

5. POPULATION AND HUMAN HEALTH

5.1 Introduction

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

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

5.1.1 Statement of Authority

This section of the EIAR has been prepared by Eoin Gilson and Karen Mulryan and reviewed by Michael Watson, of MKO. Eoin is an environmental scientist with over two years of experience with MKO and has prepared the Population and Human Health chapter for a number of wind energy EIARs in that time. Eoin holds a BSc (Hons) in Microbiology and a MSc (Hons) in Applied Environmental Science. Karen is an environmental scientist with over 3 years' experience in the commercial sector where she has undertaken extensive site surveys, watching briefs and report writing. She holds a BA and MSc in Archaeology and Heritage Studies. Michael Watson is a Project Director with MKO; with over 18 years' experience in the environmental sector. His project experience includes the management and productions of Environmental Impact Statements (EISs)/EIARs, particularly within the wind energy sector.

5.2 Population

5.2.1 Receiving Environment

Information regarding population and general socio-economic data were sourced from the Central Statistics Office (CSO), the County Offaly Development Plan 2014 – 2020, 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 2016, which is the most recent census for which a complete dataset is available, also the Census of Ireland 2011, the Census of Agriculture 2010 and from the CSO website (www.cso.ie). Census information is divided into State, Provincial, County, Major Town and District Electoral Division (DED) level.

The proposed development is located within several townlands as listed in Table 1.1 of Section 1.1 of this EIAR. The proposed wind farm site is located approximately 2km south of the town of Cloghan and 3.4km east of the town of Banagher, in County Offaly. Please refer to Figure 1.1 of Chapter 1: Introduction for the site location.

In order to assess the population in the vicinity of the proposed development, the Study Area for the Population section of this EIAR was defined in terms of the District Electoral Divisions (DEDs) where the proposed wind farm is located, as well as nearby DEDs which may be affected by the proposed development. The site of the proposed development lies predominantly within Banagher, Mounterin,

Eglis, Derryad, Shannonharbour, Cloghan and Gallen DEDs as shown in Figure 5.1. All of these DEDs will collectively be referred to hereafter as the Study Area for this chapter.

The Population Study Area has a population of 4,601 persons, as of 2016 and comprises a total land area of 170.58 km² (Source: CSO Census of the Population 2016).

The closest dwelling to the proposed Derrinlough Wind Farm is located approximately 762m from the nearest proposed turbine (T15), i.e. greater than the recommended setback distance (i.e. 4 times the tip height, 740m), as per the Draft Revised Wind Energy Development Guidelines December 2019 (currently out for public consultation).

5.2.2 Population Trends

In the four years between the 2011 and the 2016 Census, the population of Ireland increased by 3.8%. During this time, the population of County Offaly grew by 1.7% to 77,961 persons. Other population statistics for the State, County Offaly and the Study Area have been obtained from the Central Statistics Office (CSO) and are presented in Table 5.1.

Table 5.1 Population 2011 – 2016 (Source: CSO)

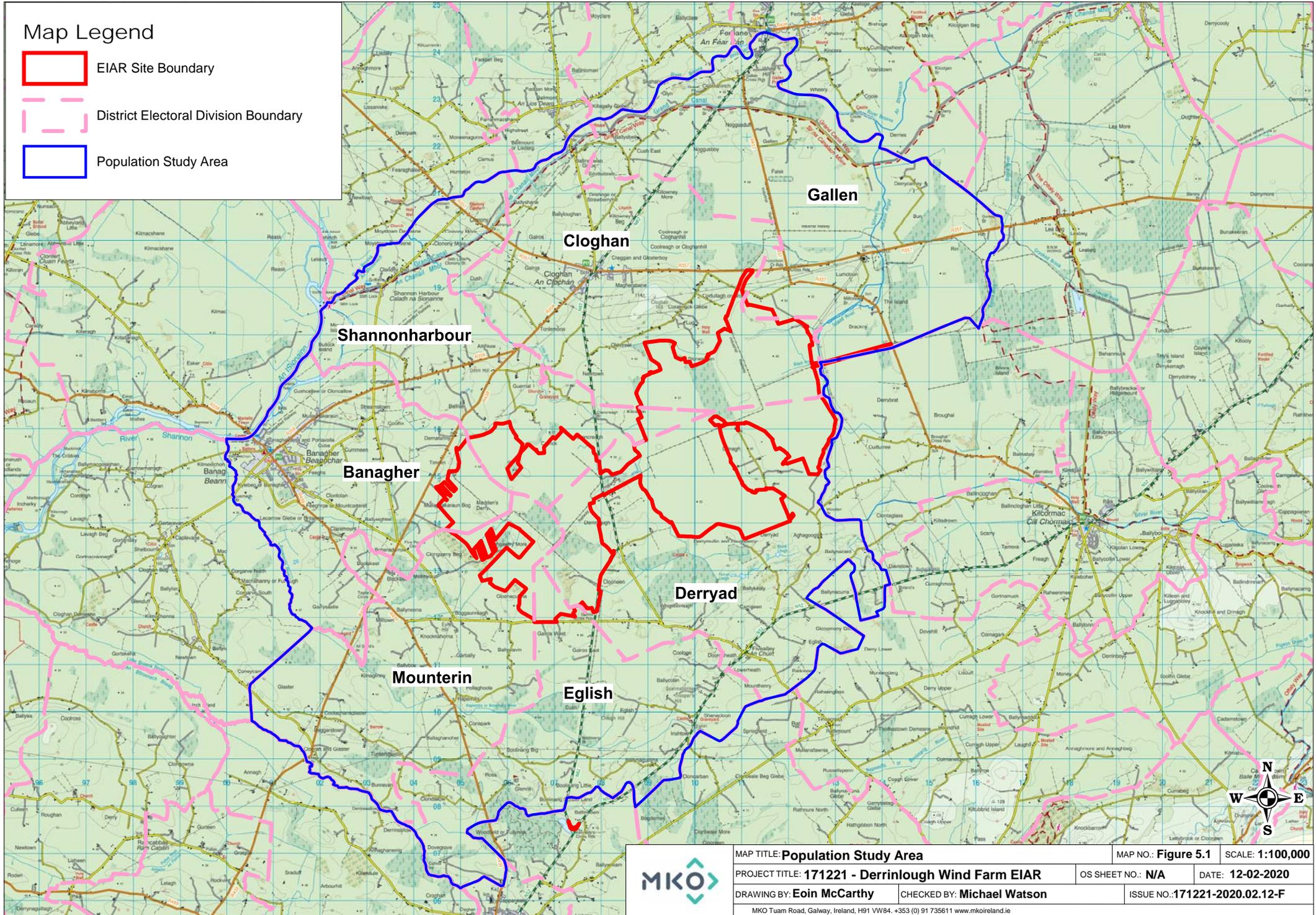
Area	Population Change		% Population Change
	2011	2016	2011 - 2016
State	4,588,252	4,761,865	3.8
County Offaly	76,687	77,961	1.7
Study Area	4,530	4,601	1.6

The data presented in Table 5.1 shows that the population of the Study Area increased by 1.6% between 2011 and 2016. This rate of population growth is lower than that recorded at State level but is similar to the County level. When the population data is examined in closer detail, it shows that the rate of population increase within the Study Area has been unevenly spread through the District Electoral Divisions (DEDs). The highest increase in the population between 2011 and 2016 occurred within Banagher DED, which experienced a 5.7% population increase. In comparison, the populations of Mounterin DED, Shannonharbour DED, Cloghan DED and Gallen DED all decreased during the same time period.

Of the DEDs that make up the Study Area for this assessment, the highest population was recorded in Banagher DED, with 2,106 persons recorded during the 2016 Census. The lowest population was recorded in Eglis DED, with 147 persons recorded during the 2016 Census.

Map Legend

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



	MAP TITLE: Population Study Area		MAP NO.: Figure 5.1	SCALE: 1:100,000
	PROJECT TITLE: 171221 - Derrinlough Wind Farm EIAR		OS SHEET NO.: N/A	DATE: 12-02-2020
	DRAWING BY: Eoin McCarthy	CHECKED BY: Michael Watson	ISSUE NO.: 171221-2020.02.12-F	
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5.2.3 Population Density

The population densities recorded within the State, County Offaly and the Study Area during the 2016 Census are shown in Table 5.2.

Table 5.2 Population Density in 2016 (Source: CSO)

Area	Population Density (Persons per square kilometre)	
	2011	2016
State	65.57	68.06
County Offaly	38.32	38.96
Study Area	25.56	26.97

The population density of the Study Area recorded during the 2016 Census was 26.97 persons per km². This figure is significantly lower than the national population densities of 68.06 persons per km² and lower than the county population densities of 38.96 persons per km².

Similar to the observed population and household trends, the population density recorded across the Study Area varies between DEDs. Eglisk DED has the lowest population density, at 7.55 persons per km², while Banagher DED has the highest population density, at 106.47 persons per km².

5.2.4 Household Statistics

The number of households and average household size recorded within the State, County Offaly and the Study Area during the 2011 and 2016 Censuses are shown in Table 5.3.

Table 5.3 Number of Household and Average Household Size 2011 – 2016 (Source: CSO)

Area	2011		2016	
	No. of Households	Avg. Size (persons)	No. of Households	Avg. Size (persons)
State	1,654,208	2.8	1,697,665	2.8
County Offaly	26,750	2.9	27,343	2.8
Study Area	1,581	2.8	1,668	2.7

In general, the figures in Table 5.3 show that while the number of households within the State, County and the 7 DEDs has increased slightly, the average number of people per household decreased slightly. Average household size recorded within the Study Area during the 2011 and 2016 Censuses are in line with that observed at State and County level during the same time periods. Similar to the trends observed above, the average household size recorded across the Study Area varies between DEDs. Mounterin DED had the highest, with 3.1 persons per household recorded in 2011 and 2016 respectively. Shannonharbour DED and Cloghan DED both recorded the lowest, with 2.8 and 2.7 persons per household recorded in 2011 and 2016, respectively.

5.2.5 Age Structure

Table 5.4 presents the population percentages of the State, County Offaly and Study Area within different age groups as defined by the Central Statistics Office during the 2016 Census. This data is also displayed in Figure 5.2.

Table 5.4 Population per Age Category in 2016 (Source: CSO)

Area	Age Category				
	0 - 14	15 - 24	25 - 44	45 - 64	65 +
State	1,006,552	576,452	1,406,291	1,135,003	637,567
County Offaly	17,727	9,358	21,191	19,094	10,591
Study Area	879	559	1188	1213	762

The proportion of the DED Study Area population within each age category is similar to those recorded at national and County level for most categories, For the Study Area, the highest population percentage occurs within the 45-64 age category.

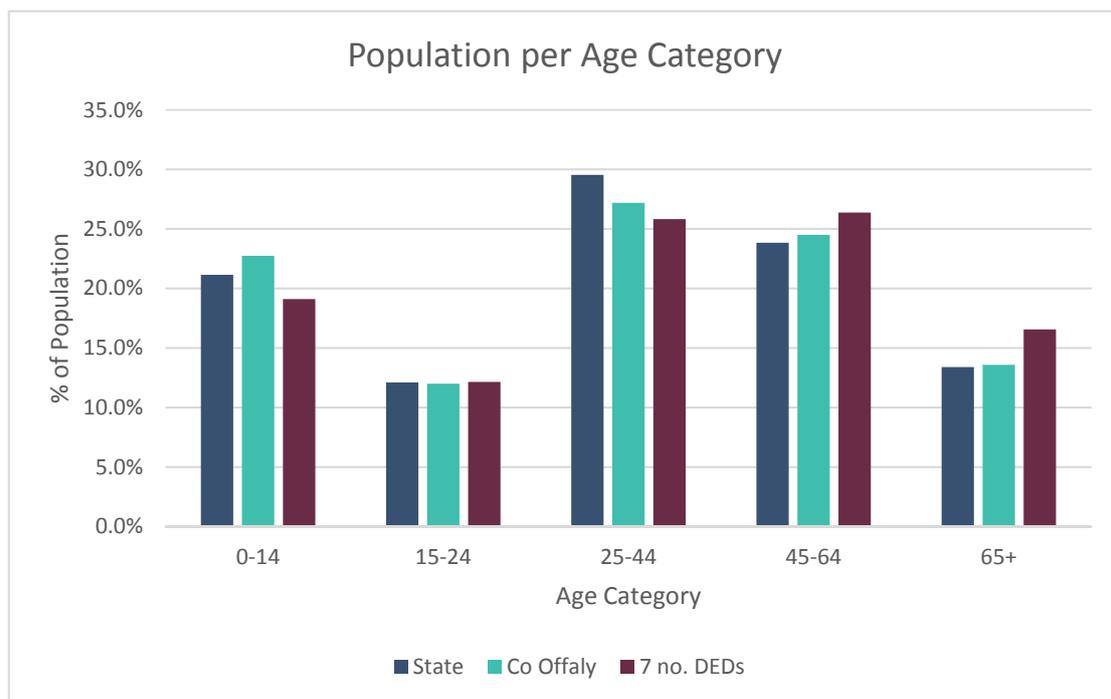


Figure 5.2 Population per Age Category in 2016 (Source: CSO)

5.2.6 Employment and Economic Activity

5.2.6.1 Employment by Socio-Economic Group

Socio-economic grouping divides the population into categories depending on the level of skill or educational attainment required. The 'Higher Professional' category includes scientists, engineers, solicitors, town planners and psychologists. The 'Lower Professional' category includes teachers, lab technicians, nurses, journalists, actors and driving instructors. Skilled occupations are divided into manual skilled such as bricklayers and building contractors; semi-skilled such as roofers and gardeners; and unskilled, which includes construction labourers, refuse collectors and window cleaners. Figure 5.3

shows the percentages of those employed in each socio-economic group in the State, County Offaly and the Study Area during 2016.

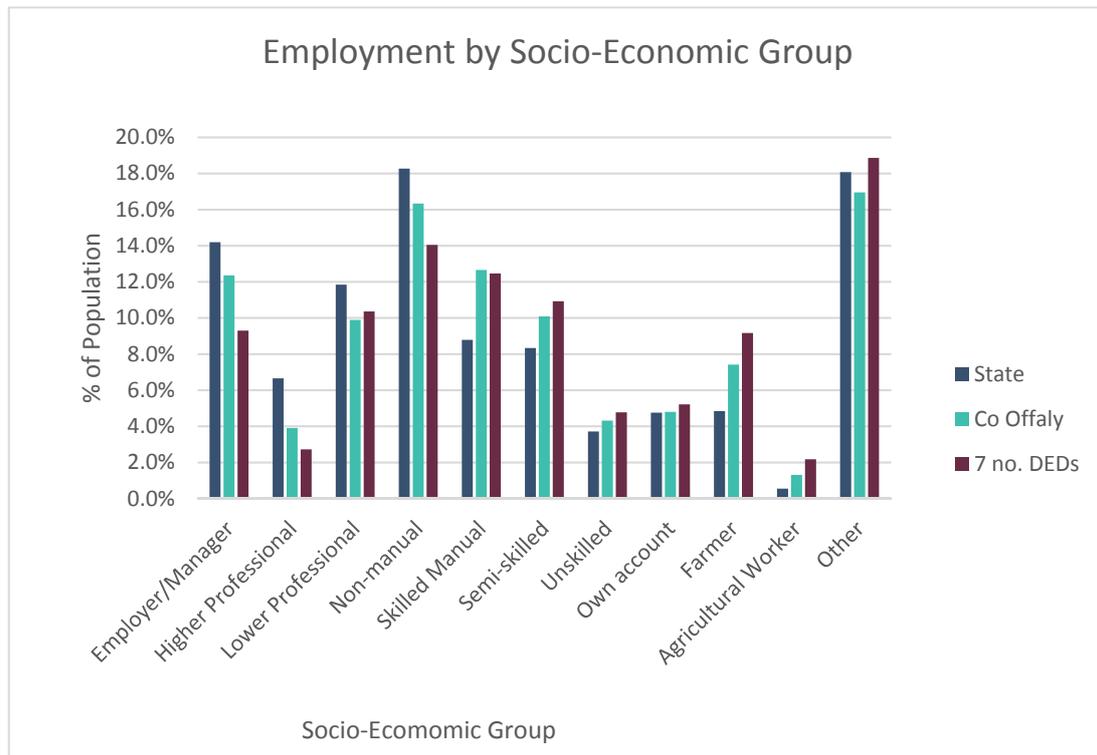


Figure 5.3 Employment by Socio-Economic Group in 2016 (Source: CSO)

The highest level of employment within the Study Area was recorded in the Other category. The levels of employment within the Employer/Manager, Higher Professional and Non-Manual categories in the Study Area were lower than those recorded for the State and County Offaly, while those recorded within the Semi-Skilled, Un-Skilled, Farmer, Agricultural Worker and Own Account categories were higher.

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

5.2.6.2 Employment and Investment Potential in the Irish Wind Energy Industry

5.2.6.2.1 Background

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

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

More recently, a report published in 2014 by Siemens entitled “‘An Enterprising Wind’ An economic analysis of the job creation potential of the wind sector in Ireland’, also in conjunction with the Irish

Wind Energy Association (IWEA), concluded that, ‘a major programme of investment in wind could have a sizeable positive effect on the labour market, resulting in substantial growth in employment.’

5.2.6.2.2 Energy Targets

The Climate Action Plan 2019 (CAP) was published on the 1st August 2019 by the Department of Communications, Climate Action and Environment. The CAP sets out an ambitious course of action over the coming years to address the impacts which climate may have on Ireland's environment, society, economic and natural resources. The CAP includes a commitment that 70% of Ireland's electricity needs will come from renewable sources by 2030. It is envisaged that wind energy will provide the largest source of renewable energy in achieving this target.

5.2.6.2.3 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.”

The Sustainable Energy Authority of Ireland estimates, in their ‘Wind Energy Roadmap 2011-2050’, that onshore and offshore wind could create 20,000 direct installation and operation/maintenance jobs by 2040 and that the wind industry would also have an annual investment potential of €12 million by the same year.

The 2014 report ‘The Value of Wind Energy to Ireland’, published by Póry, stated that growth of the wind sector in Ireland could support 23,850 jobs (construction and operational phases) by 2030. If Ireland instead chooses to not develop any more wind, then by 2030 the country will be reliant on natural gas for most of our electricity generation, at a cost of €71 million per annum in fuel import costs.

As of June 2019, there were 5,030 Megawatts (MW) of wind energy capacity installed on the island of Ireland. Of this, 3,748 MW was installed in the Republic of Ireland, with 1,282 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.

5.2.6.2.4 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 (€1.3 billion invested in the Republic of Ireland and €0.8 billion in Northern Ireland).

The report also 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.”

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

The proposed development will be contributing to the economic value that renewable energy brings to the country.

5.2.7 Land-Use

As previously noted, most of the wind farm site is cutover bog with a small proportion of commercial forestry noted on the site. The predominant surrounding land use within the Population study area is that of farmland. The total area of farmland within the 7 DEDs around the wind farm site measures approximately 8,995 hectares, comprising 52.4% of the Study Area, according to the CSO Census of Agriculture 2010. There are 269 farms located within the 7 DEDs, with an average farm size of 33.3 hectares. This is slightly smaller than the 36.5-hectare average farm size for Co. Offaly.

Within the Study Area, farming employs 537 people, and the majority of farms are family-owned and run. Table 5.5 shows the breakdown of farmed lands within the 7 DEDs. Pasture accounts for the largest proportion of farmland, followed by silage.

Table 5.5 Farm Size and Classification within the Study Area in 2010 (Source: CSO)

Characteristic	Value
Size of 7 DEDs	17,060 hectares
Total Area Farmed within 7 DEDs	8,995 hectares
Farmland as % of 7 DEDs	52.4%

Breakdown of Farmed Land	Area (hectares)
Total Pasture	3,092 ha
Total Silage	1,572 ha
Grazing	220 ha
Total Hay	250 ha
Total Potatoes	2 ha
Total Cereals	215 ha
Total Crops	254 ha

5.2.8 Services

The wind farm site is located approximately 3km east of Banagher town and 2km south of Cloghan, a village, in which the main services are located. Additionally, the nearby town of Birr lies approximately 7km south of the proposed development where local amenities including a community centre, church and shop are located.

5.2.8.1 Education

The nearest school to the site boundary of the proposed development is Lumcloon National School, located approximately 1.2 km to the northeast of the site boundary at its closest point. St. Mary's National School, Cloghan is located approximately 1.9 km to the northwest of the site boundary at its closest point and Broughal National School is located approximately 2.1 kilometres to the east of the proposed development.

The closest secondary school is Coláiste na Sionna in Banagher, located approximately 3.5 km west of the site of the proposed development.

5.2.8.2 Access and Public Transport

The site of the proposed development is accessed via the N62 National Primary Route which traverses the centre of the site. The nearest bus routes from which several daily connections are available, can be accessed in Banagher approximately 3.5 km northwest of the site.

5.2.8.3 Amenities and Community Facilities

Most of the amenities and community facilities, including GAA and other sports clubs, youth clubs and recreational areas available in the area are in the nearby settlements of Banagher, Cloghan and Ferbane, as well as in the town of Birr. Offaly County Council has a branch library at Banagher.

The varied environment of this area of County Offaly provides many opportunities for walking and cycling. The Grand Canal Greenway, The Offaly Way and The Hymany Way are all located within 10 kilometres of the site of the proposed development. The Offaly Way traverses the Lough Boora Discovery Park (<https://www.loughboora.com/>), which includes a large network of walking routes and is located to the east of the proposed development site.

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

5.3 Tourism

5.3.1 Tourism 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 2018, total tourism revenue generated in Ireland was approximately €9.1 billion, an increase on the €8.8 billion revenue recorded in 2017. Overseas tourist visits to Ireland in 2018 grew by 6.5% to 9.6 million (‘Tourism Facts 2018, Fáilte Ireland, September 2019).

Ireland is divided into seven tourism regions. Table 5.6 shows the total revenue and breakdown of overseas tourist numbers to each region in Ireland during 2018 (‘Tourism Facts 2018, Fáilte Ireland, September 2019).

Table 5.6 Overseas Tourists Revenue and Numbers 2018 (Source: Fáilte Ireland)

Region	Total Revenue (€m)	Total Number of Overseas Tourists (000s)
Dublin	€2,095m	6,309
Mid-East/Midlands	€393m	1,030
South-East	€261m	1,028
South-West	€987m	2,512
Mid-West	€11 m	1,497
West	€27m	1,963
Border	€244m	752
Total	€9,218 m	15,091

The proposed wind farm site is located within the Mid-East/Midland Region. According to ‘Regional tourism performance in 2018’ (Fáilte Ireland, September 2019) the Mid-East/Midland Region which comprises Counties Offaly, Laois, Longford, Meath, Westmeath, Kildare, Louth and Wicklow, benefited from approximately 6.8% of the total number of overseas tourists to the country and approximately 7.53% of the associated tourism income generated in Ireland in 2018.

5.3.2 Tourist Attractions

There are no key identified tourist attractions pertaining specifically to the site of the proposed development itself although it is proposed to develop a recreational and amenity facility as part of the Proposed Development.

The varied environment of this area of County Offaly provides many opportunities for walking and cycling. The Grand Canal Greenway, The Offaly Way and The Hymany Way are all located within 10 kilometres of the site of the proposed development. The Lough Boora Discovery Park (is located approximately 6 km to the east of the proposed site and includes a number of walking, cycling routes

and also offers bird watching and angling facilities. Cloghan Lake is located approximately 500 metres from the northeastern boundary of the proposed development site and is a popular fly-fishing lake.

Clonmacnoise, an early Christian site including ruins of a cathedral, eight churches, two round towers and Christian graves is located approximately 15 km to the north. Clonmacnoise has been put forward as a UNESCO World Heritage Site and is currently on UNESCO's tentative list.

Birr Castle, Gardens and Science Centre is located approximately 7km to the southwest of the site.

The River Shannon is used by a large number of recreational craft. Marinas and boat rental companies can be found along the Shannon in Banagher, 3 km to the west of the site.

5.3.3 **Tourist Attitudes to Wind Farms**

5.3.3.1 **Scottish Tourism Survey 2016**

BiGGAR Economics undertook an independent 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. It was 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 the development of wind farms impacts on the enjoyment of the Irish scenery by holidaymakers. The survey involved face-to-face interviews with 1,300 tourists (25% domestic and 75% overseas). The results of the survey are presented in the Fáilte Ireland Newsletter 2008/No.3 entitled 'Visitor Attitudes on the Environment: Wind Farms'.

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

- Almost half of those surveyed had seen at least one wind farm on their holiday to Ireland. Of these, two thirds had seen up to two wind farms during their holiday.

- Typically, wind farms are encountered in the landscape while driving or being driven (74%), while few have experienced a wind farm up close.
- Of the wind farms viewed, most contained less than ten turbines and 15% had less than five turbines.

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

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

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

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

“Almost three quarters of respondents claim that potentially greater numbers of wind farms would either have no impact on their likelihood to visit or have a strong or fairly strong positive impact on future visits to the island of Ireland. Of those who feel that a potentially greater number of wind farms would positively impact on their likelihood to visit, the key driver is their support for renewable energy and potential decreased carbon emissions.”

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

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

Further details regarding the general public perception of wind energy, including those living in the vicinity of a wind farm, are presented in Section 5.5 below.

5.4 Public Perception of Wind Energy

5.4.1 IWEA Interactions Opinion Poll on Wind Energy

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

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

5.4.2 Sustainable Energy Ireland Survey 2003

5.4.2.1 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.

5.4.2.2 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 favourably is a further indication that some experience of the structures tends to translate into positive attitudes towards wind energy.

Similar to the national survey, the surveys of those living within the vicinity of a wind farm also found that the findings are generally positive towards wind farms. Perceptions of the 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.

5.4.2.3 Survey Update 2017

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

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

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

5.4.2.4 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.”

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

5.4.3.1 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.

5.4.3.2 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 proximity.

5.4.3.3 Findings

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

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

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

The reasons that people gave for their positive attitude to the local wind farm were predominantly of a global kind, i.e. environmental protection and the promotion of renewable energy, together with opposition to a reliance on fossil fuels and nuclear power. Problems that are often cited as negative 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.

5.4.3.4 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 effects 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.

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

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

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

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

2. ‘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.”*

3. ‘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 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.’*

4. ‘Position Statement on Health and Wind Turbines’, Climate and Health Alliance, February 2012

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

“To date, there is no credible peer reviewed scientific evidence that demonstrates a direct causal link between wind turbines and adverse health impacts in people living in proximity to

them. There is no evidence for any adverse health effects from wind turbine shadow flicker or electromagnetic frequency. There is no evidence in the peer reviewed published scientific literature that suggests that there are any adverse health effects from infrasound (a component of low frequency sound) at the low levels that may be emitted by wind turbines.”

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

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

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

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

CAHA notes that:

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

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

5. ‘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 several headings, including noise and shadow flicker.

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

“There is no evidence for a set of health effects, from exposure to wind turbines that could be characterized as a “Wind Turbine Syndrome.”

The strongest epidemiological study suggests that there is not an association between noise from wind turbines and measures of psychological distress or mental health problems. There were two smaller, weaker, studies: one did note an association, one did not. Therefore, we conclude the weight of the evidence suggests no association between noise from wind turbines and measures of psychological distress or mental health problems.

None of the limited epidemiological evidence reviewed suggests an association between noise from wind turbines and pain and stiffness, diabetes, high blood pressure, tinnitus, hearing impairment, cardiovascular disease, and headache/migraine.”

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

“Scientific evidence suggests that shadow flicker does not pose a risk for eliciting seizures as a result of photic stimulation.

There is limited scientific evidence of an association between annoyance from prolonged shadow flicker (exceeding 30 minutes per day) and potential transitory cognitive and physical health effects.”

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

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

- Measurements of low-frequency sound, infrasound, tonal sound emission, and amplitude-modulated sound show that infrasound is emitted by wind turbines. The levels of infrasound at customary distances to homes are typically well below audibility thresholds.
- No cohort or case-control studies were located in this updated review of the peer-reviewed literature. Nevertheless, among the cross-sectional studies of better quality, no clear or consistent association is seen between wind turbine noise and any reported disease or other indicator of harm to human health.
- Components of wind turbine sound, including infrasound and low frequency sound, have not been shown to present unique health risks to people living near wind turbines.
- Annoyance associated with living near wind turbines is a complex phenomenon related to personal factors. Noise from turbines plays a minor role in comparison with other factors in leading people to report annoyance in the context of wind turbines.

A further 25 reviews of the scientific evidence that universally conclude that exposure to wind farms and the sound emanating from wind farms does not trigger adverse health effects, were compiled in September 2015 by Professor Simon Chapman, of the School of Public Health and Sydney University Medical School, Australia, and is included as Appendix 5.1 of this EIAR. Another recent publication by Chapman and Crichton (2017) entitled ‘Wind turbine syndrome; A communicated disease’ critically discusses why certain health impacts might often be incorrectly attributed to wind turbines.

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

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

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

The HSE position paper determines that current scientific evidence on adverse impacts of wind farms on health is weak or absent. Further research and investigative processes are required at a larger scale in order to be more informative for identifying potential health effects of exposure to wind turbine

effects. They advise developers on making use of the Draft Wind Energy Development Guidelines (2006), as a means of setting noise limits and set back distances from the nearest dwellings.

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

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

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

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

That being said, the GDG recommends renewable energy policies include provisions to ensure noise levels from wind farm developments do not rise above the guideline values for average noise exposure. The GDG also provides a conditional recommendation for the implementation of suitable measures to reduce noise exposure.

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' and the 'Draft Revised Wind Energy Development Guidelines' (Department of Housing, Planning and Local Government (DoHPLG), December 2019) (currently out for public consultation), iterate that there are no specific safety considerations in relation to the operation of wind turbines. Fencing or other restrictions are not necessary for safety considerations and should be kept to a minimum. People or animals can safely walk up to the base of the turbines.

The adopted 2006 Guidelines and the Draft 2019 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 build-up 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 resuming operation.

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.

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 ESB document ‘EMF & You’ (ESB, 2017) provides further practical information on EMF (https://esb.ie/docs/default-source/default-document-library/emf-public-information_booklet_v9.pdf?sfvrsn=0).

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

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’ and the guidance listed in Section 1.8.1 of Chapter 1: Introduction, 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.

Chapter 8: Land, Soils and Geology, Chapter 9: Hydrology and Hydrogeology, Chapter 10: Air and Climate, Chapter 11: Noise and Vibration and Chapter 14: Material Assets (Traffic and Transport) provide an assessment of the effects of the proposed development on these areas of consideration. There is the potential for negative effects on human health during the wind farm construction phase related to potential emissions to air of dust, potential emissions to land and water of hydrocarbons, release of potentially silt-laden runoff into watercourses and noise emissions. The assessments however show that the residual impacts are not significant and will not lead to significant effects on any environmental media with the potential to lead to health effects for humans. On this basis, the potential for negative health effects associated with the proposed development is imperceptible.

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

As set out in Chapter 9, potential health effects are associated with negative impacts on public and private water supplies and potential flooding. There are no mapped public or group groundwater scheme protection zones in the area of the proposed wind farm site.

The preliminary Flood Risk Assessment has also shown that the risk of the proposed wind farm contributing to downstream flooding is also very low.

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

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

5.5.5 Vulnerability of the Project to Natural Disasters and Major Accidents

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, operational and decommissioning phases are limited. Sources of pollution with the potential to cause significant environmental pollution and associated negative effects on health such as bulk storage of hydrocarbons or chemicals, storage of wastes etc. are limited.

There is limited potential for significant natural disasters to occur at the proposed Derrinlough 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: Hydrology and Hydrogeology. 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 and therefore a significant effect on human health is similarly 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 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 are no potential effects from this source.

5.6 Property Values

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

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 LBNL studies note that their results do not mean that there will never be a case of an individual home whose value goes down due to its proximity to a wind farm – however if these situations do exist, they are considered to be statistically insignificant. Therefore, although there have been claims of significant property value 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 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 5.2 of this ELAR.

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 does not provide sufficient information to enable us to rigorously measure and test the underlying causes of these differences, which may be interconnected and complex.

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

5.7 Shadow Flicker

5.7.1 Background

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

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

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

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

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

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

At distances of greater than approximately 500m between a turbine and a receptor, shadow flicker generally occurs only at sunrise or sunset when the shadow cast by the turbine is longer. The current adopted 'Wind Energy Development Guidelines for Planning Authorities' published by the Department of Environment, Heritage and Local Government (DoEHLG) in 2006, iterates that at distances greater than ten rotor diameters from a turbine, the potential for shadow flicker is very low.

Error! Reference source not found. illustrates the shadow cast by a turbine at various times during the day; the red shading represents the area where shadow flicker may occur. When the sun is high in the sky, the length of the shadow cast by the turbine is significantly shorter.

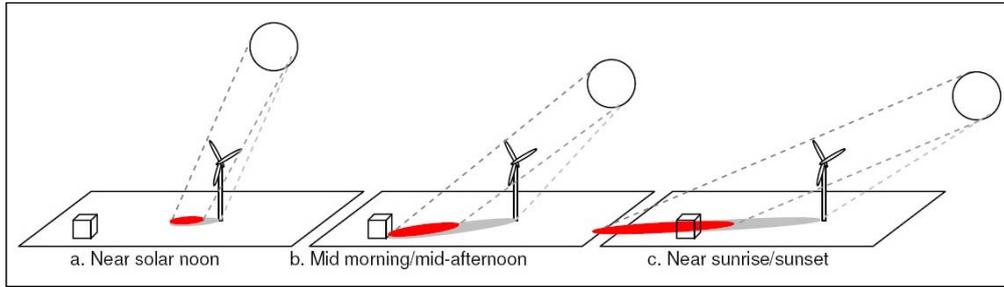


Figure 5.4 Shadow-Prone Area as Function of Time of Day (Source: Shadow Flicker Report, Helimax Energy, Dec 2008)

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

The further a property is from the turbine the less pronounced the 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 centre of the rotor’s shadow passes more quickly over the land reducing the duration of the impact.

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

5. Property usage and occupancy:

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

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

The direction of wind turbine blades changes according to wind direction, as the turbine rotor turns to face the wind. In order to cast a shadow, the turbine blades must be facing directly toward or away from the sun, so they are moving across the source of the light relative to the observer. This is demonstrated in Figure 5.5 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environment Power LLC).

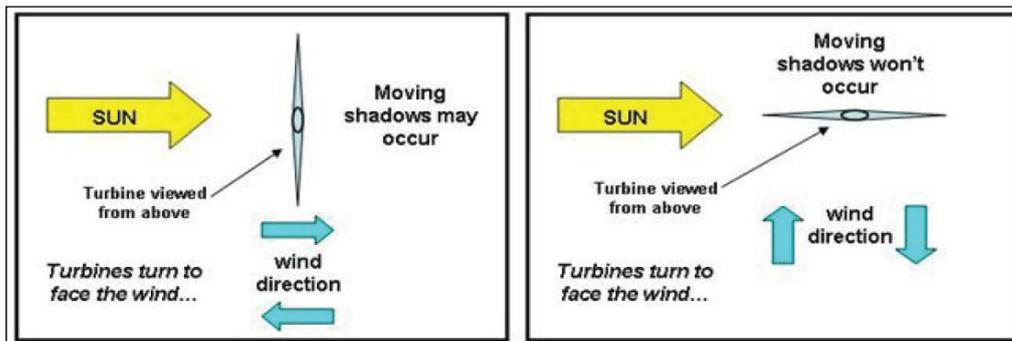


Figure 5.5 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environment Power LLC)

7. Rotation of turbine blades:

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

5.7.2 Guidance

The current, adopted guidance for shadow flicker in Ireland is derived from the ‘Wind Energy Development Guidelines for Planning Authorities 2006’ (DoEHLG), and the ‘Best Practice Guidelines for the Irish Wind Energy Industry’ (Irish Wind Energy Association, 2012). The 2006 DoEHLG Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The adopted 2006 DoEHLG guidelines are currently under review. The DoHPLG released the ‘Draft Revised Wind Energy Development Guidelines’ in December 2019 which have been released for public consultation. The Draft 2019 guidelines recommend local planning authorities and/or An Bord Pleanála impose conditions to ensure that:

“no existing dwelling or other affected property will experience shadow flicker as a result of the wind energy development subject of the planning application and the wind energy development shall be installed and operated in accordance with the shadow flicker study submitted to accompany the planning application, including any mitigation measures required.”

The Draft 2019 Guidelines are based on the recommendations set out in the ‘Proposed Revisions to Wind Energy Development Guidelines 2006 – Targeted Review’ (December 2013) and the ‘Review of the Wind Energy Development Guidelines 2006 – Preferred Draft Approach’ (June 2017).

The assessment herein is based on compliance with the 2006 guidelines. However, it should also be noted the proposed development can be brought in line with the requirements of the 2019 draft guidelines through the implementation of the mitigation measures outlined in Section 5.9.3.3.

5.7.3 Scoping

Chapter 2 of this EIAR describes the scoping and consultation exercise undertaken for the proposed Derrinlough Wind Farm. The only comment in relation to shadow flicker was included in the Health Service Executive’s response to the EIA Scoping request which reiterated what was stated in the scoping document in that shadow flicker would be assessed using a specialist computer software programme specifically designed for the wind energy industry. This assessment is included in the following sections of the EIAR.

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 DoHPLG guidelines state that careful site selection, design and planning, and good use of relevant software can help avoid the possibility of shadow flicker, all of which have been employed at the site of the proposed development. Proper siting of wind turbines is key in eliminating shadow flicker.

The occurrence of shadow flicker can be precisely predicted using specialist computer software programmes specifically developed for the wind energy industry, such as WindFarm (ReSoft) or WindFarmer (DNV.GL) or AWS OpenWind. The computer modelling of the occurrence and

magnitude of shadow flicker is made possible by the fact that the sun rises and sets in the same position in the sky on every day each year.

Any potential 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 as detailed further below.

For the purposes of this shadow flicker assessment, the software package WindFarm 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 tip height of up to 185 metres above the top of foundation. For the purposes of this assessment, a turbine with a rotor diameter of 150m and a hub height of 110m 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 185-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 185 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 section 5.9.3.3, all turbines installed onsite will comply with the current adopted 2006 DoEHLG guidelines. 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

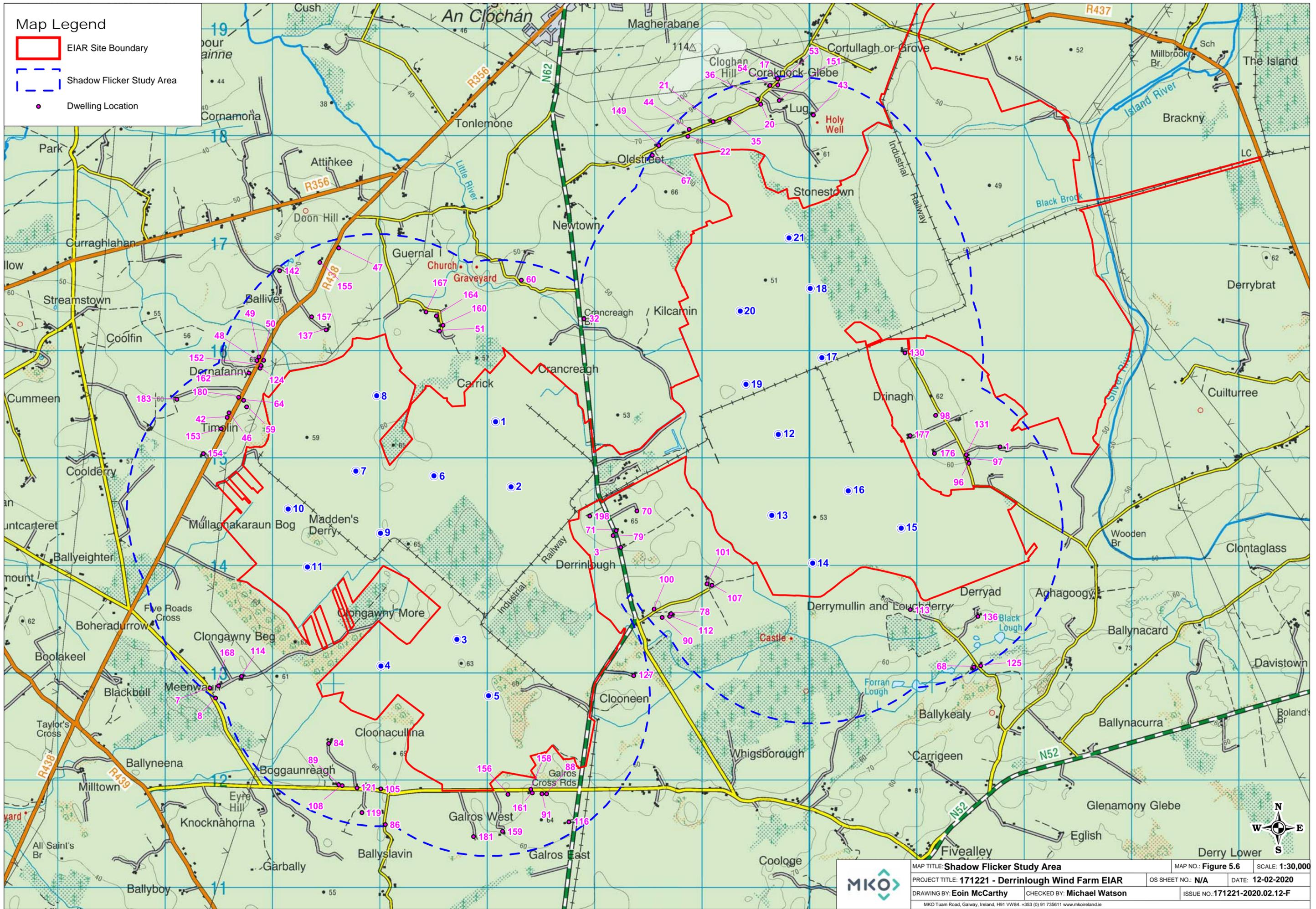
At the outset of the project, during the constraints mapping process detailed in Section 3.3.5.1 of this EIAR, all sensitive receptors within 2km of the development site boundary were identified and mapped. This included all occupied and unoccupied dwellings. In addition, a planning history search to identify properties that may have been granted planning permission, but not yet been constructed, was carried out. These properties were also added to the sensitive receptors' dataset.

The study area for the shadow flicker assessment is ten times rotor diameter from each turbine as set out in the Wind Energy Development Guidelines for Planning Authorities', DoEHLG, 2006. All residential properties located within ten rotor diameters which is assumed to be 1.5 kilometres have been included in the assessment. The closest residential property is located in excess of 750 metres from the nearest proposed turbine location.

There is a total of 82 No. sensitive receptors located within 10 rotor diameters (assumed at 1.5km) of the proposed turbine locations. No dwellings are located within the 4 times tip height setback distance of each turbine, a measure outlined in the 2019 Draft Revised Guidelines, should these come into force while this project is in the application process. The shadow flicker study area and sensitive receptor locations are shown in Figure 5.6.

Map Legend

- EIAR Site Boundary
- Shadow Flicker Study Area
- Dwelling Location



	MAP TITLE: Shadow Flicker Study Area		MAP NO.: Figure 5.6	SCALE: 1:30,000
	PROJECT TITLE: 171221 - Derrinlough Wind Farm EIAR		OS SHEET NO.: N/A	DATE: 12-02-2020
	DRAWING BY: Eoin McCarthy		CHECKED BY: Michael Watson	
	MKO Tuam Road, Galway, Ireland, H91 VW94. +353 (0) 91 735611 www.mkofireland.ie		ISSUE NO.: 171221-2020.02.12-F	

5.7.5.3 Assumptions and Limitations

Due to the latitude of Ireland and the UK, shadow flicker impacts are only possible at properties 130 degrees either side of north as turbines do not cast shadows on their southern side (ODPM Annual Report and Accounts 2004: Housing, Planning, Local Government and the Regions Committee; Planning Policy Statement 22; Draft Revised Wind Energy Development Guidelines 2019). As such properties located outside of this potential shadow flicker zone will not be impacted. However, in this assessment, all 82 no. properties within 360 degrees of the proposed development out to 1.5km were assessed for shadow flicker impact.

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

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

Each window measures one-metre-high by one-metre-wide, and tilt angle is assumed to be zero. The centre height of each window is assumed to be two metres above ground level and no screening due to trees or other buildings or vegetation is assumed. It was not considered necessary or practical to measure the dimensions of every window on every property in the study area. While the actual size of a window will marginally influence the incidence and duration of any potential shadow flicker impact, with larger windows resulting in slightly longer shadow flicker durations, any incidences or durations or shadow flicker can be countered by the measures outlined in Section 5.9.3.3 below.

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

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

The total annual shadow flicker calculated for each property assumes 100% sunshine during daytime hours, as referred to above. However, weather data for this region shows that the sun shines on average for 26.6% of the daylight hours per year. This percentage is based on Met Éireann data recorded at Birr, Co. Offaly over the 30-year period from 1979 to 2008 (www.met.ie). The actual sunshine hours at the proposed development site and therefore the percentage of time shadow flicker could actually occur is 26.6% of daylight hours. Table 5.7 therefore lists the annual shadow flicker calculated for each property

when the regional average of 26.6% sunshine is considered, to give a more accurate annual average shadow flicker prediction.

The model also does not consider that the turbine will not always be yawed such that the rotor is in the worst-case orientation. In order to include the probability of the rotor being orientated within the sun turbine vector a wind directionality factor has also been applied.

Table 5.7 outlines whether a shadow flicker mitigation strategy is required for any property within 1.5km of the proposed wind turbines which may be impacted by shadow flicker.

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 assumes that daylight hours consist of 100% sunshine. This is a conservative assumption which represents a worst-case scenario. Following the detail provided above on sunshine hours, a sunshine factor of 26.6% has been applied. Taking these probabilities into consideration, an approximation of the ‘estimated actual’ annual shadow flicker occurrence has been calculated and is presented in Table 5.7.

The estimated annual levels are then considered in the context of the DoEHLG’s Draft Revised Wind Energy Development Guidelines in December 2019 which require that no existing dwelling or other affected property experience shadow flicker as a result of any proposed wind energy development.

As stated in Section 5.1, the closest occupied dwelling is approximately 762m from any of the proposed turbine locations. For the purpose of this assessment, a buffer zone of 1.5km has been applied and all dwellings within this zone (totalling 82) were assessed for any potential shadow flicker impacts from the proposed turbine locations.

The 82 No. buildings have been modelled as part of the shadow flicker assessment, the results of which are presented in Table 5.7.

Of the 82 No. residential properties modelled; it is predicted that 50 properties may experience daily shadow flicker. Based on the 2006 DoEHLG guidelines, the daily threshold for shadow flicker is exceeded at 34 properties, however, the annual threshold for shadow flicker, once the regional sunshine average factor has been considered, is not exceeded at any property.

Additionally, it is worth noting that the ‘estimated actual’ shadow flicker listed in Table 5.7 is considered conservative and in reality, the occurrence and/or duration of shadow flicker at these properties is likely to be eliminated or significantly reduced as the following items are not considered by the model:

- Receivers may be screened by topography, 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.

Section 5.9.3.3 below outlines the mitigation strategies which may be employed at the potentially affected properties to ensure that the current adopted 2006 DoEHLG guidelines are complied with at any dwelling within the 1.5km study area. The same mitigation strategies, outlined in Section 5.9.3.3, also demonstrate that the proposed Derrinlough Wind Farm can be brought in line with the shadow flicker requirements of the Draft Revised Wind Energy Development Guidelines (2019) should they be adopted while this application is in the planning system.

Table 5.7 Maximum Potential Daily & Annual Shadow Flicker – Proposed Derrinlough Wind Farm, Co. Offaly

House No.	ITM (Easting)	ITM (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	26.6% Average Regional Sunshine applied	Proposed Turbine(s) Giving Rise to any potential Shadow Flicker impact	Mitigation Strategy Required
1	211779	215112	1219	15	00:32:24	37:24:00	09:56:54	15,16	Yes
2	208245	214175	1947	1	00:33:36	56:18:00	14:58:33	2,13	Yes
21	209105	218139	1292	21	00:16:12	04:54:00	01:18:12	21	No
22	208869	218003	1334	21	00:30:00	31:30:00	08:22:44	21	No
32	207901	216303	1264	1	00:30:36	42:30:00	11:18:18	1,20	Yes
42	204575	215385	1031	8	00:33:36	57:18:00	15:14:30	7,8,10	Yes
44	208882	218068	1390	21	00:28:48	26:24:00	07:01:21	21	No
46	204592	215428	1061	10	00:30:00	50:24:00	13:24:23	7,8,10	No
48	204852	215915	1167	8	00:31:48	44:36:00	11:51:49	7,8	Yes
49	204871	215949	1157	8	00:32:24	42:12:00	11:13:31	7,8	Yes
50	204916	215917	1100	8	00:33:36	44:36:00	11:51:49	7,8	Yes
51	206555	216189	840	8	01:04:12	87:12:00	23:11:43	1,8	Yes



House No.	ITM (Easting)	ITM (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	26.6% Average Regional Sunshine applied	Proposed Turbine(s) Giving Rise to any potential Shadow Flicker impact	Mitigation Strategy Required
59	204757	215484	1024	10	00:32:24	36:24:00	09:40:57	7,8	Yes
64	204729	215544	1247	8	00:31:12	34:30:00	09:10:37	7,8	Yes
67	208538	217827	1494	21	00:26:24	13:48:00	03:40:15	21	No
70	208395	214514	1193	2	00:31:12	55:54:00	14:52:10	2,12,13	Yes
71	208201	214330	1060	2	00:36:36	46:30:00	12:22:08	2,13	Yes
78	208712	213557	1310	13	00:27:36	16:18:00	04:20:09	14	No
79	208172	214285	1052	2	00:37:12	59:30:00	15:49:37	2,13	Yes
90	208630	213523	1392	13	00:26:24	14:30:00	03:51:25	14	No
96	211489	214958	867	15	00:42:36	70:48:00	18:49:58	15,16	Yes
97	211477	214998	892	15	00:40:48	72:06:00	19:10:43	15,16	Yes
98	211179	215405	1081	16	00:36:00	82:12:00	21:51:55	12,16,17	Yes
100	208554	213600	1412	13	00:24:36	14:24:00	03:49:49	13	No
101	209047	213835	878	13	00:37:12	26:06:00	06:56:33	14	Yes



House No.	ITM (Easting)	ITM (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	26.6% Average Regional Sunshine applied	Proposed Turbine(s) Giving Rise to any potential Shadow Flicker impact	Mitigation Strategy Required
107	209094	213822	856	13	00:39:00	29:24:00	07:49:13	14	Yes
112	208699	213532	1343	13	00:27:36	16:12:00	04:18:33	14	No
113	210942	213596	762	15	00:38:24	52:48:00	14:02:41	14	Yes
114	204709	212974	1190	11	00:28:48	14:24:00	03:49:49	4	No
121	205786	211934	1156	4	00:27:36	23:00:00	06:07:05	5	No
124	204882	215844	1128	8	00:33:00	49:24:00	13:08:25	7,8	Yes
127	208364	212981	1367	5	00:27:36	12:36:00	03:21:06	5	No
130	210893	215986	776	17	00:46:12	86:36:00	23:02:08	12,17,18	Yes
131	211464	215037	928	13	00:39:00	70:30:00	18:45:11	15,16	Yes
137	205497	216201	783	8	00:45:36	65:06:00	17:19:00	8	Yes
142	205064	216751	1484	8	00:25:48	16:12:00	04:18:33	8	No
149	208598	217918	1509	21	00:26:24	15:54:00	04:13:46	21	No
152	204890	215870	1119	8	00:33:00	48:00:00	12:46:05	7,8	Yes



House No.	ITM (Easting)	ITM (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	26.6% Average Regional Sunshine applied	Proposed Turbine(s) Giving Rise to any potential Shadow Flicker impact	Mitigation Strategy Required
153	204520	215280	972	10	00:36:36	72:12:00	19:12:19	7,8,10	Yes
154	204354	215048	948	10	00:39:36	69:06:00	18:22:50	7,10,11	Yes
157	205363	216322	953	8	00:37:12	46:24:00	12:20:33	8	Yes
160	206587	216244	904	8	00:56:24	71:42:00	19:04:20	1,8	Yes
162	204779	215799	1204	8	00:30:36	43:42:00	11:37:27	7,8	Yes
164	206525	216331	925	8	01:02:24	58:12:00	15:28:52	1,8	Yes
167	206428	216367	905	8	01:06:00	51:12:00	13:37:09	1,8	Yes
176	211168	215050	766	15	00:43:12	83:48:00	22:17:27	12,15,16,17	Yes
177	210942	215216	776	16	01:10:48	96:42:00	25:43:20	12,13,14,16	Yes
180	204682	215573	1287	8	00:30:00	32:00:00	08:30:43	7,8	Yes
183	204107	215554	1467	10	00:27:36	30:06:00	08:00:24	10	Yes
198	207955	214466	750	2	00:48:00	81:24:00	21:39:09	2,6	Yes

5.7.6.2 Cumulative Shadow Flicker

The cumulative assessment of shadow flicker generated by the proposed development and other existing and permitted wind farms within 1.5km was carried out based on the methodology, assumptions and criteria outlined in Section 5.7.4 and Section 5.7.5.

Table 5.8 below shows the potential cumulative shadow flicker impact of the proposed development in combination with existing and proposed wind farm developments within the 1.5km shadow flicker study area of the proposed development. Within the shadow flicker there is one constructed wind farms: Meenwaun Wind Farm (5 turbines permitted, 4 constructed, tip height 169m, Planning Reference 15/44). A 9-turbine wind farm is permitted at Cloghan (tip height 151.5m); however, an application to increase the tip height of these turbines to 169m has been submitted to Offaly County Council (Planning Reference 19/404) and this has been included in the cumulative shadow flicker assessment.

The cumulative assessment below includes for a worst-case scenario shadow flicker impact. All turbines proposed for Derrinlough Wind Farm in addition to all constructed and permitted wind turbines (including the proposed amendments to Cloghan Wind Farm) are assessed. Thus, should the proposed Cloghan amendment application be refused, the overall shadow impact will be less.

Table 5.8 indicates that of the 82 properties within 1.5km of the proposed development, 5 properties have the potential for cumulative shadow flicker impacts, as outlined in the following paragraphs, when the above wind farms within the 1.5km study area are assessed. Mitigation strategies are outlined in Section 5.9.3.3.

Property 22

Property 22 will experience just over 14 annual hours of shadow flicker from the proposed Derrinlough Wind Farm and the proposed amended Cloghan Wind Farm. The proposed Derrinlough Wind Farm contributes over 8 hours of this shadow flicker impact annually with the proposed Cloghan Wind Farm contributing just under 6 hours annually. Should the proposed amendment be refused for the Cloghan Wind Farm (Planning Reference 19/404), the cumulative shadow flicker impacts from the permitted 150m tip height Cloghan Wind Farm (Planning Reference 14/188) will be reduced.

It should be noted that the annual threshold for permitted cumulative shadow impact as per the adopted 2006 DoEHLG guidelines is not exceeded at this property.

Property 32

Property 32 will experience almost 63 annual hours of cumulative shadow flicker from the proposed Derrinlough Wind Farm and proposed amended Cloghan Wind Farm. The proposed Derrinlough Wind Farm contributes just over just over 11 hours of this shadow flicker impact while the proposed Cloghan Wind Farm contributes over 51 hours annually. Should the proposed amendment be refused for the Cloghan Wind Farm (Planning Reference 19/404), the cumulative shadow flicker impacts from the permitted 150m tip height Cloghan Wind Farm (Planning Reference 14/188) will be reduced.

It should be noted that while annual threshold for permitted cumulative shadow impact as per the adopted 2006 DoEHLG guidelines is exceeded at this property, this is not due to the proposed Derrinlough development which only contributes 11 annual hours of shadow flicker impact, under half the annual exceedance rate of 30 hours as per the 2006 DoEHLG guidelines.

Property 67

Property 67 will have almost 14 hours of annual cumulative shadow flicker from the proposed Derrinlough Wind Farm and proposed amended Cloghan Wind Farm. The proposed Derrinlough Wind Farm contributes under 8.5 hours of this shadow flicker impact annually while the proposed Cloghan Wind Farm contributes under 5.5 hours annually. Should the proposed amendment be refused for the Cloghan Wind Farm (Planning Reference 19/404), the cumulative shadow flicker impacts from the permitted 150m tip height Cloghan Wind Farm (Planning Reference 14/188) will be reduced.

It should be noted that the annual threshold for permitted cumulative shadow impact as per the adopted 2006 DoEHLG guidelines will not be not exceeded at this property.

Property 114

Property 114 will experience over 34 annual hours of shadow flicker from the proposed development and the Meenwaun Wind Farm. The proposed Derrinlough Wind Farm contributes under 4 hours of this shadow flicker impact annually while the Meenwaun Wind Farm contributes over 30 hours annually.

It should be noted that while annual threshold for permitted cumulative shadow impact as per the adopted 2006 DoEHLG guidelines is exceeded at this property, this is not due to the proposed Derrinlough development which only contributes 11 annual hours of shadow flicker impact, under half the annual exceedance rate of 30 hours as per the 2006 DoEHLG guidelines.

Property 149

Property 149 will experience over 17 annual hours of shadow flicker from the proposed development and proposed amended Cloghan Wind Farm. The proposed Derrinlough Wind Farm contributes just over 4 hours of this shadow flicker impact annually while the proposed Cloghan Wind Farm contributes over 13 hours annually. Should the proposed amendment be refused for the Cloghan Wind Farm (Planning Reference 19/404), the cumulative shadow flicker impacts from the permitted 150m tip height Cloghan Wind Farm (Planning Reference 14/188) will be reduced.

It should be noted that the annual threshold for permitted cumulative shadow impact as per the adopted 2006 DoEHLG guidelines will not be exceeded at this property.

Table 5.8 Potential Cumulative Shadow Flicker Impact from the Proposed Derrinlough Wind Farm and surrounding Wind Farms within 5km.

House No.	ITM (Easting)	ITM (Northing)	Distance to Nearest Turbine (metres)	Nearest Turbine	Max. Daily Cumulative Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Cumulative Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max Annual Cumulative Shadow Flicker with 26.6% Average Regional Sunshine applied	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Mitigation Strategy Required
22	208869	218003	1,334	21	00:58:48	53:30:36	14:14:01	21,35	Yes
32	207901	216303	1,264	1	01:41:24	236:33:56	62:55:35	1,20,28,29,30,31,32	Yes
67	208538	217827	1,494	21	01:06:00	52:12:28	13:53:14	21,35	Yes
114	204709	212974	1,190	11	01:01:48	128:48:29	34:15:47	4,24,25,26	Yes
149	208598	217918	1,509	21	01:02:24	66:31:48	17:41:49	21,35	No

*Turbines 1-21 are part of the proposed Derrinlough Wind farm. Turbines 22- 26 comprise the Meenwaun Wind Farm. Turbines 27-35 represent the 9 No. proposed 169m turbines of the Cloghan Wind Farm (Not yet constructed). Turbine 36 and 37 represent the Leabeg wind farm.

5.8 Residential Amenity

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

The wind farm site is located on a site mainly consisting of cutover bog with a small portion of commercial forestry on the site. As such, the amount of people accessing the site relates mainly to those cutting peat in nearby areas. The closest occupied dwelling to the proposed development is located at 762m from the proposed Turbine 15.

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 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 addresses noise). A comprehensive landscape and visual impact assessment have also been carried out, as presented in Chapter 12 of this EIAR. Impacts on human beings during the construction, operational and decommissioning phases of the proposed development is assessed in relation to each of these key issues and other environmental factors such as noise, 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, changes to land-use and 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 site would continue to be managed under the requirements of the relevant IPC licence, and existing commercial forestry, telecommunications and wind measurement would continue. This land-use will also continue if the proposed development does proceed.

If the proposed development were not to proceed, the opportunity to capture part of Offaly's valuable renewable energy resource would be lost, as would the opportunity to contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions. The opportunity to generate local employment and investment and to diversify the local economy would also be lost.

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 if site rules are not properly implemented. This will have a short-term potential significant negative impact.

Proposed Mitigation Measures

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

- Safety, Health and Welfare at Work Act 2005 (No. 10 of 2005);
- Safety, Health and Welfare at Work (General Application) Regulations 2007 (S.I. No. 299 of 2007), as amended;
- Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. 291 of 2013), as amended; and
- Safety, Health and Welfare at Work (Work at Height) Regulations 2006 (S.I. No. 318 of 2006).

A Health and Safety Plan covering all aspects of the construction process will address the Health and Safety requirements in detail. This will be prepared on a preliminary basis at the procurement stage and developed further at construction stage.

All hazards will be identified, and risks assessed. Where elimination of the risk is not feasible, appropriate mitigation and/or control measures will be established. The contractor will be obliged under the construction contract and current health and safety legislation to adequately provide for all hazards and risks associated with the construction phase of the project. Safepass registration cards are required for all construction, delivery and security staff. Construction operatives will hold a valid Construction Skills Certificate Scheme card where required. The developer is required to ensure a competent contractor is appointed to carry out the construction works. The contractor will be responsible for the implementation of procedures outlined in the Safety and Health Plan. Public safety will be addressed by restricting site access during construction. Fencing will be erected in areas of the site where uncontrolled access is not permitted. Appropriate warning signs will be posted, directing all visitors to the site manager. Appropriate warning measures including ‘goalposts’ will be used as appropriate to prevent contact with any overheads lines that traverse the site.

The scale and scope of the project requires that a Project Supervisor Design Process (PSDP) and Project Supervisor Construction Stage (PSCS) are required to be appointed in accordance with the provisions of the Health & Safety Authority’s ‘*Guidelines on the Procurement, Design and Management Requirements of the Safety, Health and Welfare at Work (Construction) Regulations 2006*’.

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

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

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

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

Residual Impact

With the implementation of the above, there will be a short-term potential slight negative residual impact on health and safety during the construction phase of the proposed development.

Significance of Effects

Based on the assessment above there will be no significant direct and indirect effects on health and safety during the construction phase of the proposed development.

5.9.2.2 Employment and Investment

The design, construction and operation of the wind farm will provide employment for technical consultants, contractors and maintenance staff. Up to approximately 100-120 jobs could be created during the construction, operation and maintenance phases of the proposed development. The construction phase of the wind farm will last between approximately between 24-30 months. Most 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 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 are over 4,400 jobs related to wind energy in Ireland in 2019, a figure which is projected to grow to over 8,000 by 2020.

Rates payments for the wind farm will contribute significant funds to Offaly County Council, which will be redirected to the provision of public services within Co. Offaly. 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

In addition to employment during the construction and operational phases of the proposed development and annual rates that will be paid to the local authority by the developer, a range of other benefits associated with the proposed development will be provided to the local community through the annual Community Gain Scheme. The aim of this scheme is to provide financial assistance to local communities and not-for-profit organisations around the development. In order to be eligible for funding, projects must fall within the thematic areas of: Amenities, Community Facilities, Culture/Heritage, Energy Efficiency/Improvements, Education and Recreation/Health. A key criterion is that the projects and initiatives will benefit the communities surrounding the wind farm.

The Near Neighbour Scheme will offer electricity bill payers living within a prescribed distance of a wind turbine an annual contribution towards their electricity usage. In addition to the electricity contribution payment, the Scheme will also offer participants a contribution towards the completion of energy measures on the property and/or education support. This is in line with existing near neighbour schemes that are active at other Bord na Móna Powergen Wind Farms.

The value of the fund for the Community Gain and Near Neighbour Schemes will be directly proportional to the installed capacity and energy produced at the site, which based on current proposals, will be in the region of €10 million over the lifetime of the project.

Renewable Energy Support Scheme/Community Ownership

Public Consultation on the Renewable Electricity Support Scheme (RESS) 1 closed for submissions in January 2020. The consultation paper set out the high-level details for the provision of a Renewable Energy Participation Scheme (REP Scheme) in Annex C (REP Scheme) for Community Participation in renewable developments. The key element proposed is:

Providing Irish Citizens, or not for profit community entities (to be defined), to invest in renewable electricity generation projects in the Republic of Ireland - prioritising those that live in closer proximity to the Relevant Projects.

The Department of Communications, Climate Action and Environment envisage finalisation of the RESS Scheme in 2020.

If the proposed development utilises the RESS then any community benefit stipulations that are outlined in the finalised RESS will be incorporated into the operation of the wind farm and will be of enduring benefit to the local community.

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 telecommunications and commercial forestry will continue on the site of the proposed development. There are also a number of Bord na Móna rail lines that pass through the bogs facilitating the transportation of milled peat to Derrinlough Briquette Factory which is located in the most western part of Drinagh bog. These rail lines will remain in operation during the construction phase of the proposed development. The proposed development will have no impact on existing land-uses as it has been designed to co-exist with these land-uses.

5.9.2.5 Tourism and Amenity

Given that there are currently no tourism attractions specifically pertaining to the site there are no impacts associated with the construction phase of the development. With regard to tourist attractions and amenity use around the site, described in Section 5.3.2, traffic management safety measures will be in place. Please see Traffic impacts below for further details on proposed mitigation measures.

5.9.2.6 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 which has the potential to cause a nuisance to sensitive receptors located closest the proposed development site. 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. 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: Noise and Vibration.

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. These measures will include:

- No plant used on site will be permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate outside of general construction hours will be surrounded by an acoustic enclosure or portable screen.
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Chapter 11 using methods outlined in British Standard BS 5228-1:2014+A1:2019 Code of practice for noise and vibration control on construction and open sites – Noise.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 7:00hrs and 19:00hrs Monday to Saturday. However, to ensure that optimal use is made of good weather periods or at critical periods within the programme (i.e. concrete pours, large turbine component delivery, rotor/blade lifting) it could occasionally be necessary to work out of these hours

Residual Impact

Following the implementation of the above mitigation measures, there will be a short-term imperceptible negative residual impact due to an increase in noise levels during the construction phase of the proposed development.

Significance of Effects

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

5.9.2.7 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. An increase in dust emissions has the potential to cause a nuisance to sensitive receptors in the immediate vicinity of the site. 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. The potential dust impacts that may occur during the construction phase of the proposed development are further described in Chapter 10: Air and Climate.

Proposed Mitigation Measures

Aggregate material for the construction of roads and turbine bases will be sourced from local quarries within the local area surrounding the site and vehicles will be inspected upon leaving any quarries. Truck wheels will be washed to remove mud and dirt before leaving the site also. All plant and materials vehicles shall be stored in the compound area or other dedicated areas. 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 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

Following the implementation of the above mitigation measures, there will be short-term slight negative impact due to dust emissions from the construction of the proposed development.

Significance of Effects

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

5.9.2.8 Traffic

Pre-Mitigation Impacts

It is proposed that the large wind turbine plant will be delivered via the M6 before turning south onto the N52 at Junction 5: Kilbeggan/Tullamore. The route follows the N52 south, bypassing Tullamore to the east and passing through the settlements of Blue Ball, Kilcormac and Five Alley. Deliveries will turn right onto the N62 (at the junction known as Kennedy's Cross) and will proceed northwards towards Cloghan to the proposed site entrances, immediately north of Derrinlough Briquette Factory. The proposed route is described in Chapter 4 of this EIAR. All deliveries of turbine components to the site will only be by way of the proposed turbine delivery route. Non-turbine construction traffic will be comprised of Heavy Goods Vehicle (HGV) and Light Goods Vehicle (LGV) movements involved in the delivery of 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 14.1 of Chapter 14: Material Assets.

The types of vehicles that will be required to negotiate the local network represent abnormal size loads and a detailed assessment of the geometry of the proposed route was therefore undertaken. This will have a temporary slight to moderate negative impact on existing road users, which will be minimised with the implementation of the mitigation measures included in the proposed traffic management plan.

With regard to the proposed underpass beneath the N62, there is the potential for short term nuisance to local road users due to the short-term, single-lane closures required during the construction of the underpass. the section of, giving rise to a slight, temporary, negative impact.

Proposed Mitigation Measures

A traffic management plan will be developed and implemented to ensure any impact is short term in duration and slight in significance during the construction of the proposed development. Prior to commencement of any works, the occupants of dwellings in the vicinity of the proposed works will be contacted and the scheduling of works will be made clear. Local access to properties will also be maintained throughout any construction works and local residents will also be supplied with the number of the works supervisor in order to ensure that disruption will be kept to a minimum. In relation to the cable laying works, the works area in any one day will be approximately 300m in length and so the potential for significant disruption is limited.

Residual Impact

Once a traffic management plan is implemented for the construction phase of the proposed development, there will be a short-term imperceptible negative residual impact on local road users.

Significance of Effects

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

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, 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

The effects set out below relate to the operational phase of the proposed wind farm.

5.9.3.1 Health and Safety

Pre-Mitigation Impact

It is not anticipated that the operation of the wind farm will present a danger to the public and livestock. Rigorous safety checks are conducted on the turbines during design, construction, commissioning and operation to ensure the risks posed to staff, landowners and general public are negligible.

Proposed Mitigation Measures

Notwithstanding the above, the following mitigation measures will be implemented during the operation of the proposed development to ensure that ensure the risks posed to staff, landowners and general public remain negligible throughout the operational life of the wind farm.

Access to the turbines is through a door at the base of the structure, which will be locked at all times outside maintenance visits.

Signs will be erected at suitable locations such as, amenity access points and carparks, setting out the conditions of public access under the relevant legislation and providing normal hours (and out of hours) contact details. Staff associated with the project will conduct frequent visits, which will include inspections to establish whether any signs have been defaced, removed or are becoming hidden by vegetation or foliage, with prompt action taken as necessary.

Signs will also be erected at suitable locations across the site as required for the ease and safety of operation of the wind farm. These signs include:

- Buried cable route markers at 50m (maximum) intervals and change of cable route direction;
- Directions to relevant turbines at junctions;
- “No access to Unauthorised Personnel” at appropriate locations;
- Speed limits signs at site entrance and junctions;
- “Warning these Premises are alarmed” at appropriate locations;
- “Danger HV” at appropriate locations;
- “Warning – Keep clear of structures during electrical storms, high winds or ice conditions” at site entrance;
- “No unauthorised vehicles beyond this point” at specific site entrances; and
- Other operational signage required as per site-specific hazards.

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

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

Residual Impact

With the implementation of the above mitigation measures, there will be a long-term, imperceptible residual impact on health and safety during the operational life of the proposed development

Significance of Effects

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

5.9.3.2 Tourism

Pre-Mitigation Impacts

Currently there are no dedicated amenity walkways within the development area. As part of the proposed development design, approximately 18 km of amenity pathways including walkways and cycleways and a 15-car carpark will be provided. Sections of new site roads will be developed and promoted for walking activities in addition to dedicated amenity walkways. These dedicated areas will provide a safer visitor experience and open the site up to locals, tourists, trail runners etc. In addition to these dedicated amenity pathways, public use links into and out of the development area such as the below will be improved/created:

- Internal link to R437 allowing further access to Drinagh and Derrybrat and to facilitate potential future connection to Lough Boora Parklands.
- Link from the R357 and L7009 providing connectivity to the local Stonestown and wider Cloghan area.
- Link to the L7005 providing connectivity to the local Drinagh area.
- Link to the Bord na Móna boundary in Clongawny West to facilitate potential future connection to the R438.
- Link to the Bord na Móna boundary in southwest Drinagh to facilitate potential future connection to the proposed Whigsborough Walkway.

Proposed Mitigation Impacts

None required.

Residual Impact

The proposed development will have a long-term positive impact on tourism due to the social and recreational benefits associated with the recreational amenity walkways/ paths.

Significance of Effects

The addition of dedicated recreational and amenity routes for locals and tourists will have a significant effect on tourism in the local area.

5.9.3.3 Shadow Flicker

Pre-Mitigation Impacts

Assuming worst-case conditions, a total of 34 residential properties may experience daily shadow flicker in excess of the current DoEHLG guideline threshold of 30 minutes per day. The DoEHLG total annual guideline limit of 30 hours is not exceeded due the proposed development once the regional sunshine average of 26.6% is considered.

Proposed Mitigation Measures

Where daily or annual shadow flicker exceedances are experienced at buildings, a site visit will be undertaken firstly to determine the level of occurrence, existing screening and window orientation. The shadow flicker prediction data will be used to select dates on which a shadow flicker event could be observed at one or multiple affected properties and the following process will be adhered to.

1. *Recording the weather conditions at the time of the site visit, including wind speeds and direction (i.e. blue sky, intermittent clouds, overcast, moderate breeze, light breeze, still etc.).*
2. *Recording the house number, time and duration of site visit and the observation point GPS coordinates.*
3. *Recording the nature of the sensitive receptor, its orientation, windows, landscaping in the vicinity, any elements of the built environment in the vicinity, vegetation.*
4. *In the event of shadow flicker being noted as occurring the details of the duration (times) of the occurrence will be recorded.*

Screening Measures

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

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

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

Wind Turbine Control Measures

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

Wind turbines can be fitted with shadow flicker control units to allow the turbines to be controlled to prevent the occurrence of shadow flicker at properties surrounding the wind farm. The shadow flicker control units will be added to any required turbines and are not cost prohibitive.

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

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

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

This measure can be utilised at the site of the proposed development to prevent incidences of shadow flicker values at any house. Therefore, the Derrinlough Wind Farm could be brought in line with the requirements of the Draft Revised Wind Energy Development Guidelines 2019 should they come in to force during the planning application process for this development.

Should a complaint be received within 12 months of commissioning of the wind farm, field investigation/monitoring will be carried out by the wind farm operator at the affected property. Notwithstanding the approach set out above should shadow flicker associated with the permitted development be perceived to cause a nuisance at any home, the affected homeowner is invited to engage with the Wind Farm Developer. The homeowner will be asked to log the date, time and duration of shadow flicker events occurring on at least five different days. The provided log will be compared with the predicted occurrence of shadow flicker at the residence, and if necessary, a field investigation will be carried out.

Residual Impact

Shadow flicker could potentially have a long-term slight negative impact. However, as the applicant has committed to a curtailment strategy for all turbines that cause an exceedance in the existing daily and annual shadow flicker limits at residential properties up to a distance of 10 rotor diameters from the proposed development, there will be no impact from shadow flicker on human beings.

Significance of Effects

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

5.9.3.4 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 regarding potential interference from the proposed wind farm. Full details are provided in of Chapter 2: Background to the Proposed Development and Section 14.2 (Telecommunications and Aviation) of Chapter 14: Material Assets. Copies of the scoping responses received are presented in Appendix 2.1 of the EIAR.

Responses were received from BT Telecoms, Eir, Netshare, Tetra Ireland, 2RN and Viatel, all of which outlined that there will be no interference risk from any of the proposed turbines providing the design complies with recommended buffer zones. The proposed design and turbine layout do not overlap with any of the telecoms links or clearance zones requested by operators. Therefore, the proposed development will have no impact on telecommunications.

5.9.3.5 Residential Amenity

Pre-Mitigation Impacts

Potential impacts on residential amenity during the operational phase of the proposed wind farm could arise primarily due to noise, shadow flicker or changes to visual amenity. Detailed noise and shadow flicker modelling have been carried out as part of this EIAR, which shows that the proposed development will be capable of meeting all required guidelines in relation to noise thresholds and the shadow flicker thresholds set out in the 2006 DoEHLG Wind Energy Guidelines.

The visual impact of the proposed development is addressed comprehensively in Chapter 12: Landscape and Visual. The proposed development has been designed to maximise turbine separation distances to dwellings in the area, with no turbines located within 750 metres of an occupied dwelling. An assessment of roadside screening was carried out for roads within 5km of the proposed turbine locations, with both the methodology and findings of this described in Section 12.7.3. Many of these roads have intermittent screening, and therefore intermittent views rather than full visibility of the site. Given the separation distance of the residential properties from the proposed turbines, and the level of existing screening in the area, the proposed development will have no significant impact on existing visual amenity at dwellings.

Proposed Mitigation Measures

There are no turbines proposed within 750 metres of any occupied dwellings. The closest dwelling to a proposed turbine location is approximately 762 metres. All mitigation as outlined under noise and vibration, dust, traffic, visual amenity and shadow flicker 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, including along the proposed turbine and construction materials haul route.

Residual Impact

With the implementation of the mitigation measures outlined in relation to noise and vibration, dust, traffic, shadow flicker and visual amenity, the proposed development will have an imperceptible impact on residential amenity.

Significance of Effects

Based on the assessment above there will be no significant direct or indirect effects on residential amenity.

5.9.4 Decommissioning Phase

The wind turbines proposed as part of the proposed development are expected to have a lifespan of approximately 30 years. Following the end of their useful life, the wind turbines may be replaced with a new set of turbines, subject to planning permission being obtained, or the site may be decommissioned fully. The substation will remain in place as it will be under the ownership of the EirGrid.

The works required during the decommissioning phase are described in Section 4.11 in Chapter 4: Description of the Proposed Development. Any impact and consequential effect that occurs during the decommissioning phase will be similar to that which occurs during the construction phase, however to a lesser extent.

5.9.5 Cumulative Effects

For the assessment of cumulative impacts, any other existing, permitted or proposed developments (wind energy or otherwise) have been considered. Further information on projects considered as part of the cumulative assessment are given in Chapter 2: Background to the Proposed Development. The impacts with the potential to have cumulative effects on human beings are discussed below and in more detail in the relevant chapters: noise (Chapter 11), visual impacts (Chapter 12) and traffic (Chapter 14).

5.9.5.1 Shadow Flicker

As outlined in Table 5.8 five dwellings may be impacted by shadow flicker from the proposed Derrinlough Wind Farm in combination with permitted wind farms within 1.5km of the development site. As such, the monitoring and subsequent mitigation measures as outlined in Section 5.9.3.3 will be implemented to ensure any dwelling which may be impacted by shadow flicker as a result of the proposed Derrinlough Wind Farm will be in compliance with the thresholds set out in the 2006 DoEHLG Wind Energy Guidelines.

5.9.5.2 Residential Amenity

Pre-Mitigation Impacts

If all permitted and proposed projects as described in the cumulative assessment in Chapter 2 being constructed at the same time, there is the potential for a resulting short term, significant, cumulative, negative impact to occur on residential amenity, in relation to noise and vibration, dust, traffic, telecommunications and visual amenity.

Proposed Mitigation Measures

There are no turbines as part of the proposed development that will be located within 750 metres of any occupied 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, including along the proposed turbine and construction materials haul route. 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 a short-term, slight negative effect on residential amenity during construction works. During the operational phase, noise and shadow flicker from the proposed and permitted projects will be limited to below guideline levels or as committed to by the developer.

Significance of Effects

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