# 5 POPULATION & HUMAN HEALTH

## 5.1 Introduction

This section of the EIAR describes the potential impacts and effects of the Proposed Development on human beings, population and human health and has been completed in accordance with the guidance set out by the Environmental Protection Agency (EPA) in particular the Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports' (EPA, August 2017). The full description of the Proposed Development is provided in Chapter 4 of this EIAR.

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

The closest inhabitable dwelling is located approximately 750 metres from the nearest proposed turbine location. There are 6 No. inhabitable dwellings located within approximately 1.5km of the proposed turbine locations and all of these are consenting properties. There is just 1 further occupied dwelling located between 1.5km and 2km of the proposed wind farm.

## 5.2 Receiving Environment

### 5.2.1 Methodology

Information regarding human beings and general socio-economic data were sourced from:

- The Central Statistics Office (CSO),
- The Donegal County Development Plan 2012-2018,
- West Tyrone Area Plan (Issues Paper 2019),
- Border Regional Planning Guidelines 2010-2022,
- Strabane Local Area Plan 1986-2001
- Omagh Area Plan 1987-2002
- 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 2011 and 2016, which is the most recent census, the Census of Agriculture 2010 and from the CSO website, www.cso.ie. Information has also been sourced from the Northern Ireland Census 2011 and the Northern Ireland Statistics and Research Agency (NISRA) website, www.nisra.gov.uk. Census information is divided into Republic of Ireland, Northern Ireland, Donegal, District Electoral Division (DED), Super Output Area (SOA) and Small Area (SA) level. Where possible, comparisons were made between DEDs in the Republic and SOAs in the North of Ireland, SOAs were used for comparison where data was unavailable at SA level. All data that is specific to the human beings study area refers to the 2011 census data, as this allows a more relevant comparison between the Republic of Ireland DEDs and Northern Ireland SOAs/SAs. The 2016 census data for the republic of Ireland was consulted as part of the assessment process, and upon comparison with the relevant 2011 data, were found to be consistent.

The Proposed Development is located in a number of townlands as listed in Table 1.1 of Section 1.1 of this EIAR. The main wind farm site is located in southeast Co. Donegal, approximately 8.0 kilometres to the southwest of the twin towns of Ballybofey & Stranolor and approximately 15.0 kilometres to the northeast of Donegal town. The site location is shown in Figure 2.1 of Chapter 2 of this EIAR.

For the purposes of this EIAR, where the 'Proposed Development site' or 'the site' is referred to, this relates to the primary study area for the Proposed Development, as delineated in red on the EIAR figures (maps). The actual site boundary for the purposes of the application for planning permission for the Proposed Development occupies a smaller area within this primary area.

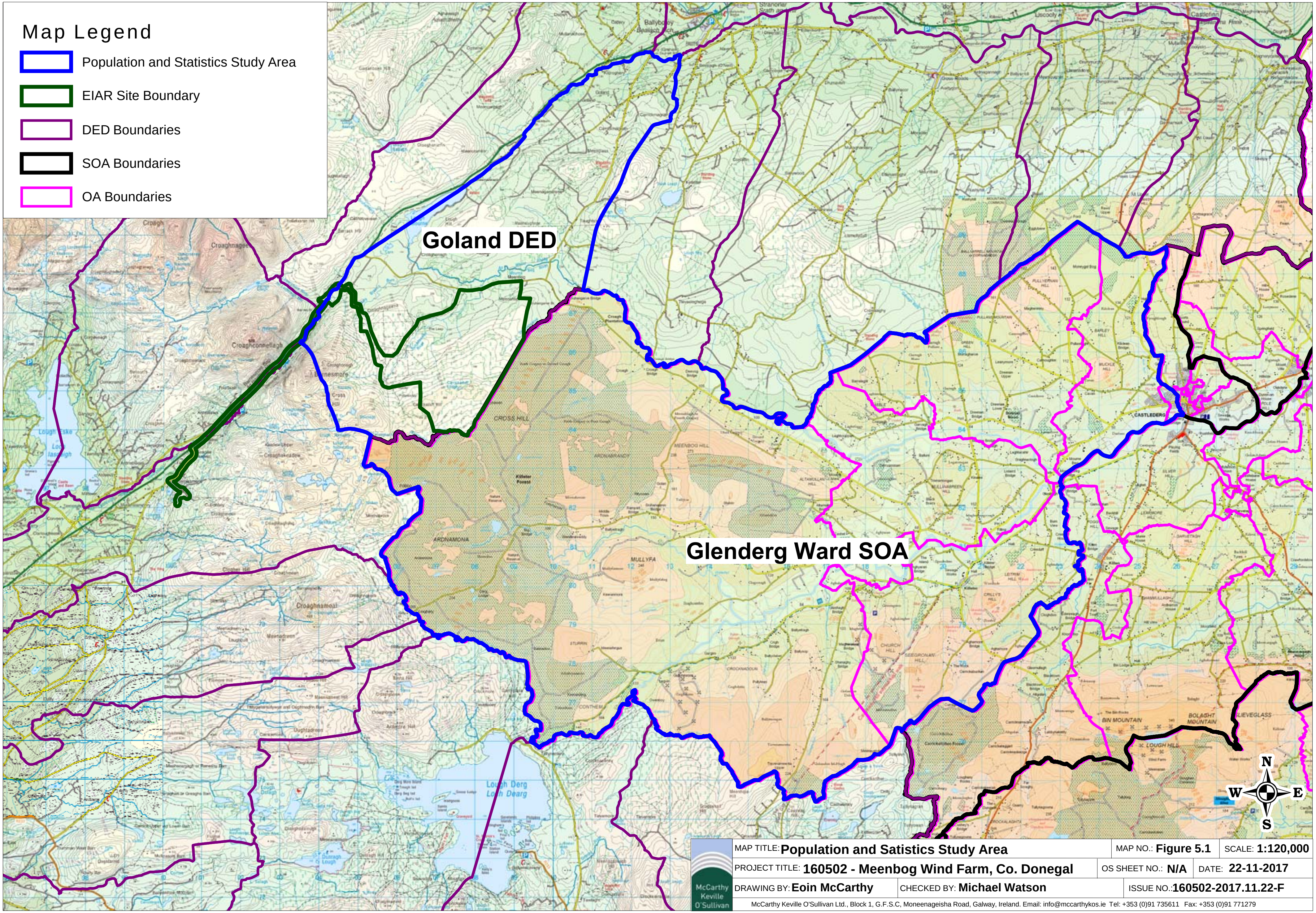
In order to make inferences about the population and other statistics in the vicinity of the main wind farm development site, the Study Area for the Po section of this EIAR was defined in terms of the District Electoral Divisions (DEDs) within Donegal and the SAs and/or Electoral Wards/SOAs within Tyrone. The site of the proposed wind farm development lies within Goland DED and is adjacent to the Glenderg Ward SOAs, as shown in Figure 5.1. Glenderg Ward SOA is comprised of six small areas, numbered N00004484 to N00004489. The Proposed Development site forms a boundary with Glenderg Ward N00004485 only. The total Study Area (for the purposes of the Human Beings assessment) has a combined population of 2,983 persons, and comprises of a total land area of 213 square kilometers. (Source: CSO Census of the Population 2011, NISRA Census 2011).

**Underground Electrical Grid Connection Route**

A connection between the Proposed Development site and the national electricity grid will be necessary to export electricity from the proposed wind farm. The planning application for the Proposed Development includes permission for 110kV grid connection cabling, as shown in the grid connection layout drawings in Appendix 4.1a. It is intended that the Proposed Development will connect to the national grid via the existing Clogher 110 kV Electricity Substation (Clogher Substation), located in the townland of Cullionboy, Co. Donegal. The Clogher Substation is located approximately 6.2 kilometres southwest of the Proposed Development at its closest point.

The current application seeks permission for underground cabling to link with the underground grid connection cabling from the Drumnahough substation currently proposed under Pl. Ref 17/50543 & ABP Ref. PL05E.248796. This is the preferred method of connection to Clogher substation. However, an alternative independent underground cabling connection from the proposed Meenbog wind farm to the Clogher substation is also assessed in this EIAR.

In order to assess potential impacts on Human Beings and human health along the grid connection route, a review of properties and planning applications in the vicinity of the proposed works was carried out, with the majority of developments along the route comprising single houses. The land-use along the grid connection comprises mainly transport, and surrounding land use is mainly agriculture with some areas of peat harvesting and forestry. The active construction area for the grid connection will be small, ranging from 150 to 300 metres in length at any one time, and it will be transient in nature as it moves along the route. Should separate crews be used during the construction phase they will generally be separated by one to two kilometres.



Map Legend
Population and Statistics Study Area
EIAR Site Boundary
DED Boundaries
SOA Boundaries
OA Boundaries
Goland DED
Glenderg Ward SOA
N
W
E
S
MAP TITLE: Population and Satistics Study Area
MAP NO.: Figure 5.1
SCALE: 1:120,000
PROJECT TITLE: 160502 - Meenbog Wind Farm, Co. Donegal
OS SHEET NO.: N/A
DATE: 22-11-2017
DRAWING BY: Eoin McCarthy
CHECKED BY: Michael Watson
ISSUE NO.: 160502-2017.11.22-F
McCarthy Keville O'Sullivan

### 5.2.2 Population

#### 5.2.2.1 Population Trends

In the four years between the 2006 and the 2011 Census, the population of Ireland increased by 8.2% while the population of Northern Ireland increased by 4.0%. In the period 2011 to 2016, the populations of Ireland and Northern Ireland increased by 3.8% and 2.7%, respectively. Between 2006 and 2011, the population of Co. Donegal grew by 9.4% to 161,137 persons, while a population reduction of 1.2% was recorded between 2011 to 2016. Other population statistics for the Republic, Northern Ireland, County Donegal and the Study Area have been obtained from the Central Statistics Office (CSO) and the Northern Ireland Statistics and Research Agency (NISRA) and are presented in Table 5.1. All data for the human beings study area refers to the 2011 census data, as this allows a more relevant comparison between the Republic of Ireland DEDs and Northern Ireland SOAs/SAs. The 2016 census data for the republic of Ireland was consulted as part of the assessment process, and upon comparison with the relevant 2011 data, were found to be consistent.

**Table 5.1 Population 2006 – 2016 (Source: CSO & NISRA)**

| Area | Population | | | % Population Change | |
|---|---|---|---|---|---|
| | 2006 | 2011 | 2016 | 2006-2011 | 2011-2016 |
| Republic of Ireland | 4,239,848 | 4,588,252 | 4,761,865 | 8.2% | 3.8% |
| Northern Ireland | 1,743,000 | 1,814,000 | 1,862,000 | 4.0 | 2.7% |
| County Donegal | 147,264 | 161,137 | 159,192 | 9.4% | -1.2% |
| Study Area | 2,837 | 2,983 | N/A | 5.1% | N/A |

The data presented in Table 5.1 shows that the population of the Study Area increased by 5.1% between 2006 and 2011. This rate of population growth is consistent with that which was recorded in the Northern Ireland, however is 3-4% below that which was recorded in the Republic of Ireland and at County level between 2006 and 2011.

Of the DEDs and SOAs that make up the Study Area for this assessment, Goland DED recorded a population of 371 persons between 2006 and 2011. Glenderg SOA recorded a population of 2,612 persons during the same period.

#### 5.2.2.2 Population Density

The population densities recorded within the Republic, Northern Ireland, County Donegal and the Study Area during the 2011 Census are shown in Table 5.2. All data for the human beings study area refers to the 2011 census data, as this allows a more relevant comparison between the Republic of Ireland DEDs and Northern Ireland SOAs/SAs. The 2016 census data for the republic of Ireland was consulted as part of the assessment process, and upon comparison with the relevant 2011 data, were found to be consistent.

**Table 5.2 Population Density in 2011 and 2016 (Source: CSO, NISRA)**

| Area | Population Density (Persons per square kilometre) | |
|---|---|---|
| | **2011** | **2016** |
| Republic of Ireland | 67.0 | 69.6 |
| Northern Ireland | 133.8 | 137.3 |
| County Donegal | 33.2 | 32.8 |
| Study Area | 24.2 | N/A |

The population density of the Study Area recorded during the 2011 Census was 24.2 persons per square kilometre. As can be observed in Table 5.2, this figure is lower than the population density recorded in the Republic of Ireland, Northern Ireland and County Donegal.

Of the DEDs and SOAs that make up the Study Area for this assessment, Goland DED recorded a population density of 8.8 persons per square kilometer and Glenderg SOA recorded a population density of 15.4 persons per square kilometer.

### 5.2.2.3 Household Statistics

The number of households and average household size recorded within the Republic of Ireland, Northern Ireland, County Donegal and the Study Area during the 2011 and 2016 Census is shown in Table 5.3. All data for the human beings study area refers to the 2011 census data, as this allows a more relevant comparison between the Republic of Ireland DEDs and Northern Ireland SOAs/SAs. The 2016 census data for the republic of Ireland was consulted as part of the assessment process, and upon comparison with the relevant 2011 data, were found to be consistent.

**Table 5.3 Number of Households and Average Household Size in 2011 and 2016 (Source: CSO, NISRA)**

| Area | 2011 | | 2016 | |
|---|---|---|---|---|
| | No. of Households | Avg. Size (persons) | No. of Households | Avg. Size (persons) |
| Republic of Ireland | 1,654,208 | 2.8 | 1,702,289 | 2.7 |
| Northern Ireland | 703,275 | 2.5 | 726,169[1] | 2.5[1] |
| County Donegal | 57,964 | 2.7 | 58,505 | 2.7 |
| Study Area[2] | 268 | 2.9 | N/A | N/A |

Notes

[1] Please note the Northern Ireland Household figures for 2016 are based on projections and not on actual census figures.

[2] For the purposes of the assessment in Table 5.3, the study area includes data from Goland DED and Glenderg Ward Number N00004485 only.

In general, the figures in Table 5.3 show that the number of households in the Study Area are in line with that observed in the Republic, Northern Ireland and County Donegal during the 2011 census period.

### 5.2.2.4 Age Structure

Table 5.4 presents the percentages for the Republic of Ireland, Northern Ireland, County Donegal and the Study Area population within different age groups as defined during the 2011 Census. This data is also displayed in Figure 5.2.

**Table 5.4 Population per Age Category in 2011 (Source: CSO, NISO)**

| Area | Age Category | | | | |
|---|---|---|---|---|---|
| | 0 - 14 | 15 – 24 | 25 - 44 | 45 – 64 | 65 + |
| Republic of Ireland | 21.3% | 12.6% | 31.6% | 22.7% | 11.7% |
| Northern Ireland | 33.2% | 23.6% | 46.7% | 41.4% | 24.7% |
| County Donegal | 22.93% | 12.27% | 28.18% | 23.30% | 13.32% |
| Study Area[1] | 20.5% | 13.8% | 31.8% | 25.4% | 8.4 |

Notes

[1] For the purposes of the assessment in Table 5.4, the study area includes data from Goland DED and Glenderg Ward No 4485 only.

The proportion of the Study Area population within each age category is similar to those recorded in the Republic and Northern Ireland and County level. Within the Study Area, the highest population percentage occurs within the 25-44 age category. The lowest population percentage occurs in the over 65 age category, which is consistent with the data from the Republic of Ireland, Northern Ireland and County level.

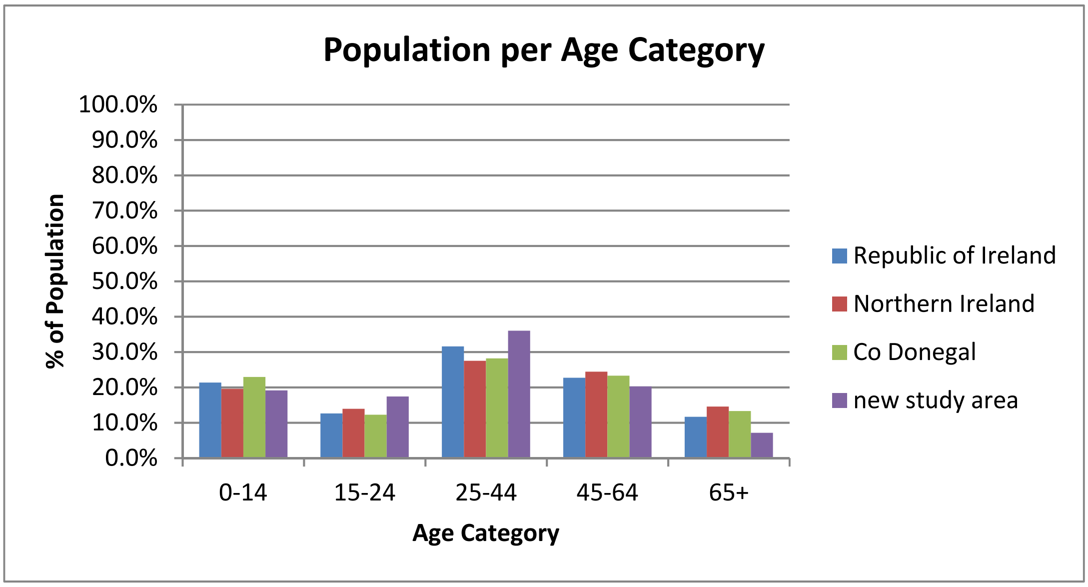



**Figure 5.2 Population per Age Category in 2011 (Source: CSO, NISRA)**

## 5.2.3 Employment and Economic Activity

### 5.2.3.1 Economic Status of the Study Area

The labour force consists of those who are able to work, i.e. those who are aged 15/16+, out of full-time education and not performing duties that prevent them from working. In 2011, there were 2,232,203 persons in the labor force in the Republic of Ireland and 821,805 in Northern Ireland. Table 5.5 shows the percentage of the total population aged 15/16+ who were in the labor force during the 2011 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 15/16+ who were *not* in the labor force, i.e. those who were students, retired, unable to work or performing home duties.

**Table 5.5 Economic Status of the Total Population Aged 15+ in 2011 (Source: CSO)**

| | Status | Republic of Ireland | Northern Ireland | County Donegal | Study[1] Area |
|---|---|---|---|---|---|
| % of population aged 15+ who are in the labor force | | **61.9%** | **64.9%** | **58.1%** | **51.2%** |
| % of which are: | At work | 81.0% | 62.1% | 73.8% | 83.4% |
| | Unemployed | 17.5% | 21.2% | 26.2% | 16.6% |
| % of population aged 15+ who are not in the labour force | | **38.1%** | **35.1%** | **41.9%** | **48.8%** |
| % of which are: | Student | 29.7% | 18.3% | 25.2% | 27.0% |
| | Home duties | 24.7% | 13.2% | 24.8% | 16.7% |
| | Retired | 33.2% | 38.3% | 36.6% | 26.3% |
| | Unable to work | 11.4% | 21.5% | 12.8% | 23.2% |
| | Other | 1.0% | 8.7 | 0.5% | 6.8% |

Notes

[1] For the purposes of the assessment in Table 5.5, the study area includes data from Goland DED and Glenderg Ward No 4485 only.

Overall, the principal economic status of those living in the Study Area is broadly similar to that recorded in the Republic of Ireland, Northern Ireland and County level. During the 2011 Census, between 62%-81.0% of those recorded as being in the labour force in the Republic of Ireland, Northern Ireland and County level were in employment. Within the Study Area, this figure was 83.4%. Of those who were not in the labour force during the 2011 Census, the highest percentage of the Study Area population were Students. The highest percentage of the Study Area population at interstate and County level were Retired.

### 5.2.3.2 Employment and Socio-Economic Grouping

Socio-economic grouping divides the population into categories depending on the level of skill or educational attainment required. These range from higher professional to unskilled. Employment in the study area falls mainly under employer/manager, non-manual and skilled manual, with a variety of sectors contributing to employment.

### 5.2.3.3 Employment and Investment Potential in the Irish Wind Energy Industry

#### *5.2.3.3.1 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."*

#### *5.2.3.3.2 Employment Potential*

The Deloitte report (2009) estimated at the time of its publication that the Island of Ireland's installed wind energy capacity would need to reach 7,800 Megawatts (MW) by 2020, in order to meet the Government's renewable energy targets. Based on these estimates, the Deloitte report stated that the Irish wind energy sector to 2020 would be capable of supporting more than 10,760 jobs through direct and indirect involvement in the sector. This number includes construction, operation and maintenance of all wind farms and assumes a steady growth in the industry over the period to 2020. It also encompasses planning and financing of wind farms, and support services such as administration, payroll and marketing/communications. There are also further employment opportunities available in other areas of the wind energy sector relating to policy, Research and Development, support services and other, which total to 935 jobs across Ireland.

Of the 10,760 jobs estimated to be created through the development of the wind energy sector, the Deloitte report states the majority of these would be provided within the construction industry:

> *"The wind sector offers great opportunities to a sector such as construction, which is currently facing downturn and rising unemployment. It is estimated that approximately 7,258 jobs will be supported by the construction element of wind farms."*

The Deloitte study on employment and investment potential assumed that there would be a steady growth in the amount of wind power rolled out between 2009 and 2020. The report states:

> *"It is crucial that the industry expands at a sustainable rate. If Ireland's increase in installed capacity is rolled out at a steady growth rate over the next eleven years then Irish companies will have sufficient time to adapt and build up their companies in order to cope with the increasing number of MW being added every year."*

As of 7th July 2017, there were 3,736 Megawatts (MW) of wind energy capacity installed on the island of Ireland[1]. Of this, 2,851 MW was installed in the Republic of Ireland, with 885 MW installed in Northern Ireland. The majority of the Republic of Ireland's installed wind energy capacity is located in Counties Donegal, Cork and Kerry

#### 5.2.3.4 Economic Value

The Deloitte report states that the construction and development of wind energy projects across the island of Ireland would involve approximately €14.75 billion of investment from 2009 up to 2020, €5.1 billion of which would be retained in the Irish economy (€4.3 billion invested in the Republic of Ireland and €0.8 billion in Northern Ireland).

The Deloitte report states that increasing the share of our energy from renewable sources will deliver significant benefits for the electricity customer, the local economy and society. It estimates that between 25 and 30% of capital investment is retained in the local economy. This typically flows to companies in construction, legal, finance and other professional services. The report states:

> *".. the framework acknowledges the need to put the energy/climate change agenda at the heart of Ireland's economic renewal. Every new wind farm development provides a substantial contribution to the local and national economy through job creation, authority rates, land rents and increased demand for local support services. More wind on the system will also result in lower and more stable energy prices for consumers while helping us achieve our energy and emissions targets."*

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[1] http://www.iwea.com/_windenergy_onshore

### 5.2.4 Land-use

The total area of farmland within the Study Area for the Human Beings assessment measures approximately 10,550 hectares or 49.7% of the Study Area, according to the CSO Census of Agriculture in Ireland 2010 and the Department of Agriculture and Rural Development Farm Structure Survey in Northern Ireland 2010. There are 244 farms located within the Study Area, with an average farm size of 43.2 hectares. This is marginally above the average farm size of 30.0 hectare for County Donegal as a whole. Within the Study Area, farming employs 300 people, and the majority of farms are family-owned and run. Table 5.6 shows the breakdown of farmed lands within the Study Area. Pasture accounts for the largest proportion of farmland while sheep account for the largest proportion of livestock.

**Table 5.6 Farm Size and Classification within the Study Area in 2000 (Source: CSO)**

| Characteristic | Value |
|---|---|
| Size of Study Area | 21234 hectares |
| Total Area Farmed within Study Area | 10,550 hectares |
| Farmland as % of Study Area | 49.7% |
| Breakdown of Farmed Land | Area (hectares) |
| Total Pasture | 9,606 ha |
| Total Crops | 83 ha |
| Total Cattle | 8,933 |
| Total Sheep | 31,925 |

### 5.2.5 Services

The site of the Proposed Development is located within the functional area of the Donegal County Development Plan 2012 – 2018 and the Border Regional Planning Guidelines 2010-2022. The nearest settlement to the site of the Proposed Development is Ballybofey, located in the Finn valley, in which the main services are located.

#### 5.2.5.1 Education

The nearest primary school to the boundary of the site of the Proposed Development is St Mary's National School, Ballybofey, Co Donegal located approximately 11 kilometres to the northeast of the Proposed Development. The closest secondary school to the site of the Proposed Development is St Columba's College, which is located approximately 13 kilometers to the northeast of the site boundary.

#### 5.2.5.2 Access and Public Transport

The site of the Proposed Development is accessed via the N15 National Primary Route at the western side of the site. From the site entrances, existing roads traverse the site in all directions. The nearest bus routes from which a number of daily connections are available, can be accessed in Ballybofey and Stanorlar approximately 8.0 kilometres north of the site and Castlederg approximately 17.0 kilometers east of the site.

#### 5.2.5.3 Amenities and Community Facilities

The majority of amenities and community facilities, including GAA and other sports clubs, youth clubs and recreational areas available in the area are located in the centers of settlement throughout the wider area. Retail and personal services within the vicinity are provided in the larger settlements such as Ballybofey, Stanorlar and Castlederg.

- The North-West Cycle Trail is a 326 kilometre circular cycle route running through Counties Donegal, Tyrone, Fermanagh, Leitrim and Sligo. A small portion of the cycle route runs through the north of the study area.

The nearest designated walking route is the Trusk Lough Walkway, located approximately 5.0 kilometres to the northeast of the Proposed Development site at its nearest point.

Community Benefit proposals, which would enhance local amenities and community facilities, are described in Section 4.5 and Section 4.6 of this EIAR.

## 5.3 Tourism

### 5.3.1 Tourist Numbers 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 2016 (the latest year for which annual Fáilte Ireland figures are available, total tourism revenue generated in Ireland was approximately €8.3 billion, an increase of approximately 8.1% from the previous year. Overseas tourist visits to Ireland in 2016 grew by 8.8% to 8.7 million (*'Tourism Facts 2016y'*, Fáilte Ireland, August 2017).

Ireland is divided into eight tourism regions. Table 5.7 shows the total revenue and breakdown of overseas tourist numbers to each region in Ireland during 2016 (*'Tourism Facts 2016'*, Fáilte Ireland, June 2017)

**Table 5.7 Overseas Tourists Revenue and Numbers 2016 (Source: Fáilte Ireland)**

| Region | Total Revenue (€m) | Total Number of Overseas Tourists (000s) |
|---|---|---|
| Dublin | €1,975 m | 5,687 |
| Mid-East | €251 m | 626 |
| Midlands | €72 m | 226 |
| South-East | €273 m | 946 |
| South-West | €849 m | 2,079 |
| Mid-West | €390 m | 1,215 |
| West | €543 m | 1,675 |
| Border | €286 m | 815 |
| Total | €4,639 m | 13,269 |

The Border region, in which the site of the Proposed Development is located, comprises County Cavan, Donegal, Leitrim, Monaghan, Sligo and Louth. This Region benefited from approximately 6.1% of the total number of overseas tourists to the country and approximately 6.2% of the total tourism income generated in Ireland in 2016.

Data showing the breakdown of overseas tourist numbers to the Border region and the associated revenue generated for 2016 was unavailable at the time of writing this EIAR (November 2017). Therefore, for the purposes of this assessment, figures from 2015 have been used ('Regional tourism performance in 2015, Fáilte Ireland, October 2016). As can be observed in Table 5.8, County Donegal had the highest tourism revenue within the Region during 2015.

**Table 5.8 Overseas Tourism to Border Region during 2015 (Source: Fáilte Ireland)**

| County | Revenue Generated by Overseas Tourists (€m) | No. of Overseas Tourists (000s) |
|---|---|---|
| Cavan | 50 | 144 |
| Donegal | 83 | 289 |
| Leitrim | 15 | 57 |
| Monaghan | 25 | 65 |
| Sligo | 51 | 186 |
| Louth | 36 | 125 |

## 5.3.2 Tourist Attractions

A small section of The North-West Cycle Trail runs through the north of the study area. The North-West Cycle Trail is a 326 kilometre circular cycle route running through Counties Donegal, Tyrone, Fermanagh, Leitrim and Sligo. There are no other tourist attractions pertaining specifically to the site of the Proposed Development.

The nearest tourist centers to the Proposed Development site are within Ballybofey, Stranorlar and Castlederg towns, located approximately 8-17 kilometres northeast and east of the site. Tourist attractions within these centers include the round tower in Ballybofey, salmon fishing on the River Finn, Castlederg Castle and Trusk Lough.

## 5.3.3 Tourist Attitudes to Wind Farms

### 5.3.3.1 Scottish Tourism Survey 2016

BiGGAR Economics undertook an independant study in 2016, entitled *'Wind Farms and Tourism Trends in Scotland'*, to understand the relationship, if any, that exists between the development of onshore wind energy 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.

Eight local authorities had seen a faster increase in wind energy deployment than the Scottish average. Of these, five also saw a larger increase in sustainable tourism employment than the Scottish average, while only three saw less growth than the Scottish average. The analysis presented in this report shows that, at the Local Authority level, the development of onshore wind energy does not have a detrimental impact on the tourism sector. This found that in the majority of cases (66%) sustainable tourism employment performed better in areas surrounding wind farms than in the wider local authority area. There was no pattern emerging that would suggest that onshore wind farm development has had a detrimental impact on the tourism sector, even at the very local level.

Overall, the conclusion of this study is that published national statistics on employment in sustainable tourism demonstrate that there is no relationship between the development of onshore wind farms and tourism employment at the level of the Scottish economy, at local authority level, nor in the areas immediately surrounding wind farm development.

#### 5.3.3.2 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 or not 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 and Northern 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 viewer, most contained less than ten turbines and 15% had less than five turbines.

With regard to 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 and Northern 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 Development throughout the site design and assessment processes. Reference has been had to the Department of the Environment, Heritage and Local Government's *'Planning Guidelines on Wind Energy Development'* 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.

## 5.4 Public Perception of Wind Energy

### 5.4.1 Sustainable Energy Ireland Survey 2003

#### 5.4.1.1 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. 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.

#### 5.4.1.2 Findings

The SEAI survey 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 impact 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 impact on the landscape is not a major concern for those living near an existing wind farm.

With regards to the economic and environmental impacts 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 favorably 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 impact 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.

#### 5.4.1.3 Conclusions

The main findings of the SEAI survey 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 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."*

### 5.4.2 Public Perceptions of Wind Power in Scotland and Ireland Survey 2005

#### 5.4.2.1 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.

#### 5.4.2.2 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 has two wind farms in close proximity.

#### 5.4.2.3 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 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, may 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 impacts 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 impact 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.

#### 5.4.2.4 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 syndrome does not adequately explain variations in public attitudes due to the degree of subjectivity involved.

## 5.5 Health Impacts of Wind Farms

### 5.5.1 Health Impact Studies

While there are anecdotal reports of negative health impacts on people who live very close to wind turbines, peer-reviewed research has generally 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.

- ***'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 also 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. Pierpoint'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 arising in humans arising from noise at the levels of that generated by wind turbines.

- ***'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."*

- ***'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 impacts on human health and, in particular, 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."*

- ***'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:

> "S*ome 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, is in contrast to the health impacts of fossil fuel energy generation.

- **'*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 impacts 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 a number of 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."*

- **Wind Turbines and Health, A Critical Review of the Scientific Literature Massachusetts Inistute 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 impact 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, was 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.

### 5.5.2 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'* state 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. People or animals can safely walk up to the base of the turbines.

The DoEHLG Guidelines state that there is a very remote possibility of injury to people from flying fragments of ice or from a damaged blade. However, most blades are composite structures with no bolts or separate components and the danger is therefore minimised. The buildup of ice on turbines is unlikely to present problems. The wind turbines will be fitted with anti-vibration sensors, which will detect any imbalance caused by icing of the blades. The sensors will prevent the turbine from operating until the blades have been de-iced.

Turbine blades are manufactured of glass reinforced plastic which will prevent any likelihood of an increase in lightning strikes within the site of the Proposed Development 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. In extremely high wind speed conditions, (usually at Beaufort Storm Force 10 or greater) the turbines will shut down to prevent excessive wear and tear, and to avoid any potential damage to the turbine components.

### 5.5.3 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 EirGrid document *'EMF & You: Information about Electric & Magnetic Fields and the electricity transmission system in Ireland'* (EirGrid, 2014) provides further practical information on EMF and is included as Appendix 5.2 of this EIAR.

Further details on the potential impacts of electromagnetic interference to telecommunications and aviation are presented in Section 14.2 of this EIAR.

### 5.5.4 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, the consideration of the effects on populations and on human health should focus on health issues and environmental hazards arising from the other environmental factors, for example water contamination, air pollution, noise, accidents, disasters.

A wind farm is not a recognised source of pollution. It is not an activity that falls within any thresholds requiring Environmental Protection Agency licensing under the Environmental Protection Agency Licensing 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.

Chapter 8 Land, Soils & Geology, Chapter 9 Hydrology, Chapter 10 Air & Climate and Chapter 11 Noise 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 and noise emissions. The assessments however show that the residual impacts are not significant and will not lead to significant effects on any environmental media. On this basis the potential for negative health effects associated with the Proposed Development is negligible.

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 wind farm will have a long term, slight, positive effect on air quality as set out in Chapter 9 which will contribute to positive effects on human health.

Potential health effects are also associated with negative impacts on public and private water supplies and potentially flooding. Chapter 9 Hydrology addresses the potential for effects on water supplies and concludes that this potential is low and the residual effects limited. The proposed site design and mitigation measures ensures that the potential for impacts on the water environment generally is low.

The assessment of flood risk in Chapter 9 Hydrology has also shown that the risk of the proposed wind farm contributing to downstream flooding is also very low.

### 5.5.5 Vulnerability of the Project to Natural Disaster

As outlined in Section 5.5.4 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 both the construction and operational 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.

There is limited potential for significant natural disasters to occur at the Meeenbog wind farm site. Ireland is a geologically stable country with a mild temperate climate. The potential natural disasters that may occur are therefore limited to flooding and fire. The risk of flooding is addressed in Chapter 9. It is considered that the risk of significant fire occurring, affecting the wind farm and causing the wind farm to have significant environmental effects is limited. 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 impacts 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 proposed wind farm site is not regulated or connected to or close to any site regulated under the Control of Major Accident Hazards Involving Dangerous Substances Regulations i.e. SEVESO sites and so there is no potential effects from this source.

## 5.6 Property Values

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 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 impacts 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 impacts 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 of these LBNL studies note that their results don't 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're rare enough to be statistically insignificant. Therefore although there have been claims of significant property value impacts near operating wind turbines that regularly surface in the press or in local communities, strong evidence to support those claims has failed to materialise in all of the major U.S. studies conducted thus far.

A further 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 5-3 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), 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 do 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 impacts of wind farms on property prices, 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.

## 5.7 Shadow Flicker

### 5.7.1 Background

Shadow flicker is an impact 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 impact 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 for well over 50% of the time. The mean cloud amount for each hour is between five and six okta. This is due to our geographical position off the northwest of Europe, close to the path of Atlantic low-pressure systems which tend to keep us in humid, cloudy airflows for much of the time. A study of mean cloud amounts at 12 stations over a 25-year period showed that the mean cloud amounts were at their minimum in April and their maximum in July. Cloud amounts were less by night than by day, with the mean minimum occurring roughly between 2100 and 0100 GMT and the mean maximum 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 500 metres between a turbine and a receptor, shadow flicker generally occurs only at sunrise or sunset when the shadow cast by the turbine is longer. At distances greater than ten rotor diameters from a turbine, the potential for shadow flicker is very low (*'Wind Energy Development Guidelines for Planning Authorities',* DoEHLG, 2006). Figure 5.4 illustrates the shadow cast by a turbine at various times during the day, where 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.

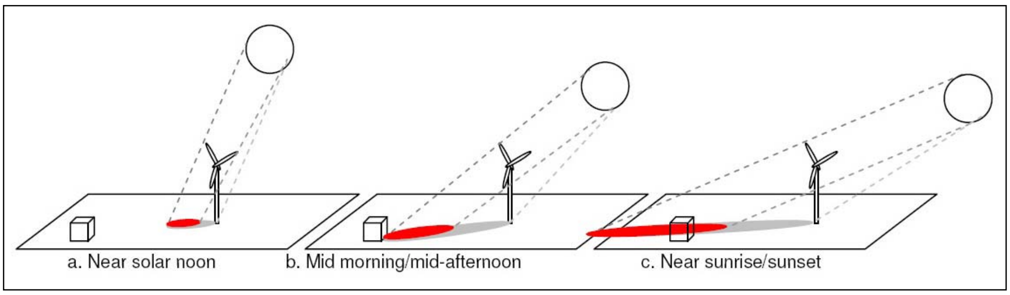



**Figure 5.4 Shadow-Prone Area as a Function of Time of Day (Source: *Shadow Flicker Report, Helimax Energy*, December 2008)**

**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 impact 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 center of the rotor's shadow passes more quickly over the land reducing the duration of the impact.

At 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.

**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 have to 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 5.5.

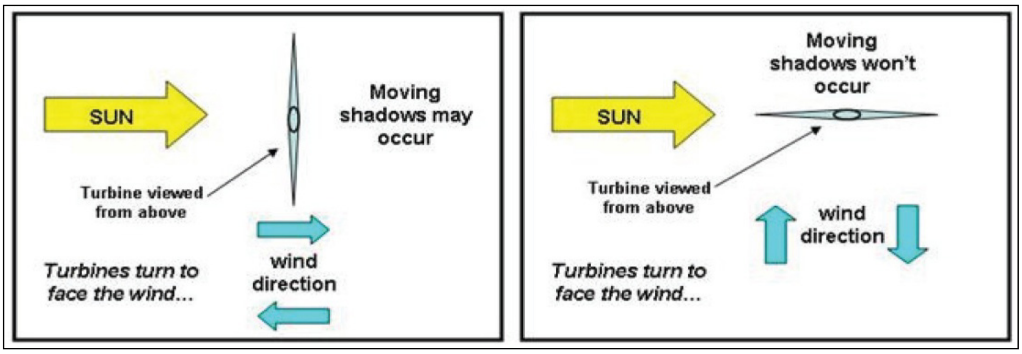



**Figure 5.5 Turbine Blade Position and Shadow Flicker Impact (Source: *Wind Fact Sheet: Shadow Flicker, Noise Environmental Power LLC*)**

**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, no shadow flicker will occur.

### 5.7.2 Guidance

The relevant Irish guidance for shadow flicker is derived from the '*Wind Energy Development Guidelines for Planning Authorities'* (Department of the Environment, Heritage and Local Government (DoEHLG), 2006) and the '*Best Practice Guidelines for the Irish Wind Energy Industry*' (Irish Wind Energy Association, 2012). The relevant Northern Ireland best practice guidance relating to shadow flicker is contained in its Planning Policy Statement No. 18 "*Renewable Energy*" (Department of the Environment, 2009).

Both the Northern Ireland and Republic of Ireland recommend that shadow flicker at dwellings within 500 metres of a proposed turbine location should not exceed a total of 30 hours per year or 30 minutes per day.

The guidelines state that shadow flicker lasts only for 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.

Although the DoEHLG thresholds apply to dwellings located within 500 metres of a proposed turbine location, for the purposes of this assessment, the guideline thresholds of 30 hours per year or 30 minutes per day have been applied to all properties located within ten rotor diameters (i.e. assumed at 1.26 kilometres) of the proposed turbines within the Proposed Development site (as per IWEA guidelines, 2012). The DoEHLG Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low. The applicant is aware that the Department of the Environment, Heritage and Local Government (DoEHLG) Wind Energy Development Planning Guidelines (2006) are currently being revised. Should these guidelines be finalised in advance of a planning decision for this application, the turbine layout as presented can comply with the revised shadow flicker limits.

### 5.7.3 Scoping

Section 2.6 in Chapter 2 of this EIAR describes the scoping and consultation exercise undertaken for the Proposed Development. No comments were received in relation to Shadow Flicker in response to scoping requests as of 25th$^{nd}$ October 2017.

### 5.7.4 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 Department of the Environment, Heritage and Local Government (DoEHLG) guidelines state that careful site selection, design and planning, and good use of relevant software can help avoid the possibility of shadow flicker in the first instance, all of which have been employed at the site of the Proposed Development. Proper siting of wind turbines is key to reducing or 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 or Wind Pro. 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 shadow flicker impact 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 if the model indicates that an exceedance of the shadow flicker guideline limit might occur, as detailed further below.

For the purposes of this shadow flicker assessment, the software package WindFarmer Version 4.1.2.3 has been used to predict the level of shadow flicker associated with the proposed wind farm development. 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.

### 5.7.5 Shadow Flicker Assessment Criteria

#### 5.7.5.1 Turbine Dimensions

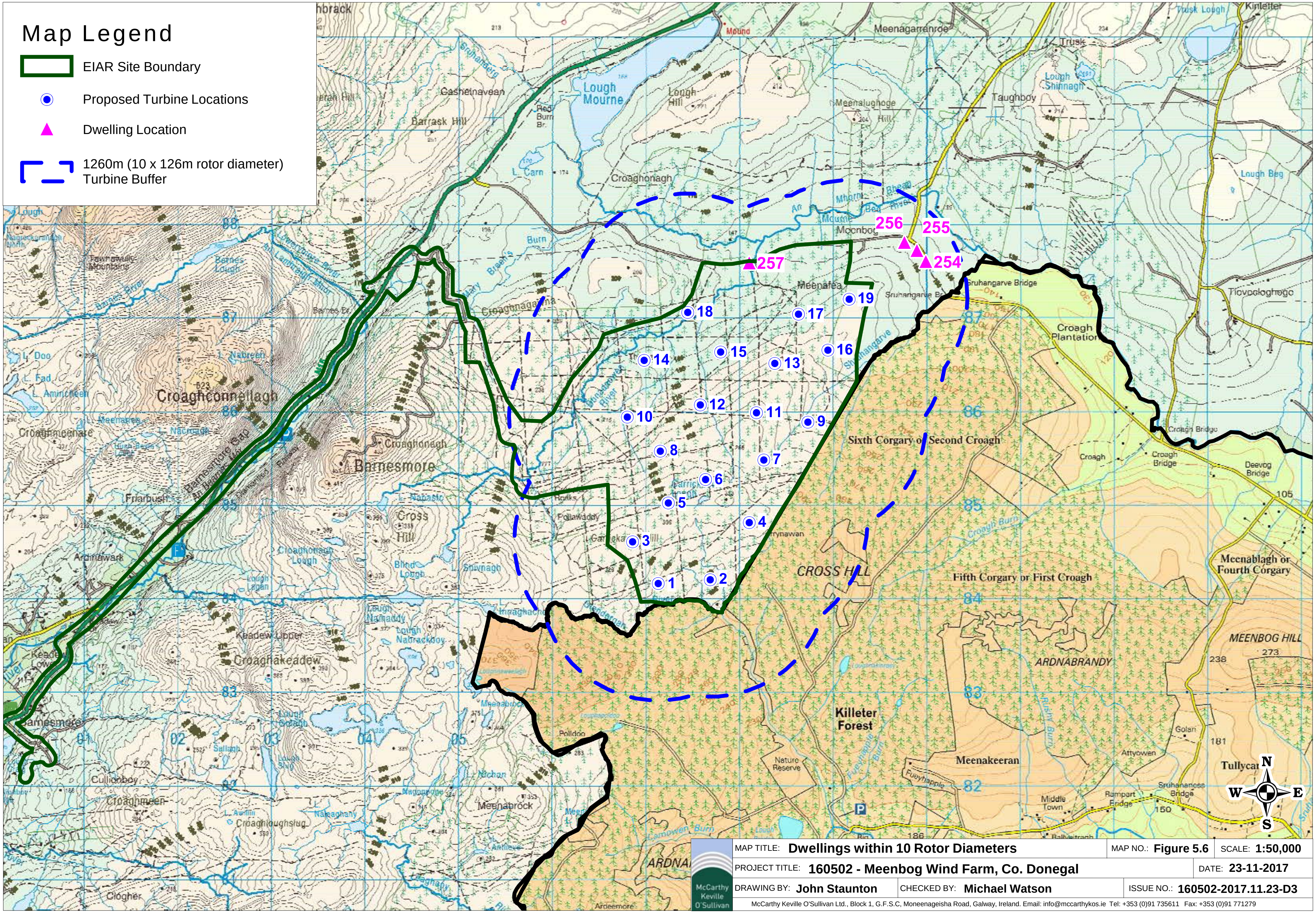
Planning permission is being sought for a turbine size envelope with a maximum tip height of up to 156.5 metres. For the purposes of this assessment, a turbine with a rotor diameter of 126 metres and a hub height of 93.5 metres was modelled in order to assess a worst-case scenario. While these dimensions have been used for the purposes of this assessment, the actual turbine to be installed on the site will be the subject of a competitive tender process, and could include turbines of a different rotor diameter and hub height configuration (within the 156.5-metre tip height envelope) than considered as part of this assessment.

Regardless of the make or model of the turbine eventually selected for installation on site, it will have a maximum tip height of up to 156.5 metres and the potential shadow flicker impact it will give rise to will be no more than that predicted in this assessment. With the benefit of the mitigation measures outlined in this section, any turbine to be installed onsite will be able to comply with the DoEHLG 2006 guideline thresholds of 30 minutes per day or 30 hours per year, through the use of turbine control software. Any references to the turbine dimensions in this shadow flicker assessment should be considered in the context of the above, and should not be construed as pre-determining the dimensions of the wind turbine to be used on the site.

#### 5.7.5.2 Study Area

There is a total of 4 No. buildings including occupied and unoccupied, located within a distance of 10 rotor diameters (assumed at 1,260 metres) from the proposed turbine locations.

The area was also the subject of a planning history search, to identify properties that may have been granted planning permission, but not yet been constructed. Of the 4 No. buildings, 3 are dwellings and 1 is derelict. The locations of the buildings are shown in Figure 5.6, with all residential buildings detailed in Table 5.9 in Section 5.7.6 below. There were no non-residential buildings to be included in the shadow flicker assessment.


Map Legend
EIAR Site Boundary
Proposed Turbine Locations
Dwelling Location
1260m (10 x 126m rotor diameter) Turbine Buffer
MAP TITLE: Dwellings within 10 Rotor Diameters
MAP NO.: Figure 5.6
SCALE: 1:50,000
PROJECT TITLE: 160502 - Meenbog Wind Farm, Co. Donegal
DATE: 23-11-2017
DRAWING BY: John Staunton
CHECKED BY: Michael Watson
ISSUE NO.: 160502-2017.11.23-D3
McCarthy Keville O'Sullivan
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Lough Mourne
Croaghconnellagh
Barnesmore
Killeter Forest
CROSS HILL
Sixth Corgary or Second Croagh
Fifth Corgary or First Croagh
Meenakeeran
ARDNABRANDY
MEENBOG HILL
257
256
255
254
N
S
E
W

#### 5.7.5.3 Assumptions and Limitations

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 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 additional incidences or durations or shadow flicker over and above those predicted in this assessment can be countered by extending the mitigation strategies outlined further 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 modeled 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 30% of the daylight hours per year. This percentage is based on Met Eireann data recorded at Malin Head over the 30-year period from 1981 to 2010 (www.met.ie). The actual sunshine hours at the Proposed Development site and therefore the percentage of time shadow flicker could actually occur is 30%. Table 5.9 below therefore lists the annual shadow flicker calculated for each property when the regional average of 30% sunshine is taken into account, to give a more accurate annual average shadow flicker prediction.

Table 5.9 below also outlines whether a shadow flicker mitigation strategy is required for each property to mitigate potential exceedances of the daily and/or annual threshold figure.

### 5.7.6 Shadow Flicker Assessment Results

#### 5.7.6.1 Daily and Annual Shadow Flicker

The WindFarm computer software 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 is based on the assumption 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 30% has been applied. Taking this into consideration, an approximation of the 'estimated actual' shadow flicker occurrence has been calculated and is outlined in Table 5.9.

The predicted maximum daily and annual shadow flicker levels are then considered in the context of the DoEHLG's guideline daily threshold of 30 minutes per day and annual threshold of 30 hours per year. If there is a predicted exceedance of the threshold limits at any property the turbines that contribute to the exceedance are also identified.

The DoEHLG Wind Energy Guidelines recommend that shadow flicker at dwellings within 500 metres of a proposed turbine location should not exceed a total of 30 hours per year. There are no dwellings within 500 metres of the proposed turbine locations. However, for the purposes of this assessment, the guideline threshold has been applied to all residential properties within 1,260 metres (ten rotor diameters) of the proposed turbine locations.

**Table 5.9 Maximum Potential Daily and Annual Shadow Flicker**

| Building No. | ITM Coordinates (Easting; Northing) | Description | Distance to Nearest Turbine (metres) | Nearest Turbine | 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 and Wind Direction (hrs:min:sec) | Turbine(s) Giving Rise to Exceedance | Mitigation Strategy Required? |
|---|---|---|---|---|---|---|---|---|---|
| 254 | 209993, 387602 | Derelict | 905 | 19 | 00:34:12 | 19:54:00 | 5:58:12 | - | No |
| 255 | 209897, 387720 | Consenting | 880 | 19 | 00:35:24 | 23:00:00 | 6:54:00 | - | No |
| 256 | 209764, 387806 | Consenting | 835 | 19 | 00:37:48 | 30:30:00 | 9:09:00 | - | No |
| 257 | 208106, 387587 | Consenting | 750 | 19 | 01:18:36 | 107:54:00 | 32:22:12 | 13, 15-19 | No |

All 4 No. properties modelled may experience daily shadow flicker in excess of the DoEHLG guideline threshold of 30 minutes per day. This prediction is assuming worst-case conditions (i.e. 100% sunshine on days where the shadow of the turbines passes over a house, wind blowing in the correct direction, no screening present, etc.). These conditions are therefore likely to occur only very rarely, if ever. Of these, three are occupied by consenting landowners, and the remaining property is derelict.

When the regional sunshine average (i.e. the mean amount of sunshine hours throughout the year) of 30% and wind direction reduction factor (34%) is taken into account, the DoEHLG total annual guideline limit of 30 hours is predicted to be exceeded at a single property. This property is occupied by a consenting landowner.

In reality, the 'estimated actual' shadow flicker is considered conservative and likely to be significantly less than predicted in Table 5.9 as the following items are not considered by the model:

- Receivers may be screened by cloud cover and/or vegetation/built form i.e. 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*[2]'.

Section 5.9.3.9 outlines the mitigation strategies which may be employed at the potentially affected properties to ensure the daily or annual shadow flicker threshold will not be exceeded.

#### 5.7.6.2 Cumulative Shadow Flicker

For the assessment of cumulative shadow flicker, any other existing, permitted or proposed wind farm would be considered where it was located within two kilometres of the proposed turbines. There were no such wind farms or single turbines located within this distance of the proposed turbines, therefore a cumulative shadow flicker assessment was not required.

## 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 tranquility experienced in the residence.

The proposed wind farm site is located in an area which is largely forested with clearfelling on-going in some localized areas, therefore a certain level of industrial activity and traffic movements are associated with the site, which will assist in the assimilation of the Proposed Development into the receiving environment. There are no properties located within approximately 750 metres of a proposed turbine location.

When considering the amenity of residents in the context of a proposed wind farm, there are three main potential impacts of relevance: 1) Shadow Flicker, 2) Noise, and

[2] Danish Wind Energy Association, 2003 http://xn--drmstrre-64ad.dk/wp-content/wind/miller/windpower%20web/en/tour/env/shadow/shadow2.htm

3) Visual Amenity. 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 11 of the EIAR addresses noise). A comprehensive landscape and visual impact assessment has also been carried out, as presented in Chapter 11 of this EIAR. Impacts on human beings during the construction and operational phases of the Proposed Development are assessed in relation to each of these key issues and other environmental factors such as traffic and dust; see Impacts in Section 5.9 below. The impact on residential amenity is then derived from an overall judgement of the combination of impacts due to shadow flicker, visual amenity, noise, traffic, dust and general disturbance.

## 5.9 Likely Significant Impacts and Associated Mitigation Measures

### 5.9.1 'Do-Nothing' Scenario

If the Proposed Development were not to proceed, the existing uses of the site for agriculture and forestry would continue. These land-uses will also continue if the Proposed Development does proceed.

If the Proposed Development were not to proceed, the opportunity to capture an even greater part of County Donegal's valuable renewable energy resource would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions.

### 5.9.2 Construction Phase

#### 5.9.2.1 Health and Safety

**Pre-Mitigation Impacts**

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

**Proposed Mitigation Measures**

During construction of the Proposed Development, 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) Regulations 2006'*. This will encompass the use of all necessary Personal Protective Equipment and adherence to the site Health and Safety Plan which will include measures to exclude members of the public from certain areas of the site during construction.

Stock-proof fencing will be erected around the borrow pit to prevent uncontrolled access to this area. Appropriate health and safety signage will also be erected on this fencing and at locations around the site.

All onsite works and health and safety requirements will be carried out to ESB/Eirgrid specifications. The constraints mapping exercise carried out at the outset of the design process ensured that no wind turbines are proposed to be located within 180 metres of the overhead lines.

**Residual Impact**
Short-term potential slight negative impact

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

#### 5.9.2.2 Employment and Investment

The design, construction and operation of the proposed wind farm will provide employment for technical consultants, contractors and maintenance staff. Up to approximately 80[3] jobs could be created during the construction, operation and maintenance phases of the Proposed Development. The construction phase of the Proposed Development will last between approximately 18 months. The majority of construction workers and materials will be sourced locally, thereby helping to sustain employment in the construction trade. This will have a short-term significant positive 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 impact on their cash flow. This will have a short-term slight positive indirect impact.

The Proposed Development 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 impact 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 impact. According to the Irish Wind Energy Association there were over 3,400 jobs directly related to wind energy in Ireland at the end of 2013 with more people joining the sector in 2014.

Rates payments in the region of €5.3 million per annum for the proposed wind farm will contribute significant funds to Donegal County Council, which will be redirected to the provision of public services within Co. Donegal. 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**
The applicant company has given careful consideration to the provision of community gain arising from the Proposed Development, if permitted and constructed. The concept of directing benefits from wind farms to the local community is promoted by the National Economic and Social Council (NESC) and the Irish Wind Energy Association (IWEA) among others. This approach recognises that, with any significant wind farm proposal, the locality in which the site is situated is making a significant contribution towards helping achieve national renewable energy and climate change targets, and the local community should derive some benefit from accommodating such a development in their locality.

[3] Deloitte & IWEA, Jobs and Investment in Irish Wind Energy – Powering Ireland's Economy.

Community gain proposals can take a number of forms, generally depending on the nature and location of the Proposed Development and the nature and make-up of the local community. In some instances, funds are paid by the developer, either annually or as a one-off payment, to a community fund that is administered by a voluntary committee. These funds may then be used for a variety of projects, such as environmental improvements, local amenities and facilities, voluntary and sporting groups and clubs, educational projects and energy efficiency improvement works.

The community gain proposal for the Proposed Development is to contribute to a Community Gain Fund to support local environmental improvements and recreational, social or community amenities and initiatives in the locality of the proposed project. This will require the establishment of a Community Gain Committee.

The community benefit scheme is proposed to be funded as follows:

- It is intended that Planree Ltd. will make an initial contribution of €6,250 per MW upon commissioning of the proposed wind farm. Should the estimated capacity of 66.5 MW be installed, this initial payment could total €415,625. This amount would then be immediately available through the liaison committee to local groups and organisations through grants.

- Further payments of €1,250 per MW will be paid into the fund annually over the estimated 30 year operational period of the wind farm, which would result in further annual payments of up to €85,000 and a total of €2.5 million in local funding over the 30 year project lifespan.

The number and size of grant allocations will be decided by a Community Fund liaison committee with various groups and project benefiting to varying degrees depending on their funding requirement. The role of community benefit has had a significant positive socio-economic impact within local communities.

The Recreational & Amenity proposal's which form part of this project will be implemented under the Community Fund and any other ideas or suggestions for future projects are welcomed.

Overall, it is concluded that the socio-economic impacts of the Proposed Development will be beneficial on a local, regional and national level.

#### 5.9.2.3 Population

Those working on the construction phase of the Proposed Development 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.

#### 5.9.2.4 Land-use

The existing land-uses of agriculture and forestry will continue on the site of the Proposed Development.

#### 5.9.2.5 Noise

**Pre-Mitigation Impacts**

There will be an increase in noise levels in the vicinity of the Proposed Development site during the construction phase, as a result of heavy machinery and construction work. These impacts will be short-term in duration. The noisiest construction activities associated with wind farm development are excavation and pouring of the turbine bases, and the extraction of stone from the borrow pits. Excavation of a 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 Development are further described in Chapter 11 of this EIAR.

**Proposed Mitigation Measures**
Best practice measures for noise control will be adhered to onsite during the construction phase of the Proposed Development in order to mitigate the slight short-term negative impact associated with this phase of the development. The measures include:

- Sensitive location of equipment, taking account of local topography and natural screening.
- Working methods: construction noise will be controlled by prescribing that standard construction work will be restricted to the specified working hours. Any construction work carried out outside of these hours shall be restricted to activities that will not generate noise of a level that may cause a nuisance. The phasing of works has also been designed with regard to avoidance of noise impacts.
- Plant will be selected taking account of the characteristics of noise emissions from each item. All plant and machinery used on the site shall comply with relevant E.U. and Irish legislation in relation to noise emissions. The timing of on- and off-site movements of plant near occupied properties will be controlled.
- Operation of plant: all construction operations shall comply with guidelines set out in British Standard documents *'BS 5338: Code of Practice for Noise Control on Construction and Demolition Sites'* and *'BS5228-1:2009+A1:2014: Code of Practice for Noise and Vibration Control on Construction and Open Sites'*. The correct fitting and proper maintenance of silencers and/or enclosures, the avoidance of excessive and unnecessary revving of vehicle engines, and the parking of equipment in locations that avoid possible impacts on noise-sensitive locations will be employed.
- Training and supervision of operatives in proper techniques to reduce site noise, and self-monitoring of noise levels, if appropriate.

**Residual Impact**
Short-term imperceptible negative impact

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

#### 5.9.2.6 Dust

**Pre-Mitigation Impacts**
Potential dust emission sources during the construction phase of the Proposed Development include upgrading of existing access tracks and construction of new access roads, turbine foundations and substation. The entry and exit of construction vehicles from the 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. These impacts will not be significant and will be relatively short-term in duration.

**Proposed Mitigation Measures**
Aggregate material for the construction of roads and turbine bases will be sourced onsite; therefore there will be no need to transport this material to the site. Truck wheels will be washed to remove mud and dirt before leaving the site. All plant and materials vehicles shall be stored in the dedicated compound area. Areas of excavation will be kept to a minimum, and stockpiling will be minimised by coordinating excavation, spreading and compaction. Construction traffic will be restricted to defined routes and a speed limit will be implemented.

In periods of extended dry weather, dust suppression may be necessary along haul roads and around the borrow pit area to ensure dust does not cause a nuisance. If necessary, water will be taken from the site's drainage system, and will be pumped into a bowser or water spreader to dampen down haul roads and the temporary site compound to prevent the generation of dust. Silty or oily water will not be used for dust suppression, because this would transfer the pollutants to the haul roads and generate polluted runoff or more dust. Water bowser movements will be carefully monitored, as the application of too much water may lead to increased runoff.

**Residual Impact**
Short-term imperceptible negative impact

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

#### 5.9.2.7 Traffic

**Pre-Mitigation Impacts**
The construction phase of the Proposed Development will last approximately 18 months. Construction materials and turbines will be delivered to the site of the Proposed Development from Killybegs, via the N15 National Primary Road.

Construction traffic will be comprised of Heavy Goods Vehicle (HGV) and Light Goods Vehicle (LGV) movements involved in the delivery of wind turbines and construction materials to the site and the export of excess construction materials and plant from the site. A complete Traffic and Transportation Assessment (TTA) of the Proposed Development has been carried out by Alan Lipscombe Traffic and Transport Consultants. The full results of the TTA are presented in Section 13 of this EIAR.

The types of vehicles that will be required to negotiate the local network represent abnormal loads and a detailed assessment of the geometry of the proposed route was therefore undertaken. It was established that short-term remedial measures may be required at some locations on the route and that further analysis and dry delivery runs will be required at these locations prior to construction.

**Proposed Mitigation Measures**
Aggregate materials for the construction of any additional site tracks will be obtained from a borrow pit on the site of the Proposed Development. This will significantly reduce the number of delivery vehicles required to access the site.

**Residual Impact**
Short-term imperceptible negative impact

**Significance of Effects**

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

#### 5.9.2.8 Tourism

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

#### 5.9.2.9 Shadow Flicker

Shadow flicker, which occurs during certain conditions due to the movement of wind turbine blades, as described in Section 5.7 of this chapter of the EIAR, occurs only during the operational phase of a wind energy development. There are therefore no shadow flicker impacts associated with the construction phase of the Proposed Development.

### 5.9.3 Operational Phase

#### 5.9.3.1 Employment and Investment

Up to three permanent maintenance staff will be employed at the site during the operational phase of the Proposed Development, having a long-term slight positive effect.

#### 5.9.3.2 Health and Safety

The operational phase of the Proposed Development poses little threat to the health and safety of the public. The Department of the Environment, Heritage and Local Government (DoEHLG)'s *'Wind Energy Development Guidelines for Planning Authorities 2006'* state 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. People or animals can safely walk up to the base of the turbines.

The DoEHLG Guidelines state that there is a very remote possibility of injury to people from flying fragments of ice or from a damaged blade. However, most blades are composite structures with no bolts or separate components and the danger is therefore minimised. The buildup of ice on turbines is unlikely to present problems. The wind turbines will be fitted with anti-vibration sensors, which will detect any imbalance caused by icing of the blades. The sensors will cause the turbine to wait until the blades have been de-iced prior to beginning operation.

The turbine blades will be manufactured of glass reinforced plastic which will prevent any likelihood of an increase in lightning strikes within the site of the Proposed Development 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. There will be no impact on health and safety.

#### 5.9.3.3 Population

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

#### 5.9.3.4 Land-use

The footprint of the Proposed Development site, including turbines, roads etc., will occupy only a small percentage of the total Study Area defined for the purposes of this EIAR. The main land-uses of agriculture, forestry and turf-cutting on the site of the Proposed Development will continue to co-exist with the proposed wind farm. Therefore, there will be no impact on land use.

#### 5.9.3.5 Noise

A baseline assessment of the existing background noise conditions was carried out, the results of which are presented in Section 10 of the EIAR. A noise assessment of the operational phase of the Proposed Development has also been carried out through modelling of the development using noise prediction software. The predicted noise levels for the Proposed Development have been compared with the existing background noise levels and the guidance levels for noise emissions from wind farms as set out by the Department of the Environment, Heritage and Local Government (DoEHLG). The noise assessment also considers the cumulative impact of other wind energy developments in the study area.

Details of the noise assessment carried out by AWN Consulting are presented in Chapter 10 of the EIAR. In summary, the noise assessment found that there are no locations where the Proposed Development exceeds the adopted day and night time noise criteria. It may be concluded that the proposed wind turbine development complies with the appropriate guidance in relation to noise and will have a neutral slight long-term impact, hence the associated impact is considered acceptable.

#### 5.9.3.6 Traffic

Up to 80 employees will be employed at the proposed wind farm during the operational phase of the project. A Traffic and Transportation Assessment (TTA) of the Proposed Development has been completed by Alan Lipscombe Traffic and Transport Consultants, the results of which are presented in Section 13 of this EIAR. The TTA found that the traffic impact created during the operational phase of the proposed wind farm will be negligible.

#### 5.9.3.7 Renewable Energy Production and Reduction in Greenhouse Gas Emissions

Emissions from energy production accounted for 19.7% of Ireland's greenhouse gas emissions in 2015 (*'Ireland's Final Greenhouse Gas Emissions in 2015'*, EPA (April, 2017). The National Climate Change Strategy 2007 – 2012 states that electricity generation from renewable sources provides the most effective way of reducing the contribution of power generation to Ireland's greenhouse gas emissions. The Proposed Development will offer significant benefits in terms of renewable energy production and reductions in greenhouse gas emissions. In this regard, it will have a long-term significant positive impact.

#### 5.9.3.8 Tourism

The Department of the Environment, Heritage and Local Government's Wind Energy Development Guidelines for Planning Authorities 2006 state that *"the results of survey work indicate that tourism and wind energy can co-exist happily"*. It is not considered that the Proposed Development would have an adverse impact on tourism infrastructure in the vicinity. Wind farms are an existing feature in the surrounding landscape, which will assist in the assimilation of the Proposed Development into this environment.

#### 5.9.3.9 Shadow Flicker

**Pre-Mitigation Impacts**

Assuming worst-case conditions, a total of 4 residential properties may experience daily shadow flicker in excess of the DoEHLG guideline threshold of 30 minutes per day. The nearest residence is approximately 750m from the nearest turbine and all 4 properties are either occupied by a consenting landowner or are derelict. The DoEHLG total annual guideline limit of 30 hours is predicted to be exceeded only at 1 No property (that which is nearest the site) when the regional sunshine average of 30% is taken into account. This property is inhabited by an involved landowner and so does not require any mitigation measures.

**Proposed Mitigation Measures**

As mentioned in Section 5.7.6 and 5.9.3.9 above, there are no properties that will require shadow flicker mitigation strategies. If however any unforeseen issues do arise with any residences in relation to shadow flicker, the mitigation measures described below can be used.

Where shadow flicker exceedances are experienced at sensitive receptors, a site visit will be undertaken firstly to determine the level of occurrence, existing screening and window orientation. If shadow flicker is found to be occurring, suitable mitigation measures such as screening and/or wind turbine control measures including turbine shutdown can be employed to limit the incidence or duration of shadow flicker at the affected property below the guideline shadow flicker limit. In event of an exceedance the procedure for logging public complaints is outlined in the CEMP at Appendix 4.4.

As the shadow flicker assessment is based on a "bare-earth" scenario, a screening assessment which accounts for features such as undulations in local topography, built structures such as sheds or walls, or vegetation, may find that there is no requirement for further mitigation strategies. In the absence of screening a number of screening measures will be proposed to the affected property owner, including the installation of window blinds or curtains in affected rooms, planting of screening vegetation or other site-specific measures agreeable to the affected party.

Turbine control measures can also be used to meet the guidelines thresholds. Any relevant turbine(s) causing an issue would be programmed to switch off for the time required to reduce daily shadow flicker to a maximum of the guideline limit of 30 minutes. Following the application of measures to reduce daily shadow flicker, the total annual shadow flicker at the affected property would also be subsequently reduced to below the guideline threshold.

The DoEHLG Wind Energy Development Planning Guidelines (2006) are currently being revised. Should these guidelines be finalised in advance of a planning decision for this application, the turbine layout as presented can comply with the revised shadow flicker limits.

**Residual Impact**

Shadow flicker will potentially have a long-term slight negative impact

**Significance of Effects**

Based on the assessment above and the mitigation measures proposed there will be no significant effects related to shadow flicker.

#### 5.9.3.10 Interference with Communication Systems

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. 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.

As part of the scoping and consultation exercise undertaken by MKO, the national and regional broadcasters and fixed and mobile phone operators were contacted with regard to potential interference from the proposed wind farm. Full details are provided in Section 2.6 of the EIAR (in Chapter 2: Background to the Proposed Development) and Section 14.2 of the EIAR (in Chapter 14: Material Assets – Telecommunications and Aviation). Copies of scoping replies received are presented in Appendix 2.1 and Appendix 2.2 of this EIAR.

Three Ireland Ltd. and Meteor Mobile Communications Ltd. flagged the presence of links in the area, none of which will be affected by the proposed wind farm as a result of the proposed distances between the links and turbines. This was confirmed by the operators.

The proposed wind farm will therefore have no impact on telecommunications or aviation communications.

#### 5.9.3.11 Amenity/Residential Amenity

**Pre-Mitigation Impacts**

There Proposed Development includes on-site recreation and amenity facilities in the future which would consist of a series of marked walkways, complimented by waypoint signage, and visitor facilities in the form of a car park, play areas, barbeque area, picnic area and community garden. The proposed amenity facilities are described in Section 4.6 of this EIAR. This represents a moderate positive impact for local amenity.

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 has been carried out as part of this EIAR, which shows that the Proposed Development will be capable of meeting all required guidelines in relation to noise and shadow flicker thresholds. As detailed above, the DoEHLG Wind Energy Development Planning Guidelines (2006) are currently being revised. Should these guidelines be finalised in advance of a planning decision for this application, the turbine layout as presented can comply with the revised shadow flicker and noise limits.

The visual impact of the Proposed Development is addressed comprehensively in Chapter 11 of this EIAR. The Proposed Development has been designed to maximise turbine separation distances to dwellings in the area, with no turbines located within approximately 750 metres of any occupied dwelling and approximately 1,600 metres from any third-party dwellings. Given the separation distance of the residential properties from the proposed turbines, the Proposed Development will have no significant impact on existing visual amenity at dwellings.

**Proposed Mitigation Measures**
There are no turbines proposed within approximately 750 metres of any occupied dwelling and approximately 1,600 metres from any third-party dwellings. All mitigation as outlined under noise and vibration, dust, traffic, visual amenity and telecommunications in this EIAR will be implemented in order to reduce insofar as possible impacts on residential amenity at properties located in the vicinity of the Proposed Development works.

**Residual Impact**
The Proposed Development will have an imperceptible impact on residential amenity.

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

### 5.9.4 Cumulative Impact Assessment

For the assessment of cumulative impacts, any other existing, permitted or Proposed Developments (wind energy or otherwise) have been considered where they had the potential to generate an in-combination or cumulative impact with the proposed Meenbog wind farm. Further information on the developments, plans and projects considered as part of the cumulative assessment are given in Section 2.7 of this EIAR. The impacts with the potential to have cumulative impacts on human beings, in particular noise, shadow flicker and visual impacts are addressed in the relevant chapters.

#### 5.9.4.1 Employment and Economic Activity

Wind farms within 20 kilometers of the Proposed Development which may be proposed, permitted or operational contribute to short term employment during the construction stages and provide the potential for long-term employment resulting from maintenance operations. This results in a long-term significant positive impact.

Other projects as described in the cumulative assessment in Section 2.7 of this EIAR also have the potential to provide employment in the short term.

#### 5.9.4.2 Tourism

##### *5.9.4.2.1 Traffic*

**Impacts**
As standalone projects or cumulatively, the construction phase of projects will have a short-term slight to moderate negative impact on tourism as nuisance from construction traffic is unavoidable.

**Proposed Mitigation Measures**
Phased development will be employed to allow for construction traffic to be managed and to minimise the volume of construction traffic using the road network at any one time. The proposed phasing is set out Section 4.7.13 of the EIAR.

**Residual Impact**
Short term slight negative impact

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

#### 5.9.4.3 Health and Safety

The proposed wind farm will have no impacts in terms of health and safety. There is no credible scientific evidence to link wind turbines with adverse health impacts.

#### 5.9.4.4 Property Values

There is no statistical evidence that home prices near wind turbines are affected post or pre-construction periods after announcing development. A long-term imperceptible cumulative impact is anticipated.

#### 5.9.4.5 Services

Potential cumulative impact through injection of money into local services though short and long-term employment and a community benefit fund. This is expected to be a long-term positive cumulative impact.

#### 5.9.4.6 Shadow Flicker

As discussed in Section 5.7.6.2 above, no cumulative shadow flicker will occur at any inhabited non-consenting properties in the vicinity of the proposed wind farm.

#### 5.9.4.7 Residential Amenity

**Pre-Mitigation Impacts**

In the unlikely event of all permitted and proposed projects as described in the cumulative assessment in Section 2.7 of this EIAR being constructed at the same time, there is the potential for a resulting cumulative negative impact to occur on residential amenity.

**Proposed Mitigation Measures**

There are no turbines proposed within approximately 1,600 metres of any occupied uninvolved dwellings. All mitigation as outlined under noise and vibration, dust, traffic, visual amenity and telecommunications in this EIAR will be implemented in order to reduce insofar as possible impacts on residential amenity at properties located in the vicinity of the Proposed Development works. It is assumed also that all mitigation measures in relation to the other cumulative projects will also be implemented.

**Residual Impact**

The Proposed Development will have an imperceptible impact on residential amenity.

**Significance of Effects**

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

## 5.10 Summary

Following consideration of the residual impacts (post-mitigation) it is noted that the Proposed Development will not result in any significant effects on Human Beings in the area surrounding the Proposed Development. Assuming worst-case conditions (i.e. 100% sunshine on days where the shadow of the turbines passes over a house, wind blowing in the correct direction, no screening present, etc.) a total of 1 residential properties may experience daily shadow flicker in excess of the DoEHLG guideline threshold of 30 minutes per day. However, this is an involved property. When the regional sunshine average figure of 30% is taken into account, the annual guideline limit of 30 hours is predicted to be exceeded at the same property. Should any problems arise with shadow flicker at any inhabited dwelling houses, employment of suitable mitigation measures will ensure that there is no exceedance of the DoEHLG Wind Energy Guideline daily values at any of the properties.

Provided that the Proposed Development is constructed and operated in accordance with the design, best practice and mitigation that is described within this application, significant effects on human beings, population and human health are not anticipated at international, national or county scale.