:12	22:09:36	5:51:47	N/A	No	No
H258	533996	741784	Dwelling	1532	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H259	533941	741811	Dwelling	1536	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H261	534011	741745	Dwelling	1560	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H262	534091	741697	Dwelling	1569	T01	00:00:00	0:00:00	0:00:00	N/A	No	No

***Derelict Property*

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
H263	535010	745312	Dwelling	1575	T02	00:00:00	0:00:00	0:00:00	N/A	No	No
H264	533904	741786	Dwelling	1576	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H265	533230	742609	Dwelling	1579	T01	00:27:00	14:03:00	3:43:03	N/A	No	No
H266	534118	741669	Dwelling	1584	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H266	534118	741669	Dwelling	1584	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H268	535049	745352	Dwelling	1606	T02	00:00:00	0:00:00	0:00:00	N/A	No	No
H270	533186	742638	Dwelling	1612	T01	00:26:24	12:49:48	3:23:41	N/A	No	No
H515	534037	741668	Dwelling	1618	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H516	538536	745352	Dwelling	1565	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
H518	535393	741822	Dwelling	1476	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H519	535393	741822	Dwelling	1476	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H520	535011	742398	Dwelling	793	T01	00:00:00	0:00:00	0:00:00	N/A	No	No
H531	533647	742611	Dwelling	1194	T01	00:35:24	40:20:24	10:40:24	1	Yes	Yes
H536	538678	742249	Dwelling	1609	T08	00:00:00	0:00:00	0:00:00	N/A	No	No

Of the 243 no. sensitive receptors modelled, it is predicted that 104 no. sensitive receptors may potentially experience daily shadow flicker in excess of the DoEHLG guideline threshold of 30 minutes per day, in the absence of mitigation measures. Of these 104 no. sensitive receptors, 13 no. are participating landowners, and therefore no mitigation is required for these sensitive receptors. Mitigation will therefore be required for the remaining 91 no. properties in order to bring the predicted levels below the threshold of 30 minutes per day and 30 hours per year. This prediction is assuming worst-case conditions (i.e. 100% sunshine on all days where the shadow of the turbines passes over a house, wind blowing in the correct direction, no screening present, etc.) and in the absence of any turbine control measures.

Of the 243 no. properties modelled, when the regional sunshine average (i.e. the mean amount of sunshine hours throughout the year) of 26.46% and is taken into account, the DoEHLG total annual guideline limit of 30 hours is predicted as to being potentially exceeded at 5 no. of the properties. Of these 5 no. properties, 2 no. are participating landowners, and therefore no mitigation is required.

It is worth nothing that in reality, the 'estimated actual' shadow flicker is considered conservative and likely to be significantly less than predicted in Table 5-10 as the following items are not considered by the model:

- Receivers may be screened by cloud cover and/or vegetation/built form i.e. hedging, adjacent buildings, farm buildings, garages or barns;
- Each receiver will not have windows facing in all directions onto the wind farm;
- At distances, greater than 500-1000m *'the rotor blade of a wind turbine will not appear to be chopping the light but the turbine will be regarded as an object with the sun behind it. Therefore, it is generally not necessary to consider shadow casting at such distances[3]'*

Section 5.9.3.14 outlines the mitigation strategies which may be employed at the potentially affected properties to ensure the daily and annual shadow flicker thresholds will not be exceeded.

5.10 Likely Significant Effects and Associated Mitigation Measures

5.10.1 'Do Nothing' Scenario

If the Proposed Project were not to proceed, the existing uses of small-scale agriculture would continue. The opportunity to harness the wind energy resource of County Galway would be lost, as would the opportunity to contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions. The opportunity to generate local employment and investment would also be lost.

5.10.2 Construction Phase

Within this section, the impact will consider the Proposed Project i.e. both the Proposed Wind Farm and the Proposed Grid Connection will be considered as a whole. Where the Proposed Wind Farm and the Proposed Grid Connection are required to be considered separately, this is identified within the assessment.

5.10.2.1 Population

Those working on the construction phase of the Proposed Project will travel daily to the Site from the wider area. The construction phase will have no effect on the population of the area in terms of changes to the population trends or density, household size or age structure.

5.10.2.1.1 *Population Levels*

Pre-Mitigation Impacts

Proposed Wind Farm

Those working on the construction phase of the Proposed Wind Farm (turbines and associated foundations and hardstanding areas, Meteorological mast, access roads, temporary construction compound, underground cabling, site drainage, hedgerow felling, and all ancillary works and apparatus), will travel daily to the Site from the wider area. The construction phase will have no impact on the population of the area in terms of changes to population trends or density, household size or age structure.

Proposed Grid Connection

Those working on the construction phase of the Proposed Grid Connection will travel daily to the site from the wider area. The construction phase will have no impact on the population of the area in terms of changes to population trends or density, household size or age structure.

5.10.2.1.2 *Employment and Investment*

Pre-Mitigation Impacts

Proposed Wind Farm

The design, construction, operation and decommissioning of the Proposed Wind Farm will provide employment for technical consultants, contractors and maintenance staff. As discussed, it is proposed to construct the Proposed Wind Farm and Proposed Grid Connection infrastructure concurrently which would require approximately 100 employees in total, with an estimated 80 jobs focussing on the construction phase of the Proposed Wind Farm. The construction phase of the Proposed Wind Farm will last between 18-24 months and the decommissioning phase will likely last approximately 6-9 months.

The Proposed Wind Farm will result in an influx of skilled people into the area, bringing specialist skills for both the construction and operational phases that could result in the transfer of these skills into the local workforce, thereby having a long-term positive effect on the local skills base. Up-skilling and training of local staff in the particular requirements of the wind energy industry is likely to lead to additional opportunities for those staff as additional wind farms are constructed in Ireland. This will have a long-term moderate positive indirect effect. Wind Energy Ireland estimates that there are over 5,000 people employed in roles related to wind energy in Ireland in 2023 This figure is anticipated to grow significantly in the coming years as the race to achieve the targets set out in the Climate Action Plan accelerates.

Proposed Grid Connection

The design, construction and operation of the Proposed Grid Connection will provide employment for technical consultants, contractors and maintenance staff. As discussed, it is proposed to construct the Proposed Wind Farm and Proposed Grid Connection infrastructure concurrently which would require approximately 100 employees in total, with an estimated 20 jobs focusing on the construction phase of the Proposed Grid Connection. Construction of the Proposed Grid Connection infrastructure is estimated to last approximately 9 months of the overall 18-24month construction timeframe.

Residual Impact

The injection of money in the form of salaries and wages to those employed during the construction phase of the Proposed Project has the potential to result in an increase in household spending and demand for goods and services in the local area. This would result in local retailers and businesses experiencing a short-term positive effect on their cash flow. This will have a short-term slight positive indirect effect.

Significance of Effects

The significance of effects on employment levels and local investment during the construction phase will be slight.

5.10.2.1.3 *Land Use Patterns & Activities*

Pre-Mitigation Impacts

Proposed Wind Farm

Current land use within the Proposed Wind Farm site comprises small scale agriculture. Current land use in the wider landscape comprises of agricultural, commercial and residential activities.

There is no potential for impact on residential and commercial land use in the area. During the construction phase there may be slight interference with agricultural practices where farm practices may be redirected to other fields temporarily.

Proposed Grid Connection

The current land use and activities at the Proposed Grid Connection footprint comprises pastoral agriculture and transport/access along the national and local road network. Within the Proposed Wind Farm site, the Proposed Grid Connection underground cabling route will follow along the proposed internal access routes. Grazing livestock will be removed from these lands as appropriate.

Local temporary traffic disruptions are likely along the N83 and L6141; however, once the construction of each element is complete, agricultural practises can return in the areas surrounding the onsite infrastructure and traffic flow will resume as normal.

The proposed works will be rolling in nature; with 100m to 200m being constructed along the N83 and L6141 at any one time. it is estimated that approx. 118 days will be required to lay the underground grid connection cable in the local road.

With respect to the traffic volumes that will be generated during the construction of the underground cabling route, it is estimated that there will be approximately 144 daily return trips made by a truck transporting materials and construction staff to and from the Site. By its nature the impacts of these additional trips will therefore be temporary and slight.

Mitigation and Monitoring

The following measures will be adhered for the Proposed Project. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

- The construction of the Proposed Grid Connection underground cabling route through the L-61461 local road, N83 National Road, and L6141 Local Road will be undertaken in a rolling construction method with 100m to 200m of cabling installed and back filled each day providing access in the evenings and night hours along the route.
- A Traffic Management Plan, agreed with the Local Authority, will be in place for the construction phase of the Proposed Grid Connection underground cabling route. The Traffic Management Plan is included as Appendix 15-2 to this EIAR.
- Local access for residents living along the Proposed Grid Connection underground cabling route will not be closed for the construction phase, along the N83 National Road the road carriageway is wide enough to have access solutions in place, and there are also alternative access roads into the area.

Residual Impact

Due to the small footprint of the above-ground elements of the Proposed Project infrastructure, on a site scale and even moreso on a local scale, the residual effect is considered Negative, direct, slight, permanent impact on land use and negative, direct, slight short-term impact on activities.

Significance of Effects

The significance of effects on employment levels and local investment during the construction phase will be slight.

5.10.2.1.4 *Property Values*

Pre-Mitigation Impacts

Proposed Wind Farm

As noted in Section 5.7 above, the conclusions from available international literature indicate that property values are not impacted by the positioning of a wind farm near them.

Proposed Grid Connection

As noted in Section 5.7 above, the conclusions from available international literature indicate that 95% of property values (residential and agricultural) show no correlation with the presence of grid infrastructure in the area, with opinions on nearby grid infrastructure diminishing over time. In some cases, property values were demonstrated to increase, however, causation with grid infrastructure cannot be determined.

Residual Impact

It is on this basis that it can be concluded that there would be a short term negative imperceptible impact from the construction phase of the Proposed Project.

Significance of Effects

The effect on property values due to the construction of the Proposed Project is not significant.

5.10.2.1.5 Tourism

Pre-Mitigation Impact

Proposed Wind Farm

Given that there are currently no tourism attractions specifically pertaining to the site there are no impacts on tourism associated with the construction phase of the Proposed Wind Farm.

The Proposed Wind Farm site has some rural aesthetic qualities given the relative lack of buildings and infrastructure present on the site. It is mostly flat agricultural farmland fields defined by vegetated field boundaries and stone walls; however, these views are common throughout the local area and due to the intensive agricultural land-use, it is noted that the landscape has been subject to substantial levels of human interference and modification. Views from within the Proposed Wind Farm site are generally contained given the surrounding flat landscape and the stone walls, treelines and hedgerows present. With regard to tourist attractions and amenity use surrounding the Proposed Wind Farm site, as described in Section 5.4, Knockma Hill is the closest tourist attraction to the Proposed Wind Farm site, however traffic management safety measures will be in place, as outlined within the Traffic and Transport Assessment, included as Section 15.1 of this EIAR where required. Please see below for Traffic impact mitigation measures and Chapter 15 Material Assets for mitigation measures relating to the Proposed Wind Farm site.

Proposed Grid Connection

Given that there are currently no tourism attractions specifically pertaining to the site there are no impacts on tourism associated with the construction phase of the substation and temporary construction compound. Furthermore, these proposed structures are located on private property therefore no entrance to tourists is currently or will be permitted. There are no tourist attractions located along the Proposed Grid Connection underground cabling route. As the Proposed Grid Connection underground cabling route is not located at a cul de sac, tourists seeking to travel to various attractions in the wider landscape during the construction phase, can utilise other routes and therefore will not be impacted by the rolling construction phase of the underground cabling route on the N83, L61461 or L6141. However, should tourists want to utilise portions of any of these roads, the laying of cables will be carried out in a rolling nature with approximately 100 - 200m of cable being constructed in one day, it is estimated that this section of the underground cabling route, including the HDD works will take 118 days to complete, as outlined within the Traffic and Transport Assessment, included as Section 15.1 of this EIAR. The location of the construction will be transient in nature with the extent of the section of road closed kept to a minimum.

Residual Impact

Based on the above it is concluded that there would be a short-term, negative, imperceptible impact on tourism and the wider landscape due to the construction phase of the Proposed Project.

Significance of Effects

The effect on tourism in the wider landscape due to construction phase the Proposed Project is not significant.

5.10.2.1.6 Residential Amenity

Pre-Mitigation Impact

Proposed Wind Farm

The potential for impacts on residential amenity is discussed in Section 5.8 above. There is the potential for impacts on residential amenity during the construction phase of the Proposed Wind Farm due to air, traffic, noise and vibration emissions due to the presence of additional traffic and plant machinery.

Proposed Grid Connection

There is potential for impacts on residential amenity due to the construction of the Proposed Grid Connection. The Proposed Grid Connection underground cabling route will be located within 2 no. local roads (L61461 and L6141) and the N83 National Road, with a total length of 14.3 km. this has the potential to give rise to traffic disruptions.

Mitigation and Monitoring Measures

All mitigation as outlined above and the corresponding chapters: Chapter 11 Air Quality, Chapter 12 Noise and Vibration, and Chapter 15 Material Assets will be implemented in order to reduce insofar as possible, impacts on residential amenity at properties located in the vicinity of Proposed Project construction works. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

Residual Impact

Based on the above it is concluded that there would be a short-term, negative, imperceptible impact on residential amenity due to the construction phase of the Proposed Project.

Significance of Effects

The effect on residential amenity due to construction phase the Proposed Project is not significant.

5.10.2.2 Health

The following impact assessment is produced in accordance with guidance as set out in Section 5.2.2

5.10.2.2.1 *Health and Safety*

Pre-Mitigation Impacts

Proposed Wind Farm

Construction of the Proposed Wind Farm will necessitate the presence of a construction site and travel on the local public road network to and from the site. Construction sites and the machinery used on them pose a potential health and safety hazard to construction workers if site rules are not properly implemented. This will have a short-term potential significant negative impact on health and safety.

Proposed Grid Connection

The construction of the Proposed Grid Connection will include working under existing 110kV lines which may impact on electrical infrastructure and supply in the area and along a local road which may give rise to traffic impacts. Furthermore, working in the cavity of power lines and traffic flow is potential health and safety hazard for construction workers.

Mitigation and Monitoring Measures

The Proposed Project will be constructed, operated and decommissioned in accordance with all relevant Health and Safety Legislation, including:

- Safety, Health and Welfare at Work Act 2005 (No. 10 of 2005);
- Safety, Health and Welfare at Work (General Application) (Amendment) Regulations 2016 (S.I. No. 36 of 2016);
- S.I. No. 528/2021 - Safety, Health and Welfare at Work (Construction) (Amendment) Regulations 2021 and
- Safety, Health and Welfare at Work (Work at Height) Regulations 2006 (S.I. No. 318 of 2006).

The following measures below are also detailed in Appendix 4-5 Construction and Environment Management Plan. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

- A Health and Safety Plan covering all aspects of the construction process will address the Health and Safety requirements in detail. This will be prepared on a preliminary basis at the procurement stage and developed further at construction stage.
- All hazards will be identified, and risks assessed. Where elimination of the risk is not feasible, appropriate mitigation and/or control measures will be established. The contractor will be obliged under the construction contract and current health and safety legislation to adequately provide for all hazards and risks associated with the construction phase of the project. Safepass registration cards are required for all construction, delivery and security staff. Construction operatives will hold a valid Construction Skills Certificate Scheme card where required. The developer is required to ensure a competent contractor is appointed to carry out the construction works. The contractor will be responsible for the implementation of procedures outlined in the Safety and Health Plan. Public safety will be addressed by restricting Site access during construction. Fencing will be erected in areas of the Site where uncontrolled access is not permitted.

- The suitability of machinery and equipment for use near power lines will be risk assessed.
- All staff will be trained on operating voltages of overhead electricity lines running the Site. All staff will be trained to be aware of the risks associated with underground cables. All contractors that may visit the Site are made aware of the location of lines before they come on to Site.
- When activities must be carried out beneath overhead lines, e.g., component delivery or substation construction, a site-specific risk assessment will be undertaken prior to any works. The risk assessment must take into account the maximum potential height that can be reached by the plant or equipment that will be used prior to any works.
- Information on safe clearances will be provided to all staff and visitors.
- Signage indicating locations and health and safety measures regarding electrical cables will be erected in canteens and on Site.
- All staff will be made aware of and adhere to the Health & Safety Authority's '*Guidelines on the Procurement, Design and Management Requirements of the Safety, Health and Welfare at Work (Construction) (Amendment) Regulations 2021'*. This will encompass the use of all necessary Personal Protective Equipment and adherence to the Site Health and Safety Plan.
- The suitability of machinery and equipment for use near power lines will be risk assessed.
- All staff will be trained on operating voltages of electricity cables running the Site. All staff will be trained to be aware of the risks associated with overhead lines. All contractors that may visit the Site are made aware of the location of lines before they come on to Site.
- When activities must be carried out beneath overhead lines, e.g., component delivery, a site-specific risk assessment will be undertaken prior to any works. The risk assessment must take into account the maximum potential height that can be reached by the plant or equipment that will be used prior to any works.
- Overhead line proximity detection equipment will be fitted to machinery when such works are required.

The scale and scope of the project requires that a Project Supervisor Design Process (PSDP) and Project Supervisor Construction Stage (PSCS) are required to be appointed in accordance with the provisions of the Health & Safety Authority's '*Guidelines on the Procurement, Design and Management Requirements of the Safety, Health and Welfare at Work (Construction) Regulations 2013'*.

The PSDP appointed for the construction stage shall be required to perform his/her duties as prescribed in the Safety, Health and Welfare at Work (Construction) Regulations. These duties include (but are not limited to):

- Identify hazards arising from the design or from the technical, organisational, planning or time related aspects of the project;
- Where possible, eliminate the hazards or reduce the risks;
- Communicate necessary control measures, design assumptions or remaining risks to the PSCS so they can be dealt with in the Safety and Health Plan;
- Ensure that the work of designers is coordinated to ensure safety;
- Organise co-operation between designers;
- Prepare a written Safety and Health Plan;
- Prepare a safety file for the completed structure and give it to the client; and
- Notify the Authority and the client of non-compliance with any written directions issued.

The PSCS appointed for the construction stage shall be required to perform his/her duties as prescribed in the Safety, Health and Welfare at Work (Construction) Regulations. These duties include (but are not limited to):

- Development of the Safety and Health Plan for the construction stage with updating where required as work progresses;
- Compile and develop safety file information.
- Reporting of accidents / incidents;
- Weekly Site meeting with PSCS;
- Coordinate arrangements for checking the implementation of safe working procedures.
- Ensure that the following are being carried out:
    - Induction of all site staff including any new staff enlisted for the project from time to time;
    - Toolbox talks as necessary;
    - Maintenance of a file which lists personnel on Site, their name, nationality, current Safe Pass number, current Construction Skills Certification Scheme (CSCS) card (where relevant) and induction date;
    - Report on site activities to include but not limited to information on accidents and incidents, disciplinary action taken and PPE compliance;
    - Monitor the compliance of contractors and others and take corrective action where necessary; and
    - Notify the Authority and the client of non-compliance with any written directions issued.

Residual Impact

With consideration of the implementation of the detailed mitigation measures there will be a short-term slight negative residual effect on health and safety during the construction phase of the Proposed Project.

Significance of Effects

Based on the assessment above the effects on health and safety during the construction phase of the Proposed Project are considered to be short term slight significant.

5.10.2.2.2 Air Quality: Dust, NO_2, PM_{10} and PM_{25} and CO_2 Emissions

Pre-Mitigation Impacts

Proposed Wind Farm

Potential dust and exhaust emission sources during the construction phase of the Proposed Wind Farm include upgrading of existing access tracks and construction of new access roads, turbine and meteorological mast foundations, temporary construction compound.

An increase in dust and exhaust emissions has the potential to cause a nuisance to sensitive receptors in the immediate vicinity of the Proposed Wind Farm site. The entry and exit of construction vehicles from the Proposed Wind Farm site may result in the transfer of mud to the public road, particularly if the weather is wet. This may cause nuisance to residents and other road users. the transport of volumes of stone to be transported into the Proposed Wind Farm site also has the potential to create dust, which could affect nearby sensitive receptors. These effects will have a short-term, slight, negative impact on air quality. The potential dust impacts that may occur during the construction phase of the Proposed Wind Farm are further described in Chapter 10: Air Quality.

Proposed Grid Connection

Potential dust and exhaust emission sources during the construction phase of the Proposed Grid Connection include the construction of a 110kV internal substation, a temporary construction compound, and the laying of approximately 14.3km of underground cabling and the road upgrade works which are associated with this process.

The entry and exit of construction vehicles from the Proposed Grid Connection has the potential to result in the transfer of mud to the public road, particularly if the weather is wet. This may cause nuisance to road users and local residents. These impacts will have a short-term slight, negative impact on air quality. The potential dust impacts may occur at construction phase of the Proposed Wind Farm are further described in Chapter 10 Air Quality.

Mitigation and Monitoring Measures

The following mitigation measures will be implemented during the construction of the Proposed Project. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

- Sporadic wetting of loose stone surface will be carried out during the construction phase to minimise movement of dust particles to the air. In periods of extended dry weather, dust suppression may be necessary along haul roads to ensure dust does not cause a nuisance. Water bowser movements will be carefully monitored to avoid, insofar as reasonably possible, increased runoff.
- All plant and materials vehicles shall be stored in dedicated areas within the Site.
- Turbines and construction vehicles will be transported to the Site on specified haul routes only.
- Construction materials for the Proposed Wind Farm and Proposed Grid Connection will be sourced locally from licenced quarries and transported on specified haul routes only.
- The agreed haul route roads adjacent to the Site will be regularly inspected for cleanliness and cleaned as necessary.
- The roads adjacent to the Site entrances will be checked weekly or damage/potholes and repaired as necessary.
- Waste material will be transferred to a licensed /permitted Materials Recovery Facility (MRF) by a fully licensed waste contractor where the waste will be sorted into individual waste streams for recycling, recovery or disposal. The MRF facility will be local to the Site to reduce the amount of emissions associated with vehicle movements
- A Construction and Environmental Management Plan (CEMP) will be in place throughout the construction phase (see Appendix 4-5).

Residual Impacts

With the implementation of the above measures for this construction phase, residual impacts on air quality from exhaust emissions associated with construction activities and machinery are considered to be in short-term imperceptible negative impact.

Significance of Effects

The effects on air quality from exhaust emissions during the construction phase of the Proposed Project are considered to be imperceptible.

5.10.2.2.3 Water Quality

Pre-Mitigation Impacts

Proposed Wind Farm

The construction phase ground works and use of plant onsite may give rise to the potential release of suspended solids and hydrocarbons into groundwaters. There are no surface watercourses within the Proposed Wind Farm. There are no underground water or sewerage networks at the Proposed Wind Farm infrastructure locations. There are no source protection zones located within the Proposed Wind Farm, however there are a number of Group Water Schemes within the Proposed Wind Farm site. There are a number of private wells located in the vicinity of the Proposed Wind Farm, and GSI mapping indicates several private boreholes in the area also. Chapter 9 Water assesses the potential for impact on group water schemes and other public water supplies during the construction phase. The pre-mitigation impact on water quality is assessed as Indirect, negative, moderate, temporary, likely effect.

Proposed Grid Connection

There are a number of Group Water Schemes located within and in close proximity to the Proposed Grid Connection infrastructure. The Proposed Grid Connection underground cabling trench depth will only be approximately 1.3m in depth, the excavation will be temporary and transient, and the cable trench will be backfilled with hardcore material. There are 4 no. watercourse crossings located along the Proposed Grid Connection underground cabling route. The proposed onsite 110kV substation and temporary construction compound are not located in proximity to any surface watercourses. The potential sources of suspended sediment include runoff from spoil excavated from the Proposed Grid Connection infrastructure and entering surface or groundwater systems. The pre-mitigation effect on water quality is assessed as indirect, negative, moderate, temporary, likely effect.

Mitigation and Monitoring Measures

It is proposed that all rock needed to construct the Proposed Project will be imported into the Site from local quarries. This rock will be used to construct the sub-base layer of proposed upgraded and new access roads, hardstand areas and turbine base areas. Once installed the subbase layer will be overlain by a clean capping layer of high-grade stone material which will be sourced from local quarries. Further information relating to the mitigation measures for control of hydrocarbons during maintenance works as described in Chapter 9: Section 9.5.2.5

A bespoke drainage design which includes but is not limited to interceptor drains, check dams, swales and ponds will be implemented on the Site. Chapter 9 of this EIAR details all best practice and mitigation measures to minimise the potential for entrainment of suspended sediment or potential hydrocarbon leak. Please see Chapter 9 for details and Chapter 18 for a full list of mitigation and monitoring measures for the Proposed Project.

Residual Impacts

With the implementation of the drainage design and all mitigation measures listed in Chapter 9: Water (separation distances, prevailing geology, topography and groundwater flow directions), it is considered that the residual effects are to be short-term, imperceptible, negative effect on water quality.

Significance of Effects

The effects on water quality during the construction phase of the Proposed Project are considered to be imperceptible.

5.10.2.2.4 Noise and Vibration

Pre-Mitigation Impacts

Proposed Wind Farm

There will be an increase in noise levels in the vicinity of the site during the construction phase, as a result of heavy machinery and construction work which has the potential to cause a nuisance to sensitive receptors as located closest the site. This will be a short-term, very low sensitivity and low magnitude of change human health. The noisiest construction activities associated with wind farm development are excavation and concrete pouring of the turbine bases. Excavation of a turbine base can typically be completed in one to two days however, and the main concrete pours are usually conducted in one continuous pour, which is done within a matter of hours.

Construction noise at any given noise sensitive location will be variable throughout the construction project, depending on the activities underway and the distance from the main construction activities to the receiving properties. The potential noise impacts that will occur during the construction phase of the Proposed Wind Farm are further described in Chapter 12: Noise and Vibration.

Proposed Grid Connection

There will be an increase in noise levels in the vicinity of the site during the construction phase, as a result of heavy machinery and construction work which has the potential to cause a nuisance to Sensitive Receptors located closest the Proposed Grid Connection works. This will be a short-term, very low sensitivity and low magnitude of change on human health due to increased noise levels from construction. The noisiest construction activities associated with the construction activities are excavation and concrete pouring of the substation and end mast foundations.

Mitigation and Monitoring Measures

Best practice measures for noise control will be adhered to on Site during the construction phase of the Proposed Project to impacts associated with this phase of the development. Please refer to Chapter 12: Noise and Vibration and Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

- No plant used on Site will be permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on Site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate outside of general construction hours will be surrounded by an acoustic enclosure or portable screen.

- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Chapter 12 using methods outlined in British Standard BS 5228-1:2014+A1:2019 Code of practice for noise and vibration control on construction and open Sites – Noise.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 7:00hrs and 19:00hrs Monday to Saturday. However, to ensure that optimal use is made of good weather periods or at critical periods within the programme (i.e., concrete pours, large turbine component delivery, rotor/blade lifting) it could occasionally be necessary to work out of these hours.

Residual Impact

With the implementation of the above mitigation measures, there will be a short-term, slight impact on health due to an increase in noise levels during the construction phase of the Proposed Project.

Significance of Effects

For the reasons outlined above, the effects on human health due to due to noise emissions from the Proposed Project during construction will be slight.

5.10.2.2.5 *Traffic and Transport*

Pre-Mitigation Effects

Proposed Wind Farm

It is proposed that the wind turbine components be delivered to the Proposed Wind Farm site from Galway Port via the N83 National Road. It is proposed that the turbine components will travel north through Galway City before joining the N83 National Road. The temporary road providing access to the Proposed Wind Farm site is then accessed from the N83 National Road. All deliveries of turbine components to the site will follow this route. The proposed route is described in further detail in Chapter 4: Description of the Proposed Project of this EIAR. Non-turbine construction traffic e.g., Heavy Goods Vehicles (HGVs) and Light Goods Vehicles (LGVs) movements involved in the delivery of construction related materials to the Proposed Wind Farm site will also enter the Proposed Wind Farm via the temporary road leaving the N83 National Road.

This will have a temporary slight negative effect on traffic users on the delivery routes.

Proposed Grid Connection

Materials to be used to construct the proposed onsite 110kV substation will be delivered to the site via the N83 and will enter from the south via the temporary road. This may have a negative temporary effect on existing road users, which will be minimised by the implementation of the mitigation measures included in the traffic management plan.

The underground cable route works will last approximately 188 days, completed with a traffic management plan in place and will follow the TII and EirGrid requirements. The grid route trenches will be excavated in a rolling manner, approx. 100-200m per day and backfilled each evening.

By its nature the effects of these additional trips and diversions on the network will be transient, will be temporary and will be slight.

Mitigation and Monitoring Measures

A complete Traffic and Transport Assessment (TTA) of the Proposed Project has been carried out by Alan Lipscombe Traffic and Transport Consultants. The full results of the TTA are presented in Section 15.1 of Chapter 15: Material Assets. A Traffic Management Plan has also been developed in order to minimise any potential effect on the local population during the construction phase of the Proposed Project due to traffic. The plan will be developed and implemented to ensure any effect is short term in duration and slight in significance during the construction of the Proposed Project. Prior to commencement of any works, the occupants of dwellings in the vicinity of the proposed works will be contacted and the scheduling of works will be made known. Local access to properties will also be maintained throughout any construction works and local residents will be supplied with the number of the works supervisor in order to ensure that disruption will be kept to a minimum. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

Residual Effects

Once the Traffic Management Plan is implemented for the construction phase of the Proposed Project, there will be a short-term slight negative effect on local road users.

Significance of Effects

Based on the assessment above, the effects on traffic from the Proposed Project during construction will be slight.

5.10.2.2.6 *Major Accidents and Natural Disasters*

Pre-Mitigation Impacts

Proposed Wind Farm

A risk register has been developed which contains all potentially relevant risks identified during the construction phase of the Proposed Wind Farm. Seven risks (Critical Infrastructure Emergencies, Severe Weather, Flooding, Utility Emergencies, Traffic Incident, Contamination, and Fire/Gas Explosion) specific to the construction phase have been identified and are presented in Chapter 16: Major Accidents and Natural Disasters. As outlined in 1.4.1 of this EIAR, the scenario with the highest risk score in terms of the occurrence of major accident and/or disaster during the construction is identified as ‘Contamination’ of the Site and risk of ‘Fire/Explosion’ during construction.

Proposed Grid Connection

A risk register has been developed which contains all potentially relevant risks identified during the construction phase of the Proposed Grid Connection. Seven risks (Critical Infrastructure Emergencies, Severe Weather, Flooding, Utility Emergencies, Traffic Incident, Contamination, and Fire/Gas Explosion) specific to the construction phase have been identified and are presented in Chapter 16: Major Accidents and Natural Disasters. The risk register concludes that there is low potential for natural disaster and/or major accident to occur at the Proposed Grid Connection. As outlined in Section 16.4.1 of this EIAR, the scenario with the highest risk score in terms of the occurrence of a major accident and/or disaster during construction is identified as ‘Contamination’ of the Site and risk of ‘Fire/Explosion’ during construction.

Residual Impact

The impact assessment concludes that the risk of a major accident and/or disaster during the construction phase of the Proposed Project is considered 'low' in accordance with the '*Guide to Risk Assessment in Major Emergency Management'* (DoEHLG, 2010).

Significance of Effects

Based on the above risk assessment in Chapter 16, the effects to/from Major Accidents and Natural Disasters during the construction phase of the Proposed Project is not significant.

5.10.2.2.7 *Shadow Flicker*

Pre-Mitigation Impacts

Proposed Project

Shadow flicker, which occurs during certain weather conditions due to the movement of wind turbine rotor blades, as described in Section 5.2.2.2 of this chapter, can only occur during the operational phase of a wind energy development. There are therefore no shadow flicker impacts associated with the construction phase of the Proposed Wind Farm or the construction or operational phase of the Proposed Grid Connection. Any shadow flicker effects that occur in the commissioning phase of the proposed turbines will be short in duration and is dealt with under Section 5.10.3.2.7 below.

5.10.3 Operational Phase

5.10.3.1 Population

The effects set out below relate to the operational phase of the Proposed Project.

5.10.3.1.1 *Population Levels*

Pre-Mitigation Impacts

Proposed Wind Farm

The operational phase of the Proposed Project will have no impact on the population of the area with regard to changes to trends, population density, household size or age structure.

Proposed Grid Connection

The operational phase of the Proposed Grid Connection will have no impact on the population of the area with regard to changes to trends, population density, household size or age structure.

Residual Impact

No residual impacts

Significance of Effects

No significance of effects.

5.10.3.1.2 *Employment and Investment*

The operational phase will present an opportunity for mechanical-electrical contractors and craftspeople to become involved with the maintenance and operation of the Proposed Project. On a long-term scale, the Proposed Project will create approximately 2-3 jobs during the operational phase relating to the maintenance and control of the Proposed Project, having a long-term slight positive effect.

The injection of money in the form of Community Gain income and landowner payments to the landowners who are participating in the Proposed Project, where a rental agreement has the potential to result in an increase in household spending and demand for goods and services in the local area. This would result in local retailers and businesses experiencing a long-term positive impact on their cash flow. This will have a long-term slight positive indirect effect.

Rates payments for the Proposed Project will contribute significant funds to Galway County Council, which will be redirected to the provision of public services within the county. These services include provisions such as road upkeep fire services, environmental protection, street lighting, footpath maintenance etc. along with other community and cultural support initiatives.

Proposed Community Benefit Scheme

Should the Proposed Project receive planning permission, there are substantial opportunities available for the local area in the form of Community Benefit Funds. The value of this fund will be directly proportional to the installed capacity and/or energy produced at the site and will support and facilitate projects and initiatives including youth, sport and community facilities, schools, educational and training initiatives, and wider amenity heritage and environmental projects. Should the Proposed Project qualify under the Renewable Energy Support Scheme (RESS), a Community Benefit Fund of €2 per megawatt hour will be available to local residents under the Community Benefit Fund. Based on this value, the Proposed Project could generate up to €300k for the Community Benefit Fund for the first 15 years of operation of the Proposed Wind Farm. If the Proposed Project does not qualify under RESS, a guaranteed fee of €1 per megawatt hour will be available to locals through the Community Benefit Fund. Based on this, the Proposed Project has the potential to generate up to €150k per annum for the Community Benefit Fund for the lifespan of the Proposed Project.

Further details on the proposed Community Gain proposals are presented in Appendix 2-1 and Section 4-5 of Chapter 4 of this EIAR.

5.10.3.1.3 *Land Use Patterns and Activities*

Pre-Mitigation Impacts

Proposed Wind Farm

The footprint of the Proposed Wind Farm will occupy only a small percentage of the site; 13.8 hectares of the overall 945-hectare site. Farming practices will not be impacted during the operational phase.

As such, its small-scale relative to the site and Population Study Area combined with its ability to coexist with ongoing site activities and activities within the landscape indicate that the Proposed Wind Farm will not impact significantly on other land uses within the site and the wider area.

Proposed Grid Connection

The Proposed Grid Connection's footprint is limited to a small percentage of the site and overall Population Study Area. During the operational phase, farming practices will resume around the onsite 110kV substation and underground cabling route footprint, and traffic movements on the L61461, N83 and L6141 will resume as normal. The small scale of the substation relative to the site and Population Study Area, its ability to coexist with ongoing site activities and activities within the landscape indicate that the Proposed Grid Connection infrastructure will have no significant impact on other land-uses within the site and the wider area.

Residual Impact

Due to the small footprint of the Proposed Project infrastructure on a Site scale and even moreso on a local scale, the residual effect is considered Negative, direct, slight, permanent effect on land use and activities during the operational phase.

Significance of Effects

The effect on land use/activities due to the operational phase of the Proposed Project will be slight.

5.10.3.1.4 *Property Values*

Pre-Mitigation Impacts

Proposed Wind Farm

As noted in Section 5.7, the conclusions from available international literature indicate that property values are not impacted by the positioning of a wind farm near houses.

Proposed Grid Connection

As noted in Section 5.7, the conclusions from available international literature indicate that property values are not impacted by the positioning of grid infrastructure near houses.

Residual Impacts

It is on this basis that it can be reasonably concluded that there would be a long-term imperceptible impact from the Proposed Project.

Significance of Effects

No significance of effects.

5.10.3.1.5 *Tourism*

Pre-Mitigation Effect

Proposed Wind Farm

There are no tourism attractions within or adjacent to the Site that could be affected by the operation of the Proposed Wind Farm. The nearest notable tourist attraction is Knockma Hill. As outlined in Section 5.4 above, Knockma Hill is recognised as a locally important walking route and amenity area. There will be a change to the landscape setting as described in Chapter 14 of this EIAR.

Proposed Grid Connection

The nearest tourist attraction to the Proposed Grid Connection underground cabling route is Knockma Hill. The Proposed Grid Connection underground cabling route will travel through the public road network (L61461m N83 and L6141).

Residual Effects

Based on the literature review in Section 5.4 the majority of studies indicate that wind farm developments do not deter visitors to tourist attractions or scenic landscapes where turbines are visually evident. As such, it is considered that the Proposed Project will have a long-term imperceptible negative impact of visitor experience to attractions in the wider landscape.

Significance of Effects

The effect on tourism in the wider landscape due to the operational phase of the Proposed Project will be imperceptible.

5.10.3.1.6 *Residential Amenity*

Pre-Mitigation Effects

Proposed Wind Farm

Potential impacts on residential amenity during the operational phase of the Proposed Wind Farm could arise primarily due to noise, shadow flicker or changes to visual amenity. Detailed noise and shadow flicker modelling have been carried out as part of this EIAR, which shows that the Proposed Wind Farm will be capable of meeting all required guideline limits in relation to noise and the shadow flicker set out in the Guidelines or the draft Guidelines if adopted. The noise and vibration assessment is detailed in Chapter 12. It should be noted that the Proposed Wind Farm will be brought in line with the noise thresholds imposed on the development by the consenting authority should the application be granted. The visual impact of the Proposed Wind Farm is addressed in Chapter 14: Landscape and Visual. The turbine locations have been designed to maximise turbine separation distances to dwellings in the area, with no turbines located within 740 metres of non-involved sensitive receptors, achieving the recommended four times turbine setback for visual amenity purposes.

Proposed Grid Connection

Potential impacts on residential amenity during the operational phase of the substation farm could arise primarily due to noise and changes to visual amenity. Detailed noise modelling has been carried for the proposed substation, please see below and Chapter 12 Noise and Vibration for details. The visual effects of the temporary construction compound, the 110kV onsite substation and the underground cable have been assessed in Chapter 14 of this EIAR also. The nearest sensitive receptor is located approximately 440m north of the proposed onsite 110kV substation location and temporary construction compound and will be further screened by hedgerows and topography. The Proposed Grid Connection electrical cabling route is located underground; therefore, no visual effects are deemed to arise from this element.

Mitigation and Monitoring Measures

- There are no turbines proposed within 740m (4 x tip height) of any sensitive receptors.
- All mitigation measures outlined in Chapter 12 (Noise), shadow flicker (Section 5.9 of this EIAR) and visual (Chapter 14) in this EIAR will be implemented in order to reduce insofar as possible, impacts on residential amenity at properties located within the in the vicinity of the Proposed Project.
- A 2.6m high palisade fence will be erected around the substation which will be painted RAL 6005 (green) to help blend the substation infrastructure in with the surrounding rural landscape. Please see Chapter 14 for residential amenity pertaining to visual effects.

Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

Residual Effects

The Proposed Project has been designed in accordance with best practice measures set out in in the Guidelines and the draft Guidelines in terms of setbacks for visual amenity. Furthermore, the Proposed Project can be brought inline to meet shadow flicker and noise thresholds imposed as part of a planning consent. The residual effect is considered to be a negative, moderate, long-term impact residential amenity with a significant residual effect for a small number of sensitive receptors located within 1km who have open views of the proposed turbines.

Significance of Effects

Based on the assessment above there will be a moderate effect on residential amenity during the operational phase and a significant effect for a small number of sensitive receptors.

5.10.3.2 Health

5.10.3.2.1 *Health and Safety*

Pre-Mitigation Effect

Proposed Wind Farm

Rigorous safety checks and continued maintenance are conducted on the turbines and ancillary infrastructure during operational phase to ensure there are no health and safety risks posed by the Proposed Wind Farm. This will have a potential long-term, slight impact on health and safety during the operation phase. Any waste generated at the site will be managed in accordance the Waste Management Act 1996 and under the relevant EU legislation.

Proposed Grid Connection

Rigorous safety checks and continued maintenance are conducted on the substation and ancillary infrastructure during design, construction, commissioning and operation to ensure the risks posed to staff and landowners are negligible. This will have a potential long-term, slight impact on health and safety during the operation phase.

Mitigation and Monitoring Measures

The following mitigation measures will be implemented during the operation of the Proposed Project to ensure that the risks posed to staff and landowners remain imperceptible throughout the operational life of the Proposed Project. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of mitigation and monitoring measures for the Proposed Project.

- Access to the turbines is through a door at the base of the structure, which will be locked at all times outside maintenance visits. The doors will only be unlocked as required for entry by authorised personnel and will be locked again following their exit.
- Staff associated with the project will conduct frequent visits, which will include inspections to establish whether any signs have been defaced, removed, faded, or are becoming hidden by vegetation or foliage, with prompt action taken as necessary.
- Signs will also be erected at suitable locations across the Site as required for the ease and safety of operation of the wind farm. These signs include:

- Buried cable route markers at 50m (maximum) intervals and change of cable route direction;
- Directions to relevant turbines at junctions;
- “No access to Unauthorised Personnel” at appropriate locations;
- Speed limits signs at Site entrance and junctions;
- “Warning these Premises are alarmed” at appropriate locations;
- “Danger HV” at appropriate locations;
- “Warning – Keep clear of structures during electrical storms, high winds or ice conditions” at Site entrance;
- “No unauthorised vehicles beyond this point” at specific Site entrances; and
- Other operational signage required as per Site-specific hazards.
- The Substation, which will be operated by Eirgrid will be locked and fenced off from public access. The substation will be operational remotely and manually 24 hours per day, 7 days a week. Supervisory operational and monitoring activities will be carried out remotely using a SCADA system, with the aid of computers connected via a telephone modem link.
- Periodic service and maintenance work which include some vehicle movement.
- For operational and inspection purposes, substation access is required.
- Servicing of the substation equipment will be carried out in accordance with the manufacturer’s specifications, which would be expected to entail the following:
- Six-month service – three-week visit
- Annual service – six-week visit
- Weekly visits as required.

An operational phase Health and Safety Plan will be developed to fully address identified Health and Safety issues associated with the operation of the Site. Access for emergency services will be available at all times.

The components of a wind turbine are designed to last up to 30-35 years and are equipped with a number of safety devices to ensure safe operation during their lifetime. During the operation of the wind farm regular maintenance of the turbines will be carried out by the turbine manufacturer or appointed service company. A project or task specific Health and Safety Plan will be developed for these works in accordance with the Site’s health and safety requirements.

Residual Effect

With the implementation of the above mitigation measures, there will be a long-term, imperceptible effect on health and safety during the operational life of the Proposed Project.

Significance of Effects

Based on the assessment above the effects on health and safety during the operational life of the Proposed Project will be imperceptible.

5.10.3.2.2 Noise and Vibration

Pre-Mitigation Effect

Proposed Wind Farm

An assessment of the operational wind turbine noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Chapter 12: Noise and Vibration. The predicted noise levels associated with the Proposed Wind Farm will be within best practice noise criteria curves recommended in the Guidelines, therefore, it is not considered that a significant effect is associated with the Proposed Wind Farm.

Proposed Grid Connection

The predicted noise level from the operation of the onsite 110kV substation at the nearest NSL (H060) at approximately 449 m from the noise source at the onsite 110kV substation (transformer of substation layout) is 24 dB LAeq,T. This level of noise is considered low, and it is concluded that there will be no significant noise emissions from the operation of the onsite 110kVsubstation at any NSL.

Mitigation and Monitoring Measures

Please see Chapter 12 Section 12.6 for noise and vibration mitigation and monitoring proposals for the Proposed Project. Please refer to Chapter 18: Schedule of Mitigation and Monitoring Measures for a full list of mitigation and monitoring measures for the Proposed Project.

Residual Effects

The predicted residual operational turbine noise effects at the closest noise sensitive receptors range from not significant to imperceptible. Please see Chapter 12 Noise and Vibration for details.

Significance of Effects

As stated in the noise assessment in Chapter 12, it has been demonstrated that the relevant national guidance in relation to noise associated with proposed wind turbines can be satisfied. The effects are considered not significant.

5.10.3.2.3 *Air Quality: Dust, NO2, PM10 and PM25 and CO2 Emissions*

Pre-Mitigation Effect

Proposed Wind Farm

The Proposed Wind Farm will require daily visits of maintenance staff in LGVs and the infrequent generation of small volumes of hydrocarbon waste. The Proposed Wind Farm will generate electricity from a renewable source, contributing to a positive impact on air quality. Over the envisaged 30-year lifespan of the Proposed Wind Farm it is expected to effectively reduce carbon dioxide emissions that would have occurred if the same energy were generated by traditional fossil fuel plants. This is a long-term moderate positive effect on Air Quality.

Proposed Grid Connection

The sources of dust and other emissions generated during the operational phase will be from infrequent visits by EirGrid maintenance to the 110kV on Site substation staff in light good vehicles (LGVs) approximately one or two visits per day, and private LGVs. Maintenance of the substation infrastructure may, on occasion, generate of small volumes of hydrocarbon waste. Any waste generated at the Site will be managed in accordance the Waste Management Act 1996 and under the relevant EU legislation. This will have a potential long-term, imperceptible impact on health during the operation phase.

Residual Effects

Impacts from dust and other emissions to air from private and maintenance on sensitive receptors during the operational phase of the Proposed Project considered to be a momentary and imperceptible. As such, this will be a long-term overall moderate positive effect on Air Quality.

Significance of Effects

The effect on air quality through the offsetting of Dust, NO_2, PM_{10} and PM_{25} and CO_2 Emissions from fossil fuels is considered have a moderate significant effect.

5.10.3.2.4 Water Quality

Pre-Mitigation Effect

Proposed Wind Farm

During the operational phase, all permanent drainage controls will be in place and the disturbance of ground and excavation works will be complete. Some minor maintenance works may be completed, such as maintenance of the site entrance, internal roads and hardstand areas. These works would be of a very minor scale and would be very infrequent. During such maintenance works there is a small risk associated with the release of hydrocarbons from site vehicles, although it is not envisaged that any significant refuelling works will be undertaken on site during the operational phase. There will be a long-term imperceptible impact on human health due to water quality.

Proposed Grid Connection

During the operational phase, all permanent drainage controls will be in place and the disturbance of ground and excavation works will be complete. Some minor maintenance works may be completed, such as maintenance of roads. These works would be of a very minor scale and would be very infrequent. During such maintenance works there is a small risk associated with the release of hydrocarbons from site vehicles, although it is not envisaged that any significant refuelling works will be undertaken on site during the operational phase. There will be a long-term imperceptible impact on human health due to water quality.

Mitigation and Monitoring Measures

The mitigation measures detailed in Chapter 9 will ensure all surface water runoff will be captured and treated prior to discharge/release. Settlement ponds, checks dams and buffered outfalls will prevent roads acting as preferential flowpaths by providing attenuation and water quality treatment.Please see Chapter 9 for details. The full list of mitigation and monitoring measures for the Proposed Project are detailed in Chapter 18.

Residual Effects

With the implementation of the Proposed Wind Farm drainage design and mitigation measures the residual effects are considered to be long term imperceptible impact on human health due to water quality.

Significance of Effects

Based on the assessment above, the effects on water quality will be imperceptible.

5.10.3.2.5 Traffic and Transport

Pre-Mitigation Effect

Proposed Wind Farm

Major component failures are considered unlikely and therefore the presence of abnormal load vehicles and HGVs at the Proposed Wind Farm site is considered extremely rare. Should a turbine component need replacing, the measures detailed in Section 5.6.2.2.5 and Chapter 15 will be implemented.

All site visits for maintenance and inspection purposes for the Proposed Wind Farm will be done so via LGVs with just one or two LGVs with day.

Proposed Grid Connection

The Proposed Grid Connection, including the onsite 110kV substation and the underground cabling route will not require ongoing maintenance during the operation phase. Visits to the Site by Eirgrid for maintenance and inspection purposes will be done so via LGVs with just one or two visits per day.

Residual Effects

Effects on local road users during the operational phase are considered to be a long term negative imperceptible impact.

Significance of Effects

Based on the assessment above, the effects on traffic will be imperceptible.

5.10.3.2.6 Major Accidents and Natural Disasters

Pre-Mitigation Effects

Proposed Wind Farm

A risk register has been developed which contains all potentially relevant risks identified during the operational phase of the Proposed Wind Farm. Five risks (, Severe Weather, Collapse/Damage to Structures, , Traffic Incident, Contamination, and Fire/Gas Explosion) specific to the operational phase have been identified and are presented in Chapter 16 Major Accidents and Natural Disasters. As outlined in Section 16.4.1, the scenario with the highest risk score in terms of the occurrence of major accident and/or disaster during operation is identified as "Fire/Explosion' during operation.

Proposed Grid Connection

A risk register has been developed which contains all potentially relevant risks identified during the operational phase of the Proposed Grid Connection. Five risks (, Severe Weather, Collapse/Damage to Structures, , Traffic Incident, Contamination, and Fire/Gas Explosion) specific to the operational phase have been identified and are presented in Chapter 16 Major Accidents and Natural Disasters. The risk register concludes that there is low potential for significant natural disasters to occur at the Proposed Grid Connection. As outlined in Section 16.4.1, the scenario with the highest risk score in terms of the occurrence of major accident and/or disaster during operation is identified as 'Fire/Explosion' during operation.

Residual Effect

The impact assessment concludes that the risk of a major accident and/or disaster during the operational phase of the Proposed Project is considered 'low' in accordance with the '*Guide to Risk Assessment in Major Emergency Management'* (DoEHLG, 2010).

Mitigation and Monitoring Measures

- The Proposed Project will be designed and built in line with current best practice and, as such, mitigation against the risk of major accidents and/or disasters will be embedded through the design. In accordance with the provision of the European Commission '*Guidance on the preparation of Environmental Impact Assessment Reports'* 2017, a Risk Management Plan will be prepared and implemented onsite to ensure an effective response to disasters or the risk of accidents. The plan will include sufficient preparedness and emergency planning measures.
- The Proposed Project will also be subject to a fire safety risk assessment in accordance with Chapter 19 of the Safety, Health and Welfare at Work Acts 2005 to 2014, which will assist in the identification of any major risks of fire onsite, and mitigation of the same during operation.

Please refer to chapter 18 Schedule of Mitigation and Monitoring Measures which details all proposed mitigation and monitoring measures for the operation of the Proposed Project.

Residual Effect

The impact assessment concludes that the risk of a major accident and/or disaster during the operational phase of the Proposed Project is considered 'low' in accordance with the '*Guide to Risk Assessment in Major Emergency Management'* (DoEHLG, 2010).

Significance of Effects

Based on the above and the risk assessment in Chapter 16, the effects to/from Major Accidents and Natural Disasters during the operational phase of the Proposed Project are not significant.

5.10.3.2.7 *Shadow Flicker*

Pre-Mitigation Effects

Proposed Wind Farm

Assuming worst-case conditions, a total of 104 properties as a result of the Laurclavagh Renewable Energy Development may experience daily shadow flicker in excess of the current DoEHLG guideline threshold of 30 minutes per day. The DoEHLG total annual guideline limit of 30 hours is predicted to be exceeded at 5 no. properties when the regional sunshine average of 26.46% is taken into account. As stated in Section 5.2.3 there are 243 no. properties located within 1.63km (of the proposed turbines, (of which 242 are inhabited dwellings, and 1 is an uninhabited derelict building). Of the 104 properties predicted to experience daily shadow flicker in excess of the current guideline threshold of 30 minutes per day, 13 are participating landowners. 91 no. existing properties may be subject to mitigation measures in order to ensure the Guideline's 30-minute daily and/or 30-hour annual shadow flicker thresholds are not exceeded.

Proposed Grid Connection

There is no potential for the Proposed Grid Connection infrastructure to cause shadow flicker, and so no effect is predicted.

Mitigation and Monitoring Measures

Where daily or annual shadow flicker exceedances are predicted at any inhabitable or third-party dwelling of the identified 91 no. sensitive receptors, a site visit will be undertaken firstly to determine the presence of existing screening and window orientation at each potentially affected property. This will determine if the receptor has an actual line of sight to any turbine and actual potential for shadow flicker to occur. Once this exercise is completed and all of the potentially affected properties, the following measures will be employed.

Screening Measures

In the event of an occurrence of shadow flicker exceeding guideline threshold values of 30 minutes per day at residential receptor locations, mitigation options will be discussed with the affected homeowner, including:

- Installation of appropriate window blinds in the affected rooms of the residence;
- Planting of screening vegetation;
- Other site-specific measures which might be agreeable to the affected party and may lead to the desired mitigation.

If agreement can be reached with the homeowner, then it would be arranged for the required mitigation to be implemented in cooperation with the affected party as soon as practically possible and for the full costs to be borne by the wind farm operator.

Wind Turbine Control Measures

If it is not possible to mitigate any identified shadow flicker limit exceedance locally using the measures detailed above, wind turbine control measures will be implemented.

Wind turbines can be fitted with shadow flicker control units to allow the turbines to be controlled to prevent the occurrence of shadow flicker at properties surrounding the wind farm. The shadow flicker control units will be added to any required turbines.

A shadow flicker control unit allows a wind turbine to be programmed and controlled using the wind farm's Supervisory Control and Data Acquisition (SCADA) system to change a particular turbine's operating mode during certain conditions or times, or even turn the turbine off if necessary.

All predicted incidents of shadow flicker can be pre-programmed into the wind farm's control software. The wind farm's SCADA control system can be programmed to shut down any particular turbine at any particular time on any given day to avoid excessive shadow flicker occurrences at properties which are not naturally screened or cannot be screened with measures outlined above. Where such wind turbine control measures are to be utilised, they need only be implemented when the specific combined circumstances occur that are necessary to give rise to the shadow flicker effect in the first instance. Therefore, if the sun is not shining on a particular day that shadow flicker was predicted to occur at a nearby property, there would be no need to shut down the relevant turbines that would have given rise to the shadow flicker at the property. Similarly, if the wind speed was below the cut-in speed that caused the turbine rotor to rotate and give rise to a shadow flicker effect at a nearby property, there would be no need to shut down the relevant turbines that otherwise would have caused shadow flicker.

The atmospheric variables that determine whether shadow flicker will occur or not, are continuously monitored at the Proposed Wind Farm and the data fed into the wind farm's SCADA control system. The strength of direct sunlight is measured by way of photocells, and if the sunlight is of sufficient strength to cast a shadow, the shadow flicker control mechanisms come into effect. Wind speed and direction are measured by anemometers and wind vanes on each turbine and on the wind farm's met mast, and similarly, and if wind speed and direction is such that a shadow will be cast, the shadow flicker control mechanisms come into effect. The moving blades of the turbine will require a short period of time to cease rotating and as such there may be a very short period (less than 3 to 5 minutes) during which the blades are slowed to a complete halt. The turbines giving rise to shadow flicker may be turned off on different days to prevent excessive wear and tear on any single turbine.

In order to ensure that the model and SCADA system is accurate and working well a site visit will be carried out to verify the system. The shadow flicker prediction data will be used to select dates on which a shadow flicker event could be observed at one or multiple affected properties and the following process will be adhered to.

1. *Recording the weather conditions at the time of the site visit, including wind speeds and direction (i.e. blue sky, intermittent clouds, overcast, moderate breeze, light breeze, still etc.).*
2. *Recording the house number, time and duration of site visit and the observation point GPS coordinates.*
3. *Recording the nature of the sensitive receptor, its orientation, windows, landscaping in the vicinity, any elements of the built environment in the vicinity, vegetation.*
4. *In the event of shadow flicker being noted as occurring the details of the duration (times) of the occurrence will be recorded.*
5. *The data will then be sent to the wind farm operational team to confirm that the model and SCADA system are working.*
6. *Following 12 months of full operation of the Proposed Project a report can be prepared for the Local Authority describing the shadow flicker mitigation measures used at the wind farm and confirming the implementation and successful operation of the system.*

This method of shadow flicker mitigation has been technically well-proven at wind farms in Ireland and also in areas outside Ireland that experience significantly longer periods of direct sunlight.

In order to demonstrate how the SCADA control system can be applied to switch off particular turbines at the relevant times and dates, Table 5-11 below lists the 91 properties at which a shadow flicker mitigation strategy may be necessary to ensure the Guidelines 30-minute per day shadow flicker threshold is not exceeded. In this case, the relevant turbine(s) would be programmed to switch off for the time required to reduce daily shadow flicker to below the guideline limit of 30 minutes. The SCADA control system would be utilised to control shadow flicker in the absence of being able to agree alternative mitigation measures with the relevant property owner. The mitigation strategy outlined in Table 5-11 below is based on the theoretical precautionary scenario. The details presented in Table 5-11 list the days per year and the turbines that could be programmed to switch off at specific times, in order to reduce daily shadow flicker to a maximum of 28 minutes, which is below the guideline limit of 30 minutes.

Table 5-11 Shadow Flicker Mitigation Strategy for Daily Shadow Flicker Exceedance - Turbine Numbers and Dates

Property No.	Max. Daily shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Day No's)*	Post-mitigation Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:min:sec)
H012	00:35:24	8:01:48	T06	39 days	153-91	≤00:28:00	≤30:00:00
H014	00:48:36	15:06:56	T01	49 days	74-97,248-272	≤00:28:00	≤30:00:00
H019	00:39:36	9:41:01	T01	48 days	148-195	≤00:28:00	≤30:00:00
H020	00:35:24	9:15:09	T07	37 days	126-143, 200-218	≤00:28:00	≤30:00:00
H021	00:48:00	15:52:59	T02, T03	68 days	62-84, 261-284, 37-46,299-309	≤00:28:00	≤30:00:00
H024	00:34:12	4:43:51	T04	20 days	346-365	≤00:28:00	≤30:00:00
H027	01:16:48	33:41:03	T04, T06, T08	96 days	1-28, 79-88, 256-265,318-365	≤00:28:00	≤30:00:00
H028	00:33:36	10:34:22	T06	63 days	141-203	≤00:28:00	≤30:00:00
H029	00:45:00	11:32:57	T08	54 days	108-134, 210-236	≤00:28:00	≤30:00:00
H032	00:48:00	15:55:31	T08	73 days	113-148, 195-231	≤00:28:00	≤30:00:00
H033	00:33:00	10:34:50	T06	38 days	139-157, 187-205	≤00:28:00	≤30:00:00
H037	00:46:12	15:34:24	T02, T03	64 days	52-74, 272-294 ,31-39, 307-315	≤00:28:00	≤30:00:00
H041	00:32:24	4:37:39	T08	16 days	83-90, 255-262	≤00:28:00	≤30:00:00
H042	00:46:48	14:02:20	T08	65 days	113-144, 199-231	≤00:28:00	≤30:00:00
H044	00:30:36	8:54:31	T04	9 days	72-75, 270-274	≤00:28:00	≤30:00:00
H046	00:32:24	10:13:53	T06	30 days	137-151, 193-207	≤00:28:00	≤30:00:00
H049	00:31:48	4:27:01	T08	13 days	83-88, 256-262	≤00:28:00	≤30:00:00
H052	00:31:48	9:49:45	T01	27 days	135-147, 196-209	≤00:28:00	≤30:00:00
H054	00:44:24	14:05:30	T02, T03	59 days	59-79, 266-287, 37-44,302-309	≤00:28:00	≤30:00:00
H055	00:31:48	8:40:32	T01	22 days	134-144, 200-210	≤00:28:00	≤30:00:00

Property No.	Max. Daily shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Day No's)*	Post-mitigation Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:min:sec)
H056	00:34:48	5:35:55	T08	23 days	93-104, 241-251	≤00:28:00	≤30:00:00
H057	00:32:24	10:33:44	T03	34 days	138-154, 190-206	≤00:28:00	≤30:00:00
H059	00:31:12	7:31:29	T01	18 days	133-141, 203-211	≤00:28:00	≤30:00:00
H061	00:44:24	14:32:10	T02,3	59 days	51-71, 274-295, 31-38, 308-315	≤00:28:00	≤30:00:00
H062	00:35:24	12:02:38	T07	53 days	134-160, 184-209	≤00:28:00	≤30:00:00
H063	00:31:48	9:43:24	T04	14 days	68-74, 272-278	≤00:28:00	≤30:00:00
H065	00:39:36	15:49:00	T07	61 days	134-210	≤00:28:00	≤30:00:00
H067	00:35:24	12:50:25	T04, T05	46 days	65-76, 270-281, 18-28, 318-328	≤00:28:00	≤30:00:00
H068	00:40:12	15:54:15	T06, T07	81 days	132-212	≤00:28:00	≤30:00:00
H069	00:39:36	14:55:21	T06, T07	64 days	139-145, 147-196, 199-205	≤00:28:00	≤30:00:00
H070	00:39:08	15:20:16	T06, T07	78 days	136-143, 145-199, 201-207	≤00:28:00	≤30:00:00
H074	00:30:06	6:19:44	T01	5 days	133-135, 209-210	≤00:28:00	≤30:00:00
H075	01:13:48	35:06:37	T04, T05, T06, T08	130 days	1-33, 34-44, 78-91, 253-266, 302-306, 313-365	≤00:28:00	≤30:00:00
H077	00:43:12	13:39:19	T02, T03	55 days	55-75, 271-290, 35-41, 305-311	≤00:28:00	≤30:00:00
H080	00:36:00	14:27:06	T04, T05	45 days	63-75, 271-283, 18-27,	≤00:28:00	≤30:00:00
H082	00:30:36	9:09:36	T03	12 days	139-144, 199-204	≤00:28:00	≤30:00:00
H085	00:31:12	9:46:16	T03	21 days	140-150, 194-203	≤00:28:00	≤30:00:00
H087	00:31:12	11:01:21	T06, T07	23 days	135-140, 155-159, 184-189, 203-208	≤00:28:00	≤30:00:00
H088	00:42:36	12:51:51	T02, T03	48 days	59-77, 269-287, 39-43, 303-307	≤00:28:00	≤30:00:00
H089	00:42:00	17:31:53	T04, T05	92 days	1-14, 17-19, 56-74, 272-291, 327-329, 332-365	≤00:28:00	≤30:00:00
H094	00:33:00	10:42:28	T07	33 days	135-151, 193-208	≤00:28:00	≤30:00:00
H095	00:37:12	13:42:00	T06, T07	65 days	140-204	≤00:28:00	≤30:00:00

Property No.	Max. Daily shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Day No's)*	Post-mitigation Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:min:sec)
H098	00:36:00	10:03:44	T07	55 days	145-199	≤00:28:00	≤30:00:00
H099	00:36:00	12:41:50	T06, T07	57 days	144-200	≤00:28:00	≤30:00:00
H104	01:06:00	32:04:41	T04, T05, T06, T08	134 days	1-41, 75-90, 255-270, 305-365	≤00:28:00	≤30:00:00
H112	00:37:12	15:13:46	T04, T05	37 days	16-19, 56-69, 276-290, 327-330	≤00:28:00	≤30:00:00
H115	00:31:48	5:24:48	T03	18 days	163-180	≤00:28:00	≤30:00:00
H124	00:38:24	10:07:32	T01	32 days	42-57, 289-304	≤00:28:00	≤30:00:00
H126	00:55:12	18:45:51	T04, T06, T08	57 days	1-7, 61-71, 273-284, 339-365	≤00:28:00	≤30:00:00
H135	00:38:24	12:56:08	T01	54 days	126-152, 193-219	≤00:28:00	≤30:00:00
H137	00:36:36	11:01:02	T02, T03	36 days	37-39, 42-56, 290-304, 307-309	≤00:28:00	≤30:00:00
H139	00:36:00	06:09:06	T01	57 days	94-106, 239-252	≤00:28:00	≤30:00:00
H141	00:35:24	05:33:22	T01	24 days	71-82, 264-275	≤00:28:00	≤30:00:00
H142	00:35:24	05:45:45	T01	25 days	87-989, 247-259	≤00:28:00	≤30:00:00
H144	00:35:24	05:39:34	T01	25 days	82-94, 252-263	≤00:28:00	≤30:00:00
H146	00:35:24	05:27:11	T01	24 days	68-79, 266-277	≤00:28:00	≤30:00:00
H149	00:35:24	14:37:25	T04, T05, T08	44 days	47-59, 286-298, 347-364	≤00:28:00	≤30:00:00
H150	00:35:24	05:27:40	T01	24 days	81-91, 254-265	≤00:28:00	≤30:00:00
H151	00:34:48	05:24:48	T01	23 days	78-88, 257-268	≤00:28:00	≤30:00:00
H152	00:34:48	05:21:38	T01	23 days	66-77, 269-279	≤00:28:00	≤30:00:00
H158	00:34:48	05:14:58	T01	22 days	75-85, 260-270	≤00:28:00	≤30:00:00
H159	00:31:48	06:36:05	T02	46 days	1,7,339, 345-365	≤00:28:00	≤30:00:00
H161	00:34:12	05:06:14	T01	22 days	73-83, 263-273	≤00:28:00	≤30:00:00
H164	00:34:48	05:49:44	T04	24 days	39-50, 295-306	≤00:28:00	≤30:00:00

Property No.	Max. Daily shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Day No's)*	Post-mitigation Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:min:sec)
H168	00:33:36	05:02:54	T01	19 days	60-68, 277-286	≤00:28:00	≤30:00:00
H170	00:34:48	10:35:10	T02	37 days	8-26, 321-338	≤00:28:00	≤30:00:00
H172	00:33:36	04:50:21	T01	19 days	66-75, 271-279	≤00:28:00	≤30:00:00
H174	00:33:00	05:07:01	T04	19 days	50-59, 287-295	≤00:28:00	≤30:00:00
H175	00:33:00	09:46:16	T02	53 days	1-15, 18-20, 326-329, 331-353, 358-365	≤00:28:00	≤30:00:00
H176	00:33:00	10:03:53	T02	40 days	2-17, 19-22, 324-327, 329-344	≤00:28:00	≤30:00:00
H180	00:30:13	09:58:48	T01	9 days	352-360	≤00:28:00	≤30:00:00
H182	00:31:12	11:10:43	T01	32 days	1-5, 12, 334, 341-365	≤00:28:00	≤30:00:00
H185	00:30:36	06:44:20	T02	15 days	8, 349-362	≤00:28:00	≤30:00:00
H195	00:32:24	12:26:27	T01	12 days	10-12, 18-20, 326-329, 335-336	≤00:28:00	≤30:00:00
H196	00:31:48	04:40:31	T01	16 days	52-59, 287-294	≤00:28:00	≤30:00:00
H198	00:32:24	09:09:55	T02	8 days	16-19, 327-330	≤00:28:00	≤30:00:00
H199	00:33:00	09:31:01	T02	10 days	18-22, 324-328	≤00:28:00	≤30:00:00
H200	00:31:12	04:27:20	T01	12 days	59-64, 282-287	≤00:28:00	≤30:00:00
H201	00:32:24	06:12:16	T01	22 days	27-37, 309-319	≤00:28:00	≤30:00:00
H202	00:33:00	06:33:52	T01	24 days	24-35, 311-322	≤00:28:00	≤30:00:00
H204	00:32:24	05:18:46	T01	17 days	33-40, 306-314	≤00:28:00	≤30:00:00
H205	00:33:00	06:57:12	T02	24 days	22-33, 313-324	≤00:28:00	≤30:00:00
H207	00:30:11	07:29:06	T02	2 days	11, 335	≤00:28:00	≤30:00:00
H210	00:32:24	06:12:54	T02	21 days	27-36, 310-320	≤00:28:00	≤30:00:00
H216	00:31:48	05:41:09	T01	18 days	119-127, 218-226	≤00:28:00	≤30:00:00
H223	00:31:12	05:45:55	T08	19 days	163-181	≤00:28:00	≤30:00:00

Property No.	Max. Daily shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Day No's)*	Post-mitigation Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:min:sec)
H233	00:30:04	04:47:49	T01	4 days	119-120, 225-226	≤00:28:00	≤30:00:00
H236	00:30:08	07:57:22	T08	7 days	138-140, 203-206	≤00:28:00	≤30:00:00
H240	00:30:36	09:16:25	T08	13 days	145-150, 193-199	≤00:28:00	≤30:00:00

Where a shadow flicker mitigation strategy is to be implemented, it is likely that the control mechanisms would only have to be applied to a turbine to bring the duration of shadow flicker down to the 28-minute post-mitigation shadow flicker target.

Table 5-12 below displays the 3 no. third-party sensitive receptors which are predicted to receive in excess of the Annual Shadow Flicker Limit of 30 hours per year.

Table 5-12 Shadow Flicker Mitigation Strategy for Annual Shadow Flicker Exceedance

Property No.	Max. Annual Shadow Flicker Adjusted for Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	Post-mitigation Maximum Daily Shadow Flicker (hrs:mins:sec)
H027	33:41:03	4,6,8	≤30:00:00
H075	35:06:37	4,5,6,8	≤30:00:00
H104	32:04:41	4,5,6,8	≤30:00:00

Overall, the details presented in Table 5-12 demonstrate that using the turbine control system, it will be possible to reduce the level of shadow flicker at any affected property to below the daily guideline limit of 30 minutes, by programming the relevant turbines to switch off at the required dates and times.

Notwithstanding this, the approach set out above should shadow flicker associated with the Proposed Wind Farm be perceived to cause nuisance at any home, the affected homeowner is invited to engage with the Wind Farm operator. Should a complaint or query in relation to shadow flicker be received within 12 months of commissioning of the Proposed Wind Farm, field investigation/monitoring will be carried out by the wind farm operator at the affected property. The homeowner will be asked to log the date, time and duration of shadow flicker events occurring on at least five different days. The provided log will be compared with the predicted occurrence of shadow flicker at the residence, and if necessary, a field investigation will be carried out. Likewise, the Proposed Project can be brought in line with the requirements of the draft Guidelines should they be adopted during the planning application process for this development.

Residual Effect

Following the implementation of the above suite of mitigation measures, the Guidelines limit of 30 mins per day or 30 hours per year will not be exceeded and this will result in a long-term, imperceptible negative residual effect from shadow flicker on human health.

Significance of Effects

Based on the assessment above and the mitigation measures proposed the effects related to shadow flicker will be not significant.

5.10.3.3 Interference with Communications Systems and EMF

Wind turbines, like all large structures, have the potential to interfere with broadcast signals, by acting as a physical barrier or causing a degree of scattering to microwave links. The alternating current, electrical generating and transformer equipment associated with wind turbines, like all electrical equipment, also generates its own electromagnetic fields, and this can interfere with broadcast communications.

EMF is often colloquially considered to have a negative effect on human health. However, as stated in Section 5.6.4 above, the EMF and ELF of electricity cables are in compliance with EU guidelines for the exposure of EMF to humans. As such, there is no potential for negative health effects on the local population due to EMF or ELF produced by any of the proposed infrastructure.

The most significant effect at a domestic level relates to a possible flicker effect caused by the moving rotor, affecting, for example, radio signals. The most significant potential effect occurs where the wind farm is directly in line with the transmitter radio path. This interference can be overcome by the installation of deflectors or repeaters.

Further details on the actions taken to ameliorate any potential interference, including the 3D mapping of links and their appropriate setback distances, can be found in Chapter 15. Following these measures, there will be no interference risk from any of the proposed turbines providing the design complies with recommended buffer zones and telecommunication solutions. Therefore, the Proposed Project will have no effect on telecommunications.

5.10.4 Decommissioning Phase

The wind turbines proposed as part of the Proposed Project are expected to have a lifespan of approximately 30 to 35 years. Following the end of their useful life, the wind turbines may be replaced with a new set of turbines, subject to planning permission being obtained, or the site of the Proposed Wind Farm may be decommissioned fully. The Proposed Grid Connection (substation and underground cabling) will remain in place as it will form part of the national electricity grid under the control of ESB / EirGrid.

The works required during the decommissioning phase are described in Section 4.10 in Chapter 4: Description of the Proposed Project. Any effect and consequential effect that occurs during the decommissioning phase will be similar to that which occurs during the construction phase, however to a lesser extent, and the mitigation measures outlined above will be implemented during the decommissioning phase also. A Decommissioning Plan has been prepared as part of this EIAR and is included as Appendix 4-7. This Decommissioning Plan follows the most up to date Scottish Natural Heritage (SNH) guidance. An updated decommissioning plan will be agreed with the local authorities three months prior to decommissioning the Proposed Project. The principles that will inform the final decommissioning plan are contained in the Construction and Environmental Management Plan (CEMP) in Appendix 4-5.

5.10.5 Cumulative and In-Combination Effects

The potential for impact between the Proposed Project (Proposed Wind Farm and Proposed Grid Connection combined), wind projects, and other relevant non-wind projects (existing, permitted or proposed) has been carried out with the purpose of identifying what influence the Proposed Project will have on population and human health as well as the interactions between these factors, when considered cumulatively and in combination with relevant existing, permitted or proposed projects and plans in the vicinity of the Site, as set out in Chapter 2 of this EIAR. Please see Section 2.8 of Chapter 2 for cumulative assessment methodology. Please refer to Appendix 2-3 for a comprehensive listing of the considered cumulative and in combination with relevant existing, permitted or proposed projects and plans in the vicinity of the Site.

As demonstrated above, there are no significant effects on Population and Human Heath arising from the construction, operation or decommissioning of the Proposed Wind Farm. The potential cumulative impact of the Proposed Project and combined with the potential impact of other projects and/or plans has been carried out with the purpose of identifying what influence the Proposed Project will have on the environment when considered collectively with approved and existing projects and projects pending a decision from the planning authority and land-uses in the defined cumulative assessment study areas as set out in Chapter 2 Section 2-8. There are no significant effects on Population and Human Health from the construction, operation of the Proposed Grid Connection.

Therefore, there will be no significant effects arising from the construction, operation or decommissioning of the Proposed Project with any existing, permitted or proposed project/plans listed in Chapter 2. There is no potential for cumulative effects arising from the construction, operation or decommissioning of the Proposed Project with other existing, permitted or proposed wind farms in the surrounding landscape. Furthermore, the closest wind farm to the Site is the permitted single turbine in the townland of Cloonascragh, roughly 5km to the northeast of the Proposed Wind Farm.

5.11 Summary

Following consideration of the residual effects (post-mitigation) it is noted that the Proposed Project will not result in any significant effects on human beings in the area surrounding the Proposed Project. Following appropriate mitigation the Guidelines shadow flicker limits will not be exceeded at any property. It is noted that the Proposed Project can be brought in line with the requirements of the draft Guidelines, should they be adopted while this application is in the planning system, through the implementation alteration of the mitigation measures outlined.

Provided that the Proposed Project is constructed, operated and decommissioned in accordance with the design, best practice and mitigation that is described within this EIAR, significant effects on population and human health employment and economic activity, land-use, residential amenity, community facilities and services, tourism, property values and health and safety are not anticipated at international, national or county scale.