Planning and Environmental Consultants

Environmental Impact Assessment Report

Carrig Renewables Wind Farm - EIAR

Chapter 5 – Population and Human Beings

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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 Carrig Renewables Wind Farm project (the "Proposed Development") on population and human health and has been completed in accordance with the guidance set out by the Environmental Protection Agency (EPA), in particular the '*Guidelines on the Information to be Contained in Environmental Impact Assessment Reports*' (EPA, 2022). The full description of the project 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.

5.2 Statement of Authority

This section of the EIAR has been prepared by Edward Ryan and Jonathan Fearon, and reviewed by Eoin McCarthy, all of whom are Environmental Scientists with MKO. Edward is an Environmental Scientist with a B.Sc. (Hons) in Environmental Science from the University of Limerick and a M.Sc. (hons) in Environmental Systems from Atlantic Technological University: ATU (formally GMIT). Edward is an Environmental Scientist with over 4 years of consultancy experience. Jonathan is an Environmental Scientist with a B.Sc. (Hons) in Environmental Science and an M.Sc. in Environmental Leadership from NUI Galway, with previous experience in local government and environmental consultancy work. Eoin is a Senior Environmental Scientist, with over 11 years of experience in private consultancy. Eoin holds a B.Sc. (Hons) in Environmental Science from NUI, Galway. His project experience includes a significant range of energy infrastructure, tourism, waste permit, flood relief scheme and quarrying projects in addition to project managing circa 600MW of wind energy projects.

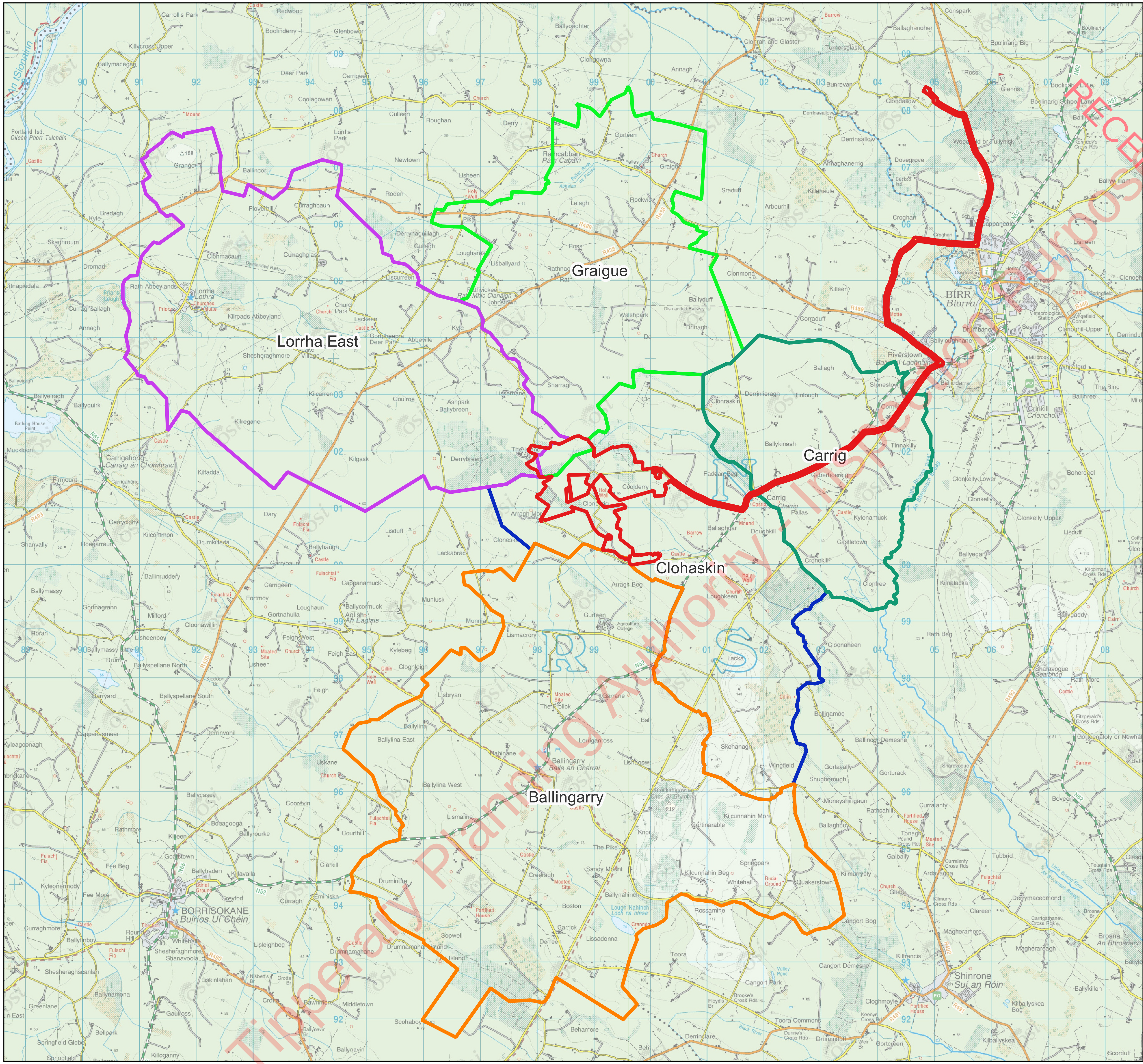
5.3 Population

5.3.1 Receiving Environment

Information regarding human beings and general socio-economic data were sourced from the Central Statistics Office (CSO), the Tipperary County Development Plan 2022 – 2028, Fáilte Ireland and any other literature pertinent to the area. The study included an examination of the population and employment characteristics of the area. This information was sourced from the Census of Ireland 2016, which is the most recent census for which a complete dataset is available, also the Census of Ireland 2011, the Census of Agriculture 2020 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 full results of the 2022 Census is due December 2023.

In order to assess the population in the vicinity of the site, the Study Area for the population section of this EIAR was defined in terms of the District Electoral Divisions (DEDs) within which the proposed wind farm turbines and supporting infrastructure (substation, temporary compounds, met mast, borrow pits, grid connection cabling) were located, as well as DEDs within close proximity of the proposed wind farm site. The wind farm development site lies solely within the Lorrha East, Clohaskin, Carrig, Graigue DEDs as shown in Figure 5-1. DEDs adjacent to the site boundary include Ballingarry. These DEDs will collectively be referred to hereafter as the Population Study Area for this chapter.

The Study Area has a total population of 1,471 as of 2016 and comprises a total land area of approximately 91km² (Source: CSO Census of the Population 2016).



Map Legend

- EIAR Site Boundary

Sharragh DEDs

- Ballingarry
- Clohaskin
- Graigue
- Lorrha East
- Carrig

Drawing Title	Population Study Area
Project Title	Carrig Wind Farm Development
Drawn By: ER	Checked By: EMC
Project No.: 211016	Drawing No.: Figure 5-1
Scale: 1:65,000	Date: 2023-09-11

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5.3.2 Population Trends

In the period 2011 to 2016, the population of Ireland increased by 3.8%. Between 2011 and 2016, the population of Co. Tipperary increased by 0.6% to 159,553 persons. Population statistics for the State, County Tipperary and the Study Area have been obtained from the Central Statistics Office (CSO) and are presented in Table 5-1. The DED within the Population Study Area with the highest population recorded in the 2016 Census was Ballingarry DED, with a population of 500. The lowest population recorded in the 2016 Census was in Carrig DED, with a population of 177.

Table 5-1 Population 2011 – 2016 (Source: CSO.ie)

Area	Population		% Population Change
	2011	2016	2011-2016
State	4,588,252	4,761,865	3.8%
County Tipperary	158,652	159,553	0.6%
Study Area	1,566	1,485	-5.2%

The data presented in Table 5-1 shows that the population of the Study Area decreased by 5.2% between 2011 and 2016. Population levels for five DEDs within the Study Area decreased at a significantly higher rate than the State and County. The DED with the greatest decrease was Lorrha East (-7.2%). This decrease within the Study Area is reflective of a general reduction in the population of rural areas around the country as people move to larger settlements, towns and cities in search of employment and education opportunities.

5.3.3 Population Density

The population densities recorded within the State, County Tipperary and the Study Area during the 2011 and 2016 Census are shown in Table 5-2.

Table 5-2 Population Density in 2011 and 2016 (Source: CSO.ie)

Area	Population Density (Persons per km^2)		% change in Population Density
	2011	2016	2011-2016
State	65.29	67.76	+3.8%
County Tipperary	36.85	37.06	+0.6%
Study Area	17.25	16.36	-5.2%

The population density of the Study Area recorded during 2016 is less than 17 persons per km^2. This figure is lower than the national population density of 67.76 persons per km^2 and the county population density of 37.06 persons per km^2 recorded for County Tipperary.

The population densities of the DEDs within the Study Area during 2016 vary between DED. Graigue DED recorded the highest population density of 15.09 persons per km^2. Clohaskin DED recorded a population density of 11.87 persons per km^2 in 2016. Lorrha East recorded the lowest population density at 9.88 persons per km^2 in 2016. All of the DEDs within the Study Area have population densities significantly lower than the State and County. The decrease in the population density within the Study Area is reflective of the reduction in total population over the same period.

5.3.4 Household Statistics

The number of households and average household size recorded within the Republic of Ireland, County Tipperary, and the Study Area during the 2011 and 2016 Census is shown in

Table 5-3.

Table 5-3 Number of Households and Average Household Size 2011 – 2016 (Source: CSO)

Area	2011		2016	
	No. of Households	Avg. Size (persons)	No. of Households	Avg. Size (persons)
Republic of Ireland	1,654,208	2.8	1,697,665	2.8
County Tipperary	58,275	2.7	59,276	2.7
Study Area	574	2.7	565	2.6

In general, the figures in Table 5-3 show that the number of households within the State and County have increased. However, the average household size remained the same in the State and County with a slight decrease for the Study Area overall. The DED of Graigue recorded the largest household size in 2016, with an average household size of 2.8 while Lorrha East and Balligarry DEDs recorded the lowest at 2.5.

5.3.4.1 Age Structure

Table 5-4 presents the percentages of the State, County Tipperary and the 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	21.14%	12.11%	29.53%	23.84%	13.39%
County Tipperary	21.33%	11.47%	26.33%	25.58%	15.29%
Study Area	17.58%	11.92%	22.09%	27.61%	20.81%

As per the County and State population percentages, the highest population percentage in the Study Area occurs within the 45-64 range age category and the lowest occurs within the 15-24 range age category. The population percentage is greater in the 45-64 and 65+ age ranges when compared with the County and State population percentages. The age category results of the Study area correspond with the trend of younger generations leaving rural areas to move to urban areas with greater education and employment opportunities.

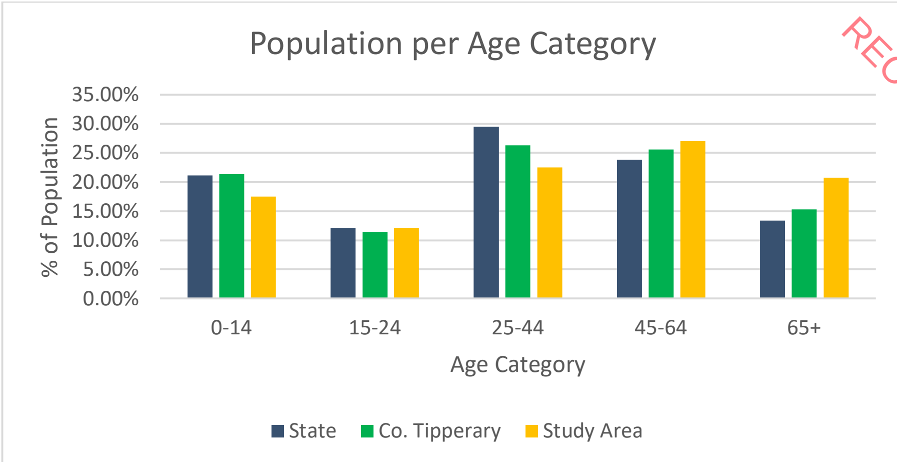

Figure 5-2 Population per Age Category in 2016 (Source: CSO)

5.3.5 Employment and Economic Activity

5.3.5.1 Economic Status

The labour force consists of those who can work, i.e. those who are aged 15+, out of full-time education and not performing duties that prevent them from working. In 2016, there were 3,755,313 persons in the labour force in the Republic of Ireland.

Table 5-5 shows the percentage of the total population aged 15+ who were in the labour force during the 2016 Republic of Ireland Census. This figure is further broken down into the percentages that were at work, seeking first time employment or unemployed. It also shows the percentage of the total population aged 15+ who were *not* in the labour force, i.e. those who were students, retired, unable to work or performing home duties.

Table 5-5 Economic Status of the Total Population Aged 15+ in 2016 (Source: CSO)

Status		Republic of Ireland	County Tipperary	Study Area
% of population aged 15+ who are in the labour force		**61.4%**	**59.2%**	**57.0%**
% of which are:	At work	87.1%	85.4%	86.0%
	First time job seeker	1.4%	1.4%	1.0%
	Unemployed	11.5%	13.2%	13.0%
% of population aged 15+ who are not in the labour force		**38.6%**	**40.8%**	**43.0%**
% of which are:	Student	29.4%	25.3%	22.4%
	Home duties	21.1%	22.3%	23.0%
	Retired	37.6%	38.6%	45.8%
	Unable to work	10.9%	12.9%	8.0%

Status		Republic of Ireland	County Tipperary	Study Area
	Other	1.0%	0.9%	0.8%

Overall, the principal economic status of those within the labour force living in Study Area is similar to that recorded at State and County level, with between 0 to 4% average difference apparent. Of those who were not in the labour force during the 2016 Census, the highest percentage of the population in the Study Area was in the 'Retired' category, which is the same as figures recorded at national and County level that show 'retired' as the highest category.

5.3.5.2 Employment and Investment Potential in the Irish Wind Energy Industry

5.3.5.2.1 *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.'* The report considers the three potential types of direct employment created, as a result of increased investment in wind energy, to be:

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

5.3.5.2.2 *Energy Targets*

The Climate Action Plan 2023(CAP) was published on the 21st of December 2022 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 80% 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. The plan also includes a target of at least 5 Gigawatts of offshore wind energy being produced by 2030.

5.3.5.2.3 Employment Potential

The 2014 report "An Enterprising Wind: An economic analysis of the job creation potential of the wind sector in Ireland" published by the Irish Wind Energy Association (IWEA) predicted that the wind energy sector in Ireland would result in 6,659 direct jobs in a scenario where 4GW capacity is achieved by 2020. This figure of 6,659 is broken down further; 5,596 of these jobs are associated directly with the construction and installation of windfarms, while the remaining 1,063 jobs are associated with the national grid. Under this scenario this contributes 1.66 direct jobs per Megawatt (MW) of wind capacity throughout the various stages of installation. According to Wind Energy Ireland, the installed wind capacity in Ireland is over 4.2GW as of February 2021, which would support employment during the last decade. Ireland needs to achieve a total of 8.2GW of onshore wind by 2030 which will further support further employment.

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

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

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

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

As of December 2022, there were over 5,585 Megawatts (MW) of wind energy capacity installed on the island of Ireland. Of this, 4,332.5 MW was installed in the Republic of Ireland, with 1,276 MW installed in Northern Ireland. The majority of the Republic of Ireland's installed wind energy capacity is located in Counties Mayo, Galway, Cork and Kerry.

5.3.5.2.4 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 (€4.3 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. This tallies with the Deloitte report which indicated that more wind energy feeding into the national grid would result in lower and more stable energy costs for consumers.

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

5.3.6 Land-Use

The land-use/activities within the Proposed Development site comprises predominantly of cutover peat bogs, followed by pastureland and mixed forestry, and to a lesser extent, a mixture of transitional woodland-shrub, non-irrigated arable land and coniferous forestry.

Grid infrastructure in the area includes a 110kV line which runs from Dallow 110kV substation, approximately 8.1km northeast of the site, terminating at the Derrycarney 110kV substation, approximately 22.5km northeast of the site.

There are 26 no. operational wind farms in Tipperary to date. The nearest operational wind farm is Carrig Wind Farm (Pl. Ref: 5123496), 2.4km southeast of the site, followed by Skehanagh Wind Farm, approximately 3.3km southeast of the site. Meenwaun Wind Farm in County Offaly is located approximately 11.9km northeast of the site.

5.3.7 Services

The proposed wind farm site is located approximately 6.6km southwest of Birr town, where the grid connection will feed into. Other settlement areas in the wider region include Borriskane, 9.7km to the southwest of the site and Portumna 12.8km to the west of the site. All three centres provide retail, recreational, educational, and religious services.

5.3.7.1 Education

The closest primary school is Scoil Flannain Naofa National School Rathcabbin approx. 5.1km north of the Proposed Development, beyond that Mercy Primary School in the town of Birr and Crinkill National School in Birr, 6.6km northeast and 6.9km east of the proposed site, respectively. The nearest secondary school is located in Birr– St. Brendan's Community School is 6.9km to the northeast. The

Technological University of the Shannon: Midlands (third-level education), Athlone, County Westmeath is located approximately 39.2km north of the proposed wind farm site and the University of Limerick is located in Limerick city, approximately 55.44km southwest of the Proposed Development site.

5.3.7.2 Access and Public Transport

The site entrance to the south of the site is accessed through the N52 national secondary road and is accessed via the local road L5040 and forestry tracks.

There are two local bus services,. Kearns Transport provides transport between Birr to Tullamore on a daily basis. Bus Eireann coaches stop at Birr on their Limerick to Birr service 730. The nearest train station to the Proposed Development site is the Cloughjordan train station 12.8km south of the proposed wind farm site providing connections with Dublin Heuston - Limerick via Nenagh.

5.3.7.3 Amenities and Community Facilities

There is one facility located adjacent or in the surrounding environs of the Proposed Development site. The Church of the Annunciation is located 1.5km east to the site boundary off the N52 and is located along the route of the proposed grid connection. Amenities and community facilities, including GAA and other sports clubs, youth clubs, recreational areas and water sport activities area located in Birr, Borriskane and Portumna.

5.4 Tourism

5.4.1 Tourist Numbers and Revenue

Tourism is one of the major contributors to the national economy and is a significant source of full time and seasonal employment. During 2019, overseas tourists to Ireland grew by 0.7% to 9.7 million. In 2019, out-of-state (Overseas and Northern Ireland) tourist expenditure amounted to €5.6 billion. With a further €1.8 billion spent by overseas visitors on fares to Irish carriers, foreign exchange earnings were €7.4 billion. Domestic tourism expenditure amounted to €2.1 billion, making tourism a €9.5 billion industry (*Key Tourism Facts 2019 Fáilte Ireland, March 2021*). The Central Statistics Office's official count of direct employment in 'Accommodation and food service activities', a category which includes hotels, restaurants, bars, canteens and catering, was 177,700 in Q3 2019 (7.6% of total employment) and rises to 260,000 when including seasonal and casual employment in the industry.

The Republic of 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 2019 ('*Tourism Facts 2019*, Fáilte Ireland, March 2021).

Table 5-6 Overseas Tourists Revenue and Numbers 2019 (Source: Fáilte Ireland)

Region	Total Revenue (€m)	Total Number of Non Domestic Tourists (000s)
Dublin	€2,305m	6,927
Mid East/Midlands	€ 400m	1,124
South-East	€282m	995
South-West	€995m	2,373

Mid West	€480m	1,455
West	€701m	2,056
Border	€411m	1,365
Total	**€5,574 m**	**16,295**

The MidWest Region, in which the site of the Proposed Development is located, comprises Counties Clare, Limerick and North Tipperary. This Region benefited from approximately 9% of the total number of overseas tourists to the country and approximately 9% of the total tourism income generated in Ireland in 2019.

Table 5-7 presents the county by county breakdown of overseas tourist numbers and revenue to the West Region during 2017 (‘*2017 Topline Tourism Performance By Region, Fáilte Ireland, August 2018*)[1]. There is no published County by County tourism breakdown for 2018 to 2022 to date). As can be observed North Tipperary had a tourism revenue of at €69 million.

Table 5-7 Overseas Tourism to Border Region during 2017 (Source: Fáilte Ireland)

County	Revenue Generated by Overseas and domestic Tourists (€m)	No. of Overseas Tourists (000s)
Clare	244	1,111
North Tipperary	69	301
Limerick	307	931

5.4.1.1 Tourist Attractions

There are no identified tourist attractions pertaining specifically to the site of the Proposed Development itself. The varied natural landscape and scenic amenity of this area provide many opportunities for general outdoor recreation within the wider area including cycling, as discussed above. Scohaboy Bog Walk - Loop of Laghile and Loughaun National Trail is located 7.5km south of the Proposed Development. Portumna Forest Park is located 14.5km West and Victorias Lock Newry Hiking area is located 11.5km North of the site.

The nearest tourist centres to the Proposed Development site are located 5-10km from the Proposed Development site. Tourist attractions within these centres include hiking, walking, cycling and water sport activities, National Parks and local trails and looped walks.

County Tipperary has a wide range of nationally significant tourism assets which include the following:

- Rock of Cashel – St. Patricks Rock in Cashel
- Cahir Castle
- Glen of Aherlow Nature Park
- Brú Ború Cultural Centre for theatre performances, comedy and traditional Irish Music–Cashel

[1] *2017 Topline Tourism Performance By Region, Fáilte Ireland, August 2018 Available at:* *https://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/2_Regional_SurveysReports/2017-topline-regional-performance-(003).pdf?ext=.pdf*

- Boat trips on Lough Derg
- Mitchelstown Caves for exploration of three caverns filled with dripstone formations, stalactites and stalagmites and views of Galtee mountains outside – Cahir

Within 15km of the Proposed Development site:

- Birr Castle and Demense
- St Ruadhan's Abbey
- Redwood castle
- Portumna Castle & Gardens
- Leap Castle

5.4.1.2 Tourist Attitudes to Wind Farms

5.4.1.2.1 *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. The study therefore considered the evidence at a local authority level and in the immediate vicinity of constructed wind farms.

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

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

> "*Although this study does not suggest that there is any direct relationship between tourism sector growth and wind farm development, it does show that wind farms do not cause a decrease in tourism employment either at a local or a national level."*

5.4.1.2.2 *Fáilte Ireland Surveys 2007 and 2012*

In 2007, Fáilte Ireland in association with the Northern Ireland Tourist Board carried out a survey of domestic and overseas holidaymakers to Ireland in order to determine their attitudes to wind farms. The purpose of the survey was to assess whether or not the development of wind farms impacts on the enjoyment of the Irish scenery by holidaymakers. The survey involved face-to-face interviews with 1,300 tourists (25% domestic and 75% overseas). The results of the survey are presented in the Fáilte Ireland Newsletter 2008/No.3 entitled *'Visitor Attitudes on the Environment: Wind Farms'*.

The Fáilte Ireland survey results indicate that most visitors are broadly positive towards the idea of building wind farms in Ireland. 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.

With regard to the perceived impact of wind farms on sightseeing, the Fáilte Ireland report states:

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

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

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

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

The report goes on to state that while there is a generally positive disposition among tourists towards wind development in Ireland, it is important also to take account of the views of the one in seven tourists who are negatively disposed towards wind farms. This requires good planning on the part of the wind farm developer as well as the Local Authority. Good planning has been an integral component of the Proposed Development throughout the site design and assessment processes. Reference has been had to the Department of the Environment, Heritage and Local Government's *'Planning Guidelines on Wind Energy Development 2006'* and the Draft Revised Wind Energy Development Guidelines December 2019 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 public perception of wind energy, including those living in the vicinity of a wind farm, are presented in Section 5.5 below.

5.5 Public Perception of Wind Energy

5.5.1 Sustainable Energy Ireland Survey 2003

5.5.1.1 Background

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

5.5.1.1.1 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.

5.5.1.2 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.

5.5.1.2.1 *Conclusions*

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

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

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

5.5.1.3.1 *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.

5.5.1.3.2 *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. In Ireland, surveys were carried out at two sites in Counties Cork and Kerry, each of which has two wind farms in close proximity.

5.5.1.3.3 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, may people regard them as an attractive addition."*

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

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

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

5.5.1.3.4 *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 opposition by some residents to wind energy developments in close proximity does not adequately explain variations in public attitudes due to the degree of subjectivity involved.

5.5.2 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 oppose wind power while 16% of both samples neither favour nor oppose it. Amongst those in favour of wind power, the majority cited environmental and climate concerns as their main reasons for supporting such developments. Other reasons cited for supporting wind energy developments include: "economic benefits," "reliable/efficient," "positive experience with wind energy" and recognise it as a "safe resource." When questioned about wind developments in their local area, 55% of nationally represented sample favour or tend to favour such proposals and 51% of the rural population reported the same. Reasons cited for supporting wind developments in their local area include: "good for the environment," "social responsibility," "create jobs," "good for the community."

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

5.5.3 Health Impacts of Wind Farms

5.5.3.1 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 also assessed the impact of low-frequency noise from wind turbines on humans. The independent review found that:

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

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

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, in particular, to validate the finding of the *'Wind Turbine Sound and Health Effects - An Expert Panel Review'* (see Item 2 above) that:

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

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, is in contrast to 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 a number of headings, including noise and shadow flicker.

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

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

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

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

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 Revised Wind Energy Development Guidelines (2013), 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, therefore, 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, however, it states that no evidence is available to facilitate the recommendation of one type of intervention over another.

5.5.4 Turbine Safety

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

The DoEHLG Guidelines state that there is a very remote possibility of injury to people from flying fragments of ice or from a damaged blade. However, most blades are composite structures with no bolts or separate components and the danger is therefore minimised. The 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 beginning 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.

5.5.5 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 Section 14.2 of this EIAR.

5.5.6 Assessment of Effects on Human Health

As set out in the Department of Housing, Planning, Community and Local Government Key Issues Consultation Paper on the Transposition of the EIA Directive 2017, the consideration of the effects on populations and on human health should focus on health issues and environmental hazards arising from the other environmental factors, for example water contamination, air pollution, noise, accidents, disasters.

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

Chapters 8 Land, Soils & Geology, Chapter 9 Hydrology & Hydrogeology, Chapter 10 Air & Climate, Chapter 11 Noise & Vibration and Chapter 14: Material Assets (Roads and Traffic) 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 (**Appendix 9-1** of this EIAR) 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 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.

5.5.7 Vulnerability of the Project to Natural Disaster

An assessment of the Proposed Development's vulnerability to natural disasters can be found in Chapter 15 of this EIAR. A brief discussion can be found below.

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

There is limited potential for significant natural disasters to occur at the Proposed Development. 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 and landslide events. The risk peat instability and failure (landslide) occurring on the site is addressed in the Geotechnical and Peat Stability Assessment Report included in Appendix 8-1 of this EIAR which concludes that the Proposed Development has an acceptable margin of safety and is suitable for wind farm development. The risk of flooding is addressed in Chapter 9. It is considered that the risk of significant fire occurring, affecting the wind farm and causing the wind farm to have significant environmental effects is limited. As described earlier, there are no significant sources of pollution in the wind farm with the potential to cause environmental or health effects. Also, the spacing of the turbines and distance of turbines from any properties limits the potential for impacts on human health. The issue of turbine safety is addressed in Section 5.5.4 above.

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 is 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 EIAR.

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

- No evidence of a consistent negative effect on house prices: Across a very wide range of analyses, including results that replicate and improve on the approach used by Gibbons (2014), we do not find a consistent negative effect of wind turbines or wind farms when averaging across the entire sample of Scottish wind turbines and their surrounding houses. Most results either show no significant effect on the change in price of properties within 2km or 3km or find the effect to be positive.

- Results vary across areas: The results vary across different regions of Scotland. Our data 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[2].

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

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

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

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

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

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

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

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

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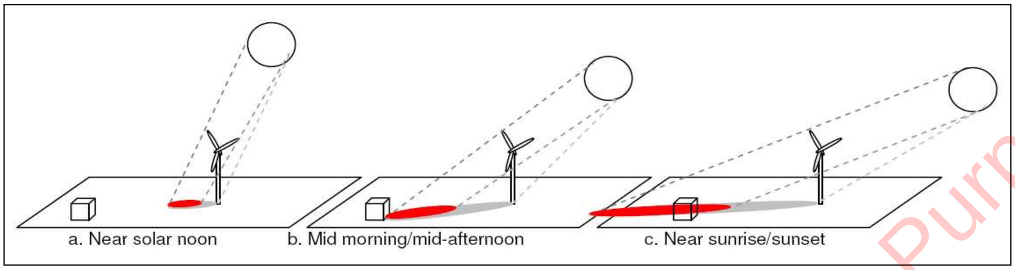
[2] Parsons Brinckerhoff (2010) Update of UK Shadow Flicker Evidence Base Department of Energy and Climate Change. Department of Energy and Climate Change. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48052/1416-update-uk-shadow-flicker-evidence-base.pdf

At distances of greater than approximately 500 metres between a turbine and a receptor, shadow flicker generally occurs only at sunrise or sunset when the shadow cast by the turbine is longer. At distances greater than ten rotor diameters from a turbine, the potential for shadow flicker is very low (*'Wind Energy Development Guidelines for Planning Authorities'*, DoEHLG, 2006). Figure 5-3 illustrates the shadow cast by a turbine at various times during the day, where the red shading represents the area where shadow flicker may occur. When the sun is high in the sky, the length of the shadow cast by the turbine is significantly shorter.

Figure 5-3 Shadow-Prone Area as a Function of Time of Day (Source: Shadow Flicker Report, Helimax Energy, December 2008)



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

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

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

5. *Property usage and occupancy:*

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

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

The direction of wind turbine blades changes according to wind direction, as the turbine rotor turns to face the wind. In order to cast a shadow, the turbine blades have to be facing directly toward or away from the sun, so they are moving across the source of the light relative to the observer. This is demonstrated in Figure 5-4.

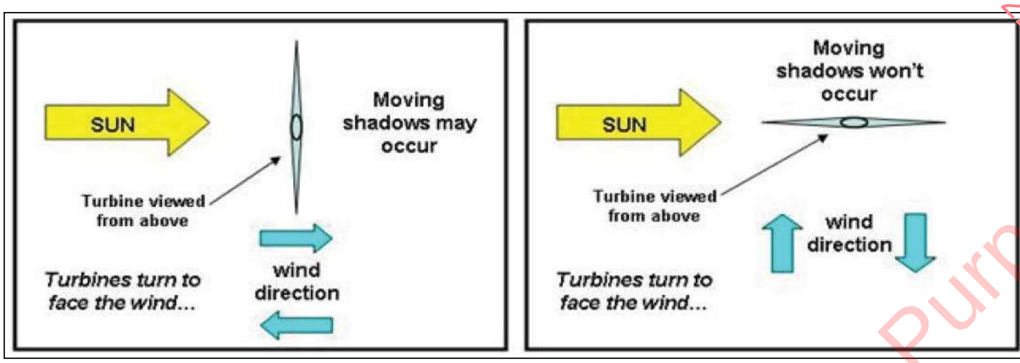


Figure 5-4 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environmental Power LLC)

7. *Rotation of turbine blades:*

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

5.7.2 Guidance

The relevant Irish guidance for shadow flicker is derived from the '*Wind Energy Development Guidelines for Planning Authorities*' (Department of the Environment, Heritage and Local Government (DoEHLG), 2006) and the '*Best Practice Guidelines for the Irish Wind Energy Industry'* (Irish Wind Energy Association, 2012).

The DoEHLG 2006 wind energy guidelines recommend that shadow flicker at dwellings within 500 metres of a proposed turbine location should not exceed a total of 30 hours per year or 30 minutes per day. A significant minimum separation distance from houses of 740m has been achieved with the project design.

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

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

Although the DoEHLG thresholds apply to dwellings located within 500 metres of a proposed turbine location, for the purposes of this assessment, the guideline thresholds of 30 hours per year or 30 minutes per day have been applied to all properties located within ten rotor diameters (i.e. assumed at 1,850 metres as a worst-case scenario) of the proposed turbines within the Proposed Development site (as per IWEA guidelines, 2012). The DoEHLG Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The adopted 2006 DoEHLG guidelines are currently under review. The DoHPLG released the 'Draft Revised Wind Energy Development Guidelines' in December 2019. 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 current DoEHLG Guidelines limit (30 hours per year or 30 minutes per day However, it should also be noted the Proposed Development can be brought in line with the requirements of the 2019 draft guidelines, should they be adopted while this application is in the planning system, through the implementation of the mitigation measures outlined in Section 5.9.3.10.

5.7.3 Shadow Flicker Prediction Methodology

Shadow flicker occurs only under certain, combined circumstances, as detailed above. Where shadow flicker does occur, it is generally short-lived. The Department of the Environment, Heritage and Local Government (DoEHLG) guidelines state that careful site selection, design and planning, and good use of relevant software can help avoid the possibility of shadow flicker in the first instance, all of which have been employed at the site of the Proposed Development. Proper siting of wind turbines is key to reducing or eliminating shadow flicker.

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

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

For the purposes of this shadow flicker assessment, the software package ReSoft WindFarm Version 5.0.1.2 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.

5.7.4 Shadow Flicker Assessment Criteria

5.7.4.1 Turbine Dimensions

The proposed wind turbines to be installed on the site will have a ground-to-blade tip height, hub height and blade length within the following, limited, ranges:

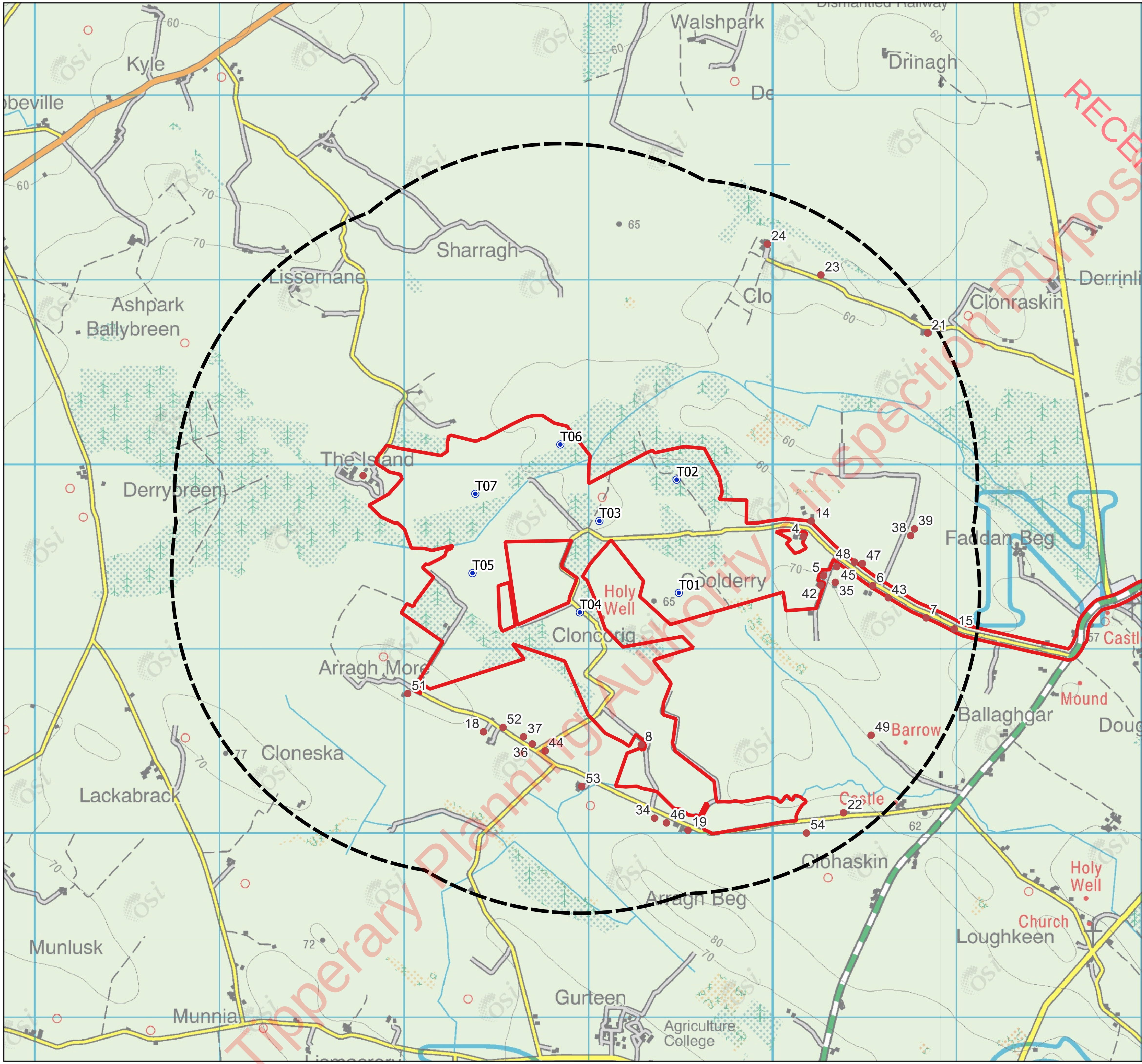
- Turbine Tip Height – Maximum height 185 metres, Minimum height 179.5 metres
- Hub Height – Maximum height 110.5 metres, Minimum height 103.5 metres
- Blade Length: - Maximum length 81.5 metres, Minimum length 74.5 metres.

Planning permission is being sought for a turbine with a minimum tip height of 179.5m and a maximum tip height of 185m. The potential shadow flicker impact the turbines will give rise to will be no more than that predicted in this assessment using the maximum proposed rotor diameter of 163m. With the benefit of the mitigation measures outlined in this section, any turbine to be installed onsite will be able to comply with the DoEHLG 2006 guidelines thresholds of 30 minutes per day or 30 hours per year, or with the revised guidelines if required, through the use of turbine control software. Any references to the turbine dimensions in this shadow flicker assessment should be considered in the context of the above and should not be construed as pre-determining the dimensions of the wind turbine to be used on the site.

5.7.4.2 Study Area

There is a total of 31 No. residential buildings within a distance of 10 rotor diameters (assumed at 1,630 metres) from the proposed turbine locations.

The 1,630m study area was also the subject of a planning history search, to identify properties that may have been granted planning permission, but not yet been constructed. The locations of all dwellings in the study area are shown in Figure 5-5, with all dwellings detailed in Table 5-9 in Section 5.7.5 below.



Map Legend

- EIAR Site Boundary
- Proposed Turbine Layout (7 no. turbines)
- Sensitive Receptors (31 no. receptors)
- Shadow Flicker Study Area 1.63km Turbine Buffer (10 x 163m Rotor Diameter)

Drawing Title	Shadow Flicker Study Area
Project Title	Carrig Wind Farm Development
Drawn By: ER	Checked By: EMC
Project No.: 211016	Drawing No.: Figure 5-5
Scale: 1:20,000	Date: 2023-09-11

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5.7.4.3 Assumptions and Limitations

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

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

Each window measures one-metre-high by one-metre-wide, and tilt angle is assumed to be zero. The centre height of each window is assumed to be two metres above ground level and no screening due to trees or other buildings or vegetation is assumed. It was not considered necessary or practical to measure the dimensions of every window on every property in the study area. While the actual size of a window will marginally influence the incidence and duration of any potential shadow flicker impact, with larger windows resulting in slightly longer shadow flicker durations, any additional incidences or durations or shadow flicker over and above those predicted in this assessment can be countered by extending the mitigation strategies outlined in Section 5.9.3.10.

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

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

The total annual shadow flicker calculated for each property assumes 100% sunshine during daytime hours, as referred to above. However, weather data for this region shows that the sun shines on average for 26.46% of the daylight hours per year. This percentage is based on Met Éireann data recorded at Birr 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 26.46% of daylight hours. Table 5-9 below lists the annual shadow flicker calculated for each property when the regional average of 26.46% sunshine is taken into account, to give a more accurate annual average shadow flicker prediction. Table 5-9 below also outlines whether a shadow flicker mitigation strategy is required for each property to mitigate potential exceedances of the daily and/or annual threshold figure.

5.7.5 Shadow Flicker Assessment Results

5.7.5.1 Daily and Annual Shadow Flicker

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

The model results assume worst-case conditions, including:

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

The maximum daily shadow flicker model is based on the assumption that daylight hours consist of 100% sunshine. This is a conservative assumption which represents a worst-case scenario. Following the detail provided above on sunshine hours, a sunshine factor of 26.46% 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 5-9.

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

The DoEHLG Wind Energy Guidelines 2006 recommend that shadow flicker at dwellings should not exceed a total of 30 hours per year. As outlined in Section 5.1, a significant minimum separation distance from any residential dwelling of 741m, i.e. distance between nearest turbine (T05) to the nearest dwelling (H51) has been achieved with the project design. However, for the purposes of this assessment, the guideline thresholds has been applied to all residential properties within 1,630 metres of the proposed turbine locations.

A total of 31 No. residential buildings have been included in the shadow flicker assessment, the results of which are presented in Table 5-9 below.

Table 5-8 Shadow Flicker Results for Carrig Wind Farm, Co. Tipperary.

Building No. (House ID)	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Distance to Nearest Turbine (metres)	Nearest Turbine	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (26.46%) (hrs:min:sec)	Turbine(s) Giving Rise to Shadow Flicker Exceedance	Mitigation Strategy Required (for Potential Day Exceedance)?
4	600119	701641	742	T01	01:07:48	169:06:00	44:44:28	1,2,3,4	Yes
5	600227	701429	790	T01	00:49:12	121:30:00	32:08:49	1,2,3,4	Yes
6	600493	701374	1051	T01	00:37:48	83:54:00	22:11:55	1,2	Yes
7	600783	701200	1348	T01	00:30:00	40:00:00	10:35:00	0	No
8	599239	700512	792	T04	00:00:00	00:00:00	00:00:00	0	No
14	600160	701724	763	T02	01:08:24	141:12:00	37:21:33	1,2,3,4	Yes
15	600935	701140	1505	T01	00:27:00	12:18:00	03:15:16	0	No
18	598384	700583	832	T04	00:33:36	28:00:00	07:24:30	1	Yes
19	599492	700049	1287	T01	00:00:00	00:00:00	00:00:00	0	No
21	600792	702743	1577	T02	00:26:24	13:30:00	03:34:19	0	No
22	600335	700144	1489	T01	00:00:00	00:00:00	00:00:00	0	No
23	600213	703058	1358	T02	00:27:36	15:54:00	04:12:25	0	No

24	599923	703225	1369	T02	00:28:12	29:06:00	07:41:58	0	No
34	599311	700115	1187	T04	00:00:00	00:00:00	00:00:00	0	No
35	600290	701392	850	T01	00:46:12	99:48:00	26:24:19	1,2,3	Yes
36	598648	700517	758	T04	00:00:00	00:00:00	00:00:00	0	No
37	598601	700555	740	T04	00:00:00	00:00:00	00:00:00	0	No
38	600699	701646	1294	T01	00:31:12	33:54:00	08:58:10	1,2	Yes
39	600720	701682	1317	T02	00:31:12	32:24:00	08:34:21	1,2	Yes
42	600212	701377	771	T01	00:50:24	117:12:00	31:00:33	1,2,3,4	Yes
43	600578	701309	1136	T01	00:35:24	71:30:00	18:55:04	1,2	Yes
44	598718	700479	774	T04	00:00:00	00:00:00	00:00:00	0	No
45	600299	701477	868	T01	00:45:00	109:00:00	28:50:23	1,2,3	Yes
46	599375	700089	1234	T04	00:00:00	00:00:00	00:00:00	0	No
47	600437	701494	1008	T01	00:39:00	77:12:00	20:25:33	1,2	Yes
48	600396	701502	968	T01	00:40:48	88:36:00	23:26:31	1,2	Yes
49	600485	700564	1297	T01	00:31:48	22:54:00	06:03:32	1	Yes
51	597973	700790	741	T05	00:40:48	61:54:00	16:22:40	4	Yes

52	598490	700606	750	T04	00:31:48	20:12:00	05:20:40	1	Yes
53	598916	700287	943	T04	00:00:00	00:00:00	00:00:00	0	No
54	600134	700034	1474	T01	00:00:00	00:00:00	00:00:00	0	No

Of the 31 No. properties modelled, it is predicted that 16 No. properties may potentially experience daily shadow flicker in excess of the DoEHLG guideline threshold of 30 minutes per day. This prediction is assuming worst-case conditions (i.e. 100% sunshine on all days where the shadow of the turbines passes over a house, wind blowing in the correct direction, no screening present, etc.) and in the absence of any turbine control measures.

Of the 31 No. properties modelled, when the regional sunshine average (i.e. the mean amount of sunshine hours throughout the year) of 26.46% and is taken into account, the DoEHLG total annual guideline limit of 30 hours is predicted as being potentially exceeded at 4 No. of the properties.

It is worth nothing that in reality, the 'estimated actual' shadow flicker is considered conservative and likely to be significantly less than predicted in Table 5-9 as the following items are not considered by the model:

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

Section 5.9.3.11 outlines the mitigation strategies which may be employed at the potentially affected properties to ensure the daily shadow flicker threshold will not be exceeded.

5.7.6 Comparative Shadow Flicker Assessment

A comparative assessment was undertaken where turbines with alternative dimensions within the proposed range, as detailed in Section 4.1 of Chapter 4 of the EIAR, were modelled and compared against Scenario 1 as set out in Section 5.7.4 and Table 5-9. The three comparative modelled turbines are as follows:

- **Scenario 1: Lowest Hub (103.5m) & Longest Blade (81.5m)**
- **Scenario 2: Intermediate Hub Height (107.5) & Intermediate Blade Length (77.5m)**
- **Scenario 3: Highest Hub (110.5m) & Shortest Blade (74.5m)**

For all turbines modelled, the study area remained unchanged at 1.63km. The summary of assessment results are presented in Appendix 5-4: Comparative Shadow Flicker Assessment.

The findings of the assessment indicate that of the 31 no. properties modelled, daily shadow flicker exceedance is experienced at 16 no. properties for Scenario 1, at 12 no. properties for Scenario 2, and at 12 no. properties for the Scenario 3. Of the 31 no. properties modelled, when adjusted for regional sunshine, annual shadow flicker exceedance is experienced at 4 no. properties for Scenario 1, 2 no. dwellings (H18, H20, H23) Scenario 2, and at 2 no. properties for Scenario 3. The results of this comparative assessment support the consideration that a worst-case scenario for potential shadow flicker effects is the Scenario 1, i.e., a combination of the lowest hub height and the maximum rotor diameter (therefore providing the maximum tip height).

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

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. There closest occupied dwelling is located approximately 740 metres of a proposed turbine location. The Proposed Development site is located in an area which is currently used for turf-cutting, agriculture and some commercial forestry. Turf-cutting, agriculture and commercial forestry will still be carried out at the site should the Proposed Development application be successful. Thus, the existing land use and industrial activity will be retained in the surrounding landscape. This continuation of existing activities and landuse will assist in the assimilation of the Proposed Development into the current receiving environment.

When considering the amenity of residents in the context of a proposed wind farm, there are four main potential impacts of relevance: 1) Shadow Flicker, 2) Noise, 3) Visual Amenity and 4) Telecommunications. Shadow flicker and noise are quantifiable aspects of residential amenity while visual amenity is more subjective. Detailed shadow flicker and noise modelling have been completed as part of this EIAR (Section 5.7 above refers to shadow flicker modelling, Chapter 11 of the EIAR addresses noise). A comprehensive landscape and visual impact assessment has also been carried out, as presented in Chapter 13 of this EIAR. Impacts on human beings during the construction, operational and decommissioning phases of the Proposed Development are assessed in relation to each of these key issues and other environmental factors such as traffic and dust; see Impacts in Section 5.9 below. The impact on residential amenity is then derived from an overall judgement of the combination of impacts due to shadow flicker, changes to land-use and visual amenity, noise, traffic, dust and general disturbance.

5.9 Likely Significant Impacts and Associated Mitigation Measures

The below assessment evaluates the impact (where there is the potential for an impact to occur) on health and safety, employment, population, land-use, tourism, noise, dust, traffic, shadow flicker and residential amenity during the construction, operation and decommissioning phases, as a result of the Proposed Development.

5.9.1 'Do-Nothing' Scenario

If the Proposed Development were not to proceed, the existing use of the site as commercial forestry 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 County Tipperary'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.

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 overhead 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 or indirect effects.

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. Approximately, up to 70 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 12 – 18 months. The majority of construction workers and materials will be sourced locally, thereby helping to sustain employment in the construction trade. This will have a short-term significant positive impact.

The injection of money in the form of salaries and wages to those employed during the construction phase of the 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.

During construction, additional indirect employment will be created in the region through the supply of services and materials to the renewable energy development. There will also be income generated by local employment from the purchase of local services i.e. travel, goods and lodgings.

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.

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

Proposed Community Benefit Scheme

Two important areas of Government policy development are nearing completion which will have a bearing on the establishment of future community benefit funds, the draft updated Wind Energy Guidelines and the Renewable Energy Support Scheme (RESS), the terms and conditions for which were published in December 2019. Both sets of policy are expected to provide the Government requirements on future community benefit funds for renewable energy projects. We will fully take into account these two important policies when finalised as we present the Applicants approach to community benefit.

Should the Proposed Development receive planning permission, there are substantial opportunities available for the local area in the form of Community Benefit Funds. Based on the current proposal, a Community Benefit Fund would attract a community contribution in the region of approximately €265,000/year per year, assuming it becomes a Renewable Energy Support Scheme project, for the local community over the lifetime of the project. The exact value of this fund will be directly proportional to the installed capacity and/or energy produced at the site and will support and facilitate projects and initiatives including youth, sport and community facilities, schools, educational and training initiatives, and wider amenity, heritage, and environmental projects.

Further details on the proposed Community Gain proposals are presented in Appendix 2-2 and Section 4.5 in Chapter 4 of this EIAR.

The Community Benefit Fund belongs to the local community. The premise of the fund is that it should be used to bring about significant, positive change in the local area. To make this happen, our first task will be to form a benefit fund development working group that clearly represents both the close neighbours to the project as well as nearby communities. This group will then work on designing the governance and structure of a community entity that would administer the Community Benefit Fund.

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-use of commercial forestry will continue on the site of the Proposed Development. However, a small section of commercial forestry within the site will be felled as part of the wind farm development. Whilst there will be a change of land use in these areas to facilitate the development of the wind turbines and infrastructure, this is an acceptable and unavoidable part of the Proposed Development.

The existing land-use of road networks will continue on the proposed grid connection route options. There will be no change to existing land-uses in the wider area as a result of the proposed grid connection.

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 5.4.1.1, traffic management measures will be in place during the construction phase of the Proposed Development to ensure that any potential impacts to tourism-related traffic is mitigated against. 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. These effects will be short-term in duration. The noisiest construction activities associated with wind farm development are excavation, pouring of the turbine bases and the extraction of stone from the borrow pit. 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 effects that will occur during the construction phase of the Proposed Development are further described in Chapter 12 of this EIAR. This will have a temporary slight negative impact.

With regard to the proposed grid connection route; construction works will give rise to noise, however these noise impacts will have no additional effect as there are no sensitive receptors located along the proposed grid connection cabling route.

Proposed Mitigation Measures

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

- Local residents will be kept informed of the proposed working schedule, where appropriate, including the times and duration of any abnormally noisy activity that may cause concern;
- The core hours for construction activity will be 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 Saturday. There will be no working on Sundays and Public Holidays;
- Any extraordinary site work occurring outside of the core working hours (for example, crane operations lifting components onto the tower) will be programmed, when appropriate, so that haulage vehicles would not arrive at or leave the site between 19:00 and 07:00, with the exception of abnormal loads that would be scheduled to avoid anticipated periods of high traffic flows;
- A ll vehicles and mechanical plant will be fitted with effective exhaust silencers and be subject to programmed maintenance;

- Inherently quiet plant will be selected where appropriate and available - all major compressors would be 'sound reduced' models fitted with properly lined and sealed acoustic covers, which would be kept closed whenever the machines are in use;
- All ancillary pneumatic percussive tools will b e fitted with mufflers or silencers of the type recommended by the manufacturers;
- Machines will be shut down between work periods (or when not in use) or throttled down to a minimum;
- All equipment used on site will be regularly maintained, including maintenance related to noise emissions;
- Vehicles will be loaded carefully to ensure minimal drop heights so as to minimise noise during this operation; and
- All ancillary plant such as generators and pumps will be positioned so as to cause minimum noise disturbance and if necessary, temporary acoustic screens or enclosures will be provided.

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. The entry and exit of construction vehicles from the site may result in the transfer of mud to the public road, particularly if the weather is wet. This may cause nuisance to residents and other road users. These impacts will not be significant and will be relatively short-term in duration.

Proposed Mitigation Measures

The majority of aggregate material for the construction of roads and turbine bases will be sourced from the proposed borrow pit located within the main site of the proposed wind farm development, therefore limiting the distance needed to transport this material to the site. Truck wheels will be washed to remove mud and dirt before leaving the site. All plant and materials vehicles shall be stored in the 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.

The active construction area along the intended grid connection route options will be small, ranging from 150-300m in length at any one time. Should separate crews be used during the construction phase they will generally be separated by 1-2km. All construction machinery will be maintained in good operational order while on-site, minimising any emissions that are likely to arise. Aggregate materials for the construction of the cabling route will be sourced locally to reduce the amount of emissions associated with vehicle movements. Potential dust emissions during the construction period will not be significant and will be relatively short-term in duration.

Residual Impact

Short-term imperceptible negative impact

Significance of Effects

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

5.9.2.8 Traffic

Pre-Mitigation Impacts

It is intended that the port of entry for large turbine components will be Shannon Foynes, County Limerick. Vehicles delivering large turbine components and other abnormal loads to the site will depart from Shannon Foynes Port in Co. Limerick, the turbines will be transported east via the N69 and N18 as far the western outskirts of Limerick city before merging onto the M7 motorway. At Junction 21 (Borris-in-Ossory), the turbine delivery vehicle exits the M7 motorway, travelling north on the R435 regional road for approximately 2.2km. In the townland of Townparks (west of Borris-in-Ossory), the delivery vehicle joins the R445 regional road and travels northwest along this road for approximately 9.4km. The vehicle joins the N62 national road in the townland of Benamore and progresses west towards the town of Roscrea. The route follows the N62 through Roscrea and travels northwards to Birr. In the townland of Townparks (Birr), the vehicle turns west off the N62 and travels west and then southwest along an unnamed local road before merging onto the N52 in the townland of Drumbane. The vehicle continues southwest, through the villages of Riverstown and Carrig in Co. Tipperary and turns west onto the L5040 local road in the townland of Clohaskin. The vehicle travels west on the L5040 for approximately 1.1km to the Proposed Development entrance that is located on the northern side of the L5040.

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 Chapter 15 of this EIAR.

The types of vehicles that will be required to negotiate the local network, carrying turbine components, represent abnormal size loads and a detailed assessment of the geometry of the proposed route was therefore undertaken. This will have a short-term slight negative impact on local road users.

With regard to the grid connection route, there is the potential for short term nuisance to local road users along the short section of cabling route located along the public road network, giving rise to a short-term slight negative impact.

Proposed Mitigation Measures

A traffic management plan (included as Appendix 15-2) will be developed and implemented to ensure any impact is short term in duration and slight in significance along the proposed grid connection route. 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 identified in line with the Engagement plan. 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 100-150m in length and so the potential for significant disruption is limited.

Residual Impact

Once the 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 of the EIAR, occurs only during the operational phase of a wind energy development. There are therefore no shadow flicker impacts associated with the construction phase of the Proposed Development.

5.9.3 Operational Phase

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

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 imperceptible.

Proposed Mitigation Measures

Notwithstanding the above, the following mitigation measures will be implemented during the operation of the Proposed Development to ensure that 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 Employment and Investment

The operational phase will present an opportunity for mechanical-electrical contractors and craftspeople to become involved with the maintenance and operation of the wind farm. On a long-term scale, the Proposed Development will create approximately 3-4 jobs during the operational phase relating to the maintenance and control of the wind farm, having a long-term slight positive effect.

5.9.3.3 Population

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

5.9.3.4 Land-use

The footprint of the Proposed Development site, including turbines, roads etc., will occupy only a small percentage of the total Study Area defined for the purposes of this EIAR. The main land-use of commercial forestry and during the operational phase, any commercial forestry activity on the site will continue to co-exist with the wind farm. The Proposed Development will have no impact on other land-uses within the wider area.

5.9.3.5 Property Values

As noted in Section 5.6 above, the conclusions from available international literature indicate that property values are not impacted by the positioning of wind farms near houses. It is on this basis that it can be reasonably concluded that there would be a long-term imperceptible impact from the Proposed Development.

5.9.3.6 Noise

A baseline assessment of the existing background noise conditions was carried out, the results of which are presented in Chapter 11 of the EIAR. A noise assessment of the operational phase of the Proposed Development has also been carried out through modelling of the development using noise prediction software. The predicted noise levels for the Proposed Development have been compared with the existing background noise levels and the best practice guidance levels for noise emissions from wind farms.

Details of the noise assessment carried out by TNEI Consulting are presented in Chapter 11 of the EIAR. The noise assessment determined that the predicted operational noise effect at the closest noise sensitive receptors to the site is of a moderate, negative, long-term nature. It is noted that this effect considers the periods of greatest potential effect prior to mitigation, i.e. the worst-case scenario. For the majority of locations assessed, operation of the proposed turbines will have a slight, negative, long-term effect. The noise assessment notes that these effects should be considered in terms that the effect is variable, and that this assessment considers periods of the greatest potential effect.

As stated in the noise assessment in Chapter 12, it has been demonstrated that the relevant national guidance in relation to noise associated with proposed wind turbines can be satisfied, therefore the predicted impact associated with the operational turbines is long term and not significant.

5.9.3.7 Traffic

Two to three service technicians may have to attend to the site of the proposed wind farm during on a weekly basis of operational phase of the project. A Traffic and Transportation Assessment (TTA) of the Proposed Development has been completed by Alan Lipscombe Traffic and Transport Consultants, the results of which are presented in Chapter 15 of this EIAR. The TTA found that there will be a long-term imperceptible impact on traffic created during the operational phase of the proposed wind farm.

5.9.3.8 Renewable Energy Production and Reduction in Greenhouse Gas Emissions

In July 2022, the EPA published 'Ireland's Provisional Greenhouse Gas Emissions 1990-2022' which indicates that Irelands emissions have decreased by 11.4% from 1990 to 2021. Electricity generated from wind increased by 15.3% in 2020, the increase of which contributed to the 8.1% decrease in the emissions intensity of power generation in 2020 to 295g CO2/kWh. The National Climate Change Strategy 2007 – 2012 stated that electricity generation from renewable sources provides the most effective way of reducing the contribution of power generation to Ireland's greenhouse gas emissions. The Proposed Development will offer significant benefits in terms of renewable energy production and reductions in greenhouse gas emissions. In this regard, it will have a long-term significant positive effect. The carbon loss and savings due to the Proposed Development are discussed in Chapter 10 of this EIAR.

5.9.3.9 Tourism and Amenity

Pre-Mitigation Impacts

Given that there are currently no tourism attractions or amenity walkways located within the site there are no impacts associated with the operational phase of the development. The Department of the Environment, Heritage and Local Government's Wind Energy Development Guidelines for Planning Authorities 2006 state that "the results of survey work indicate that tourism and wind energy can co-exist happily". It is not considered that the Proposed Development would have an adverse impact on tourism infrastructure in the vicinity. Renewable energy developments are an existing feature in the surrounding landscape, which will assist in the assimilation of the Proposed Development into this environment.

Proposed Mitigation Impacts

None required.

Residual Impact

The Proposed Development will have a long-term, positive impact on local amenity due to the social and recreational benefits associated with the recreational amenity walkways/ paths. With the opening up of the site to the public, the amenity proposal will also facilitate the Councils goals in creating more trail links for existing and new users and boosting the tourism economy.

Significance of Effects

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

5.9.3.10 Shadow Flicker

Pre-Mitigation Impacts

Assuming worst-case conditions, a total of 16 properties as a result of the Carrig Wind Farm may experience daily shadow flicker in excess of the current DoEHLG guideline threshold of 30 minutes per day. The DoEHLG total annual guideline limit of 30 hours is predicted to be exceeded at 4 No. properties when the regional sunshine average of 26.46% is taken into account.

Proposed Mitigation Measures

Screening Measures

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

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

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

Wind Turbine Control Measures

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

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

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

The atmospheric variables that determine whether shadow flicker will occur or not, are continuously monitored at the 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.

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

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

This method of shadow flicker mitigation has been technically well-proven at wind farms in Ireland and also in areas outside Ireland that experience significantly longer periods of direct sunlight.
In order to demonstrate how the SCADA control system can be applied to switch off particular turbines at the relevant times and dates, Table 5-10 below lists the 16 properties at which a shadow flicker mitigation strategy may be necessary to ensure the Guidelines 30-minute per day shadow flicker threshold is not exceeded. In this case, the relevant turbine(s) would be programmed to switch off for the time required to reduce daily shadow flicker to below the guideline limit of 30 minutes. The SCADA control system would be utilised to control shadow flicker in the absence of being able to agree alternative mitigation measures with the relevant property owner. The mitigation strategy outlined in Table 5-10 below is based on the theoretical precautionary scenario. The details presented in Table 5-10 list the days per year and the turbines that could be programmed to switch off at specific times, in order to reduce daily shadow flicker to a maximum of 28 minutes, which is below the guideline limit of 30 minutes.

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

Overall, the details presented in Table 5-10 demonstrate that using the turbine control system, it will be possible to reduce the level of shadow flicker at any affected property to below the daily guideline limit of 30 minutes, by programming the relevant turbines to switch off at the required dates and times.

Table 5-10 lists the 16 no. properties at which a shadow flicker mitigation strategy may be necessary to ensure the Guideline's 30-minute daily and/or 30-hour annual shadow flicker thresholds are not exceeded. In this case, the relevant turbine(s) would be programmed to switch off for the time required to ensure that the annual shadow flicker limit of 30 hours annually is not exceeded. The SCADA control system would be utilised to control shadow flicker in the absence of being able to agree suitable alternative mitigation measures with the relevant property owner. Table 5-10 below illustrates the relevant turbines that may need to be controlled, based on the 'worst-case impact' of shadow flicker impacts modelled.

Table 5-10 Shadow Flicker Mitigation Strategy for Annual Shadow Flicker Exceedance

Property No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Days)	Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:mins:sec)
7	00:31:12	8:37:31	T01, T02	17	64-66; 105-109; 235-240; 279-281;	≤00:28:00	≤30:00:00
8	00:31:12	9:01:20	T01, T02	24	65-69; 107-113; 276-280;	≤00:28:00	≤30:00:00
10	00:35:24	19:01:25	T01, T02	56	86-97; 136-152; 192-207; 248-258;	≤00:28:00	≤30:00:00
11	00:37:48	22:19:51	T01, T02	76	81-94; 134-156; 188-210 251-264;	≤00:28:00	≤30:00:00
12	00:31:48	6:01:57	T01	22	161-182	≤00:28:00	≤30:00:00
13	00:39:00	20:41:25	T01, T02	74	70-84; 124-145; 198-219; 261-275;	≤00:28:00	≤30:00:00
14	00:40:48	23:51:55	T01, T02	86	68-84; 125-150; 194-219; 261-277;	≤00:28:00	≤30:00:00
16	00:45:00	28:58:19	T01, T02, T03	134	68-88; 103-107; 132-212; 237-242; 257-277;	≤00:28:00	≤30:00:00

Property No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Days)	Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:mins:sec)
17	00:46:12	26:29:05	T01, T02, T03	116	77-97; 109-114; 143-201; 230-235; 247-268;	≤00:28:00	≤30:00:00
18	00:49:12	32:15:10	T01, T02, T03, T04	139	72-95; 107-114; 143-201; 230-237; 250-273;	≤00:28:00	≤30:00:00
20	00:50:24	31:11:40	T01, T02, T03, T04	125	77-102; 111-119; 153-191; 225-233; 243-268;	≤00:28:00	≤30:00:00
21	01:08:24	37:39:01	T01, T02, T03, T04	153	38-63; 85-94; 109-147; 197-236; 250-260; 282-308;	≤00:28:00	≤30:00:00
23	01:07:48	44:52:24	T01, T02, T03, T04	187	44-72; 57-63; 91-102; 121-223; 242-253; 273-301;	≤00:28:00	≤30:00:00
33	00:31:48	5:19:05	T01	14	166-179;	≤00:28:00	≤30:00:00
34	00:33:36	7:22:55	T01	34	156-189;	≤00:28:00	≤30:00:00
35	00:40:48	16:33:46	T04	70	126-155; 190-219;	≤00:28:00	≤30:00:00

Notwithstanding the approach set out above should shadow flicker associated with the Proposed Development be perceived to cause a nuisance at any home, the affected homeowner is invited to engage with the Developer. Should a complaint or query in relation to shadow flicker 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. 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. The implementation of the above mitigation measures, where necessary, will ensure that there will be no shadow flicker exceedances of the existing daily and annual shadow flicker limits at properties within 10 rotor diameters from the Proposed Development as recommended in the current 2006 DoEHLG guidelines. Likewise, the Proposed Development can be brought in line with the requirements of the Draft Revised Wind Energy Development Guidelines 2019 should they be adopted during the planning application process for this development.

Planning permission is being sought for a turbine with a minimum tip height of 179.5m and a maximum tip height of 185m. The potential shadow flicker impact the turbines will give rise to will be no more than that predicted in this assessment using the maximum proposed rotor diameter of 163m. With the benefit of the mitigation measures outlined in this section, any turbine to be installed onsite will be able to comply with the DoEHLG 2006 guidelines thresholds of 30 minutes per day or 30 hours per year, or with the revised guidelines if required, through the use of turbine control software. Any references to the turbine dimensions in this shadow flicker assessment should be considered in the context of the above and should not be construed as pre-determining the dimensions of the wind turbine to be used on the site.

Significance of Effects

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

5.9.3.11 Residential Amenity

Potential impacts on residential amenity during the operational phase of the proposed wind farm could arise primarily due to noise, shadow flicker, changes to visual amenity or interference with telecommunications. 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 and the Draft Revised Wind Energy Development Guidelines 2019.

The visual impact of the Proposed Development is addressed comprehensively in Chapter 14 of this EIAR. An assessment of roadside screening was carried out for roads within 5 kilometres of the proposed turbine locations, with both the methodology and findings of this described in Chapter 14 of this EIAR. Many of these roads have intermittent/partial and dense screening, and therefore these roads which fall within the ZTV will have more screening and therefore reduced views, rather than the full visibility that the ZTV suggests. 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.

As part of the scoping and consultation exercise undertaken by MKO, the national and regional broadcasters and fixed and mobile phone operators were contacted with regard to potential interference from the proposed wind farm. Full details are provided in Section 2.6 of the EIAR (in Chapter 2: Background to the Proposed Development) and Section 15.2 of the EIAR (in Chapter 15: Material Assets – Telecommunications and Aviation). Copies of scoping replies received are presented in Appendix 2-1 of the EIAR. The proposed wind farm will have no impact on telecommunications.

Proposed Mitigation Measures

As detailed above, the closest proposed turbine (T4) is 740m from the nearest dwelling. 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 and the grid connection cabling route.

Residual Impact

With the implementation of the mitigation measures outlined in relation to noise and vibration, dust, traffic, shadow flicker, telecommunications and visual amenity, the Proposed Development will have no significant impact on residential amenity.

Significance of Effects

Based on the assessment above there will be no significant 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 works required during the decommissioning phase are described in Section 4.9 in Chapter 4: Description of the Proposed Development and the accompanying Decommissioning Plan included as Appendix 4-5 of this EIAR.

Any impact and consequential effect that occurs during the decommissioning phase will be similar to that which occurs during part of the construction phase when turbines were being erected. The impacts and associated effects will be materially less than during the construction phase as significant ground works are not required to decommission a wind farm.

The decommissioning phase will have no impact on shadow flicker, interference with communications system, residential amenity, employment, tourism or health & safety once all standard construction phase mitigation measures described above are implemented.

5.9.5 Cumulative Effects

For the assessment of cumulative effects, any other existing, permitted or Proposed Developments (wind energy or otherwise) have been considered (Refer to Chapter 2, Section 2.8 of this EIAR). The factors to be considered in relation to cumulative effects include population and human health, biodiversity, land, soil, water, air, climate, material assets, landscape, and cultural heritage as well as the interactions between these factors.

The potential cumulative effect of the Proposed Development and other relevant developments has been carried out with the purpose of identifying what influence the Proposed Development will have on the surrounding environment when considered cumulatively and in combination with relevant approved, and existing projects in the vicinity of the Site.

Further information on projects considered as part of the cumulative assessment are given in Chapter 2: Background and Policy. 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 12), visual impacts (Chapter 14) and traffic (Chapter 15).

5.9.5.1 Employment and Economic Activity

Developments considered as part of the cumulative project list that are proposed, permitted, or already existing contribute to short-term employment during the construction stages and provide the potential for long-term employment resulting from maintenance operations. This results in a long-term significant positive effect.

5.9.5.2 Tourism and Amenity

There are no key identified tourist attractions pertaining specifically to the Wind Farm Site itself. The Grid Connection underground electrical cabling route will be located within the public road network. Once operational the road corridors in which the underground electrical cabling route is located will be fully reinstated with no potential to give rise to any operational phase effects.

It is not considered that the Proposed Development together with other permitted or proposed projects and plans in the area, (wind energy or otherwise), as set out in Appendix 2-3 of this EIAR, will cumulatively affect any tourism infrastructure in the wider area. There are no existing wind farms in the surrounding area, the closest proposed wind farm development is 2.4km southeast from the Wind Farm Site. As also noted in Section 5.3 above, the conclusions from available research indicate there is a generally positive disposition among tourists towards wind development in Ireland. It is on this basis that it can be concluded that there would be a long-term imperceptible cumulative effect from the Proposed Development and other projects in the area.

5.9.5.3 Air (Dust)

The nature of the Proposed Development is such that, once operational, it will have a long-term, moderate, positive effect on the air quality.

During the construction phase of the Proposed Development, and the construction phase of the existing, permitted and proposed projects and plans (wind energy or otherwise), as set out in Appendix 2-3 of this EIAR, that are yet to be constructed, there will be minor emissions from construction plant and machinery and potential dust emissions associated with the construction activities. However, once the mitigation proposals, as outlined in Chapter 10: Air Quality are implemented during the construction phase of the Proposed Development, there will be no cumulative negative effect on air and climate.

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

5.9.5.4 Health and Safety

The Proposed Development will have a short-term potential slight negative residual effect on health and safety during the construction phase of the Proposed Development, and a long-term, imperceptible residual effect on health and safety during the operational life of the Proposed Development.. All other existing, permitted or proposed projects and plans (wind energy or otherwise), as set out in Section 2.7

in Chapter 2 of this EIAR, would be expected to follow all relevant Health and Safety Legislation during the construction, operation and decommissioning phases of the Proposed Development. It is on this basis that it can be concluded that there would be a long-term imperceptible cumulative effect from the Proposed Development and other developments in the area.

5.9.5.5 Property Values

As noted in Section 5.6 above, the conclusions from available international literature indicate that property values are not impacted by the positioning of wind farms near houses. It is on this basis that it can be concluded that there would be a long-term imperceptible cumulative effect from the Proposed Development and other potential wind farm developments in the area. It should be noted that there are no other existing wind farm developments in the area, with the closest proposed wind farm development at a distance of 2.4km from the Wind Farm Site

5.9.5.6 Services

The rate payments from the Proposed Development and other existing, permitted and proposed projects and plans (wind energy or otherwise), as set out in Appendix 2-3 of this EIAR, in the area will contribute significant funds to Tipperary County Council, which will be redirected to the provision of public services within the County. In addition, the injection of money into local services though the establishment of community benefit funds is also expected to be a long-term positive cumulative effect.

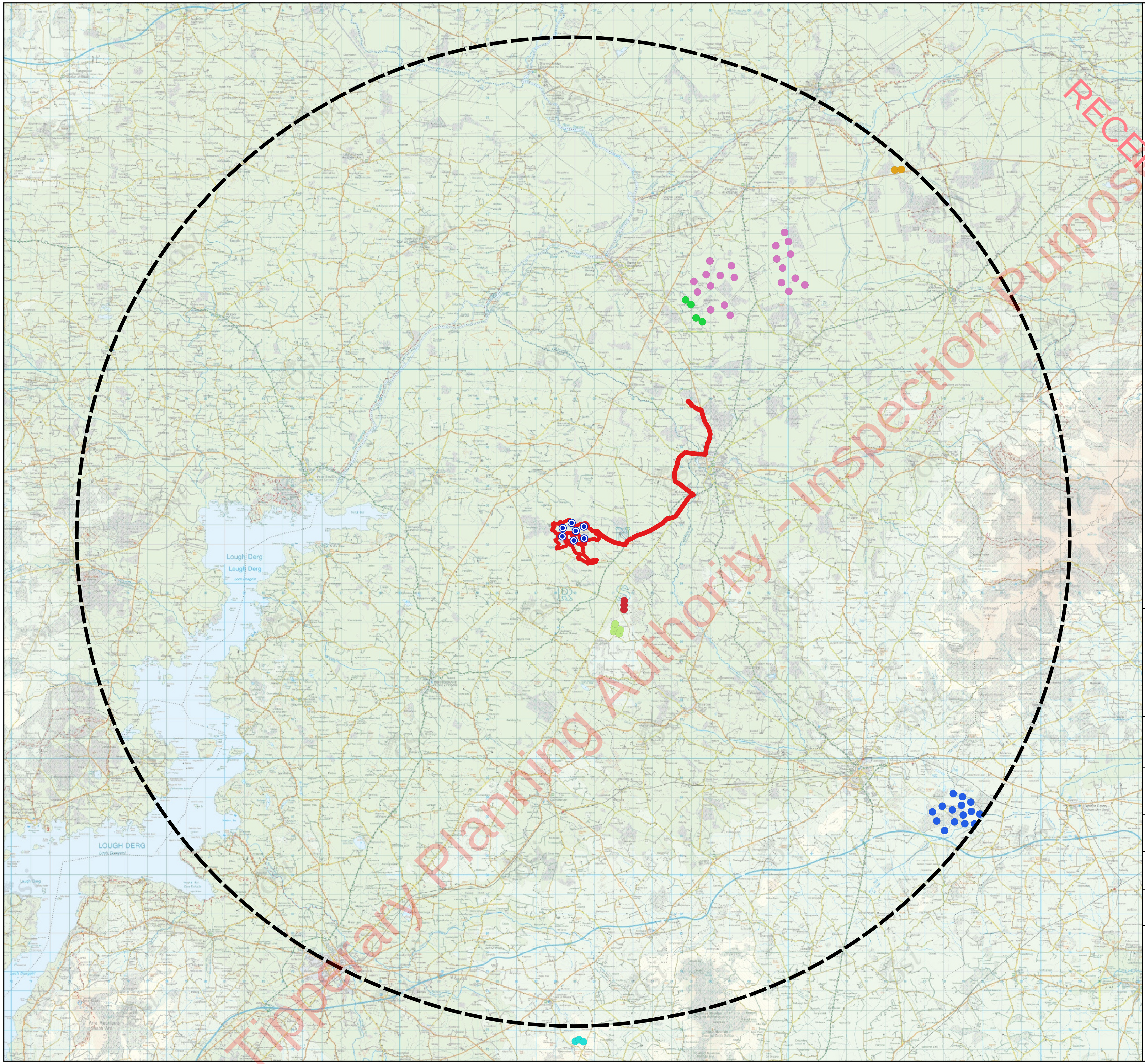
5.9.5.7 Noise

The potential for noise impacts during the construction and operational phase of the Proposed Development is assessed fully in Chapter 12: Noise.

The assessment concluded that there is no significant noise and vibration effects associated with the construction phase of the Proposed Development in combination with any other existing, permitted and proposed project and plans in the area, (wind energy or otherwise)

5.9.5.8 Shadow Flicker

There are no other existing, permitted or proposed wind farm developments within 10 rotor diameters of the Shadow Flicker Study Area for the Proposed Development as shown in Figure 5-6. Therefore, there is no potential for shadow flicker from the Proposed Development in combination with other wind farm developments.



Map Legend

- Proposed Turbine Layout (7 no. turbines)
- EIAR Site Boundary
- 25km Cumulative Study Area

Nearby Wind Farms

- Ballinlough-Ikerrin
- Carrig
- Derrinlough
- Leabeg
- Meenwuan
- Monaincha Bog
- Skehanagh
- Cloghan

N

Drawing Title	Cumulative Shadow Flicker Assessment
Project Title	Carrig Wind Farm Development
Drawn By: ER	Checked By: EMC
Project No.: 211016	Drawing No.: Figure 5-6
Scale: 1:190,000	Date: 2023-09-11

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5.9.5.9 Residential Amenity

Pre-Mitigation Effects

There are no other existing wind farm developments in the area, with the closest proposed wind farm development at a distance of 2.4 km from the Wind Farm Site. There is no potential for cumulative noise, shadow flicker and residential visual effects from the Proposed Development and other wind farm developments in the area. In the extremely unlikely event that all permitted and proposed projects listed in Appendix 2-3, other than that of wind energy developments, are constructed at the same time, there is the potential for a resulting short term, significant, cumulative, negative effect 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 740 metres of any inhabitable 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 effects on residential amenity at properties located in the vicinity of the Proposed Development works.

Residual Effect

The Proposed Development will have a short-term, slight negative effect on residential amenity during construction works. There are no other existing wind farm developments in the area, with the closest proposed wind farm development at a distance approximately 4km from the Proposed Development, and so there is no potential for cumulative noise, shadow flicker and residential visual effects from the Proposed Development and other wind farm developments in the area.

Significance of Effects

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