Planning and Environmental Consultants

Environmental Impact Assessment Report

Seskin Wind Farm, Co. Carlow

Chapter 5 – Population and Human Health

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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 Proposed Project 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 Proposed Project is provided in Chapter 4 of this EIAR.

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

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

5.2 Statement of Authority

This section of the EIAR has been prepared by Brandon Taylor and Catherine Johnson, and reviewed by Ellen Costello, all of MKO. Brandon is an Environmental Scientist with MKO with over one year of private consultancy experience. Brandon holds a BSc (Hons) in Geography from McGill University, and a MSc (Hons) in Coastal & Marine Environments from the University of Galway. Catherine is an Environmental Scientist with MKO with over one year of private consultancy experience and expertise in climate and sustainability matters. Catherine holds a BSc in Earth and Ocean Science and a LLM in Global Environment and Climate Change Law. Prior to joining MKO in 2022, Catherine worked as an Environmental Social Governance (ESG) analyst for Acasta in Edinburgh. Catherine has expertise regarding international climate law and policy, earth processes, ocean science, and sustainability/ESG. Catherine has been involved in a myriad of environmental service offerings at MKO including EIA Screenings and Reports, climate and sustainability related work and renewable energy infrastructure projects. Ellen is a Project Environmental Scientist with over four years of consultancy experience with MKO and has been involved in a number of wind energy EIAR applications including the compilation of numerous chapters and the preparation of population and human health assessments and reports for EIAs. Ellen holds a BSc. in Earth Science and a MSc. in Climate Change: Integrated Environmental and Social Science Aspects. This report has been reviewed by Sean Creedon (B.Sc., M.Sc.). Sean has 22 years' experience in planning and environmental impact elements within all stages of wind farm project delivery.

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 Carlow County Development Plan 2022 – 2028, the Kilkenny County Development Plan 2021-2027, Fáilte Ireland, and any other literature pertinent to the area. The study included an examination of the population and employment characteristics of the area. This information was sourced from the Census of Ireland 2022, which is the most recent census for which a complete dataset is available, also the Census of Ireland 2016, the Census of Agriculture 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.

In order to assess the population in the vicinity of the Proposed Wind Farm, the Population Study Area for the population section of this EIAR was defined in terms of the District Electoral Divisions (DEDs) within which the Proposed Wind Farm and is located, as well as DEDs within close proximity of the Proposed Project. The Proposed Wind Farm lies solely within the Ridge and Rathornan DEDs as shown in Figure 5-1. These DEDs will collectively be referred to hereafter as the Population Study Area for this chapter.

The Population Study Area has a total population of 729 as of 2022 and comprises a total land area of approximately 37km² (Source: CSO Census of the Population 2022).

There are 117 no. properties located within 1.55 kilometres (i.e ten rotor diameter) of any proposed wind turbine location, with 16 of those properties belonging to landowners who are participating in the Proposed Project. The closest inhabitable dwelling is located approximately 724m, from the nearest proposed turbine location (T3). There is a derelict property that is located approximately 563m from the nearest proposed turbine location (T3). Of the 48 no. properties located within 1 kilometres of the proposed turbines, 42 are inhabitable dwellings and 6 are derelict. For the shadow flicker assessment, which is further detailed in Section 5.8 below, the Shadow Flicker Study Area is defined as 10 times rotor diameter from each turbine as set out in the *'Wind Energy Development Guidelines for Planning Authorities'* (Department of the Environment, Heritage, and Local Government (DoEHLG), 2006) (hereafter referred to as DoEHLG 2006 Guidelines). The Shadow Flicker Study Area for this assessment is 1.55kms based on a maximum rotor diameter of 155m and is further detailed in Section 5.8.5 below.

In order to assess the population in the vicinity of the Proposed Grid Connection Route, a review of properties and planning applications in the vicinity of the underground electrical cabling route was carried out. There are approximately 92 no. properties located within 100m of the Proposed Grid Connection Route. The active construction area for the Proposed Grid Connection Route will be small, ranging from 150 to 300 metres in length at any one time, and it will be transient in nature as it moves along the route. Should separate crews be used during the construction phase they will generally be separated by one to two kilometres.

5.3.2 Population Trends

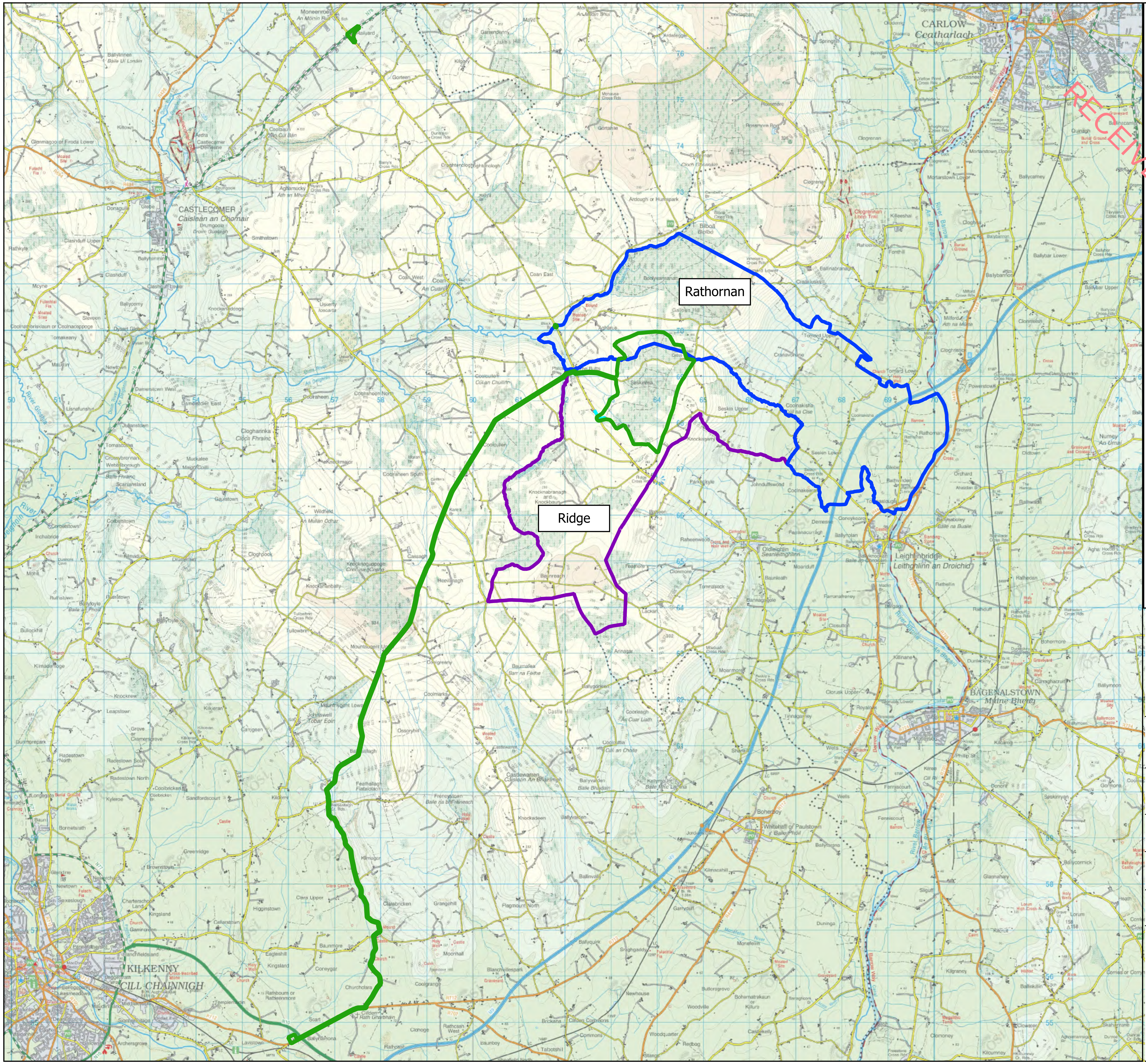
In the period between the 2016 and the 2022 Census, the population of Ireland increased by 8%. During this time, the population of County Carlow grew by 9% to 61,968 persons. Other population statistics for the State, County Carlow, and the Population Study Area have been obtained from the Central Statistics Office (CSO) and are presented in Table 5-1.

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

Area	Population Change		% Population Change
	2016	2022	2016 - 2022
State	4,761,865	5,149,139	8%
County Carlow	56,932	61,968	9%
Population Study Area	737	729	-1%

The data presented in Table 5-1 shows that the population of the Population Study Area decreased by 1% between 2016 and 2022. This decrease was not in line with the population growth seen for Ireland and County Carlow (8 % and 9% respectively). When the population data is examined in closer detail, it shows that the rate of population increase within the Population Study Area differs between both DEDs comprising the Population Study Area. The Ridge DED increased its population by 2% to 298 persons from 292 persons while the Rathornan DED decreased its population by 3% from 445 persons to 431 persons.

This overall decrease observed within the Population 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.



Map Legend

EIAR Site Boundary

Seskin DEDs
- Ridge
- Rathornan

Drawing Title: Population Study Area	
Project Title: Seskin Wind Farm, Co. Carlow	
Drawn By: CJ	Checked By: EC
Project No.: 220246	Drawing No.: Figure 5-1
Scale: 1:80,000	Date: 2024-01-18

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5.3.3 Population Density

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

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

Area	Population Density (Persons per square kilometre)		% change in Population Density
	2016	2022	2016-2022
State	67.76	73.27	+8%
County Carlow	63.47	69.08	+9%
Population Study Area	19.92	19.70	-1%

The population density of the Population Study Area recorded during the 2022 Census was 19.70 persons per km^2. This figure is lower than the national population density of 73.27 persons per km^2 and the County Carlow population density of 69.08 persons per $km^{2.}$ These findings indicate that the Population Study Area has a low population density.

Similar to the trends observed in Section 5.3.3 above, the population density recorded across the Population Study Area varies between DEDs. Ridge DED has a lower population density, at 17.18 persons per km^2 and Rathornan DED has a higher population density, at 22.25 persons per km^2. Both DEDs comprising the Population Study Area have population densities significantly lower than the State and County.

5.3.4 Household Statistics

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

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

Area	2016		2022	
	No. of Households	Avg. Size (persons)	No. of Households	Avg. Size (persons)
State	1,702,289	2.75	1,841,152	2.74
County Carlow	20,537	2.76	22,238	2.77
Population Study Area	217	3.18	227	3.08

In general, the figures in Table 5-3 show that the number of households within the State and County has increased from 2016 to 2022. The number of households in the Population Study Area has also increased slightly, however, the average size of the household from 2016 to 2022 decreased slightly from 2.75 persons per household to 2.74 persons per household. Average household size recorded within the Population Study Area during the 2022 Census is above both the County and State level. Similar to the trends observed above, the average household size recorded across the Population Study Area varies between DEDs. The Rathornan DED had 2.93 persons per household recorded in 2022, and the Ridge DED had 3.30 persons per household. The number of private households in Co. Carlow has increased to 22,238 in 2022 from 20,537 in 2016, with the average number of persons in a private household also having increased.

5.3.5 Age Structure

Table 5-4 presents the population percentages of the State, County Carlow, and the Population Study Area within different age groups as defined by the Central Statistics Office during the 2022 Census. This data is also displayed in Figure 5-2.

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

Area	Age Category				
	0 - 14	15 – 24	25 - 44	45 - 64	65 +
State	19.7%	12.5%	27.6%	25.1%	15.1%
County Carlow	19.9%	13.1%	26.5%	25.5%	15.0%
Population Study Area	16%	14%	19%	31%	20%

The proportion of the Population Study Area population is broadly similar to those recorded at national and county level for most categories, expect for the age category of 45-65 and 65+ where the Population Study Area population percentage is 31% and 20%, respectively. For the Population Study Area, the highest population percentage occurs within the 45-64 age category (Figure 5-2). This age category would be considered to be less sensitive to change when compared to other age categories. The lowest population percentage within the Population Study Area occurs within the 15-24 range age category, at 14%. This is higher than both the State and County population percentages, with this age category being considered one of the more sensitive age categories to change. The age category results of the Population Study Area correspond with the trend of younger generations leaving rural areas to move to urban areas with greater education and employment opportunities.

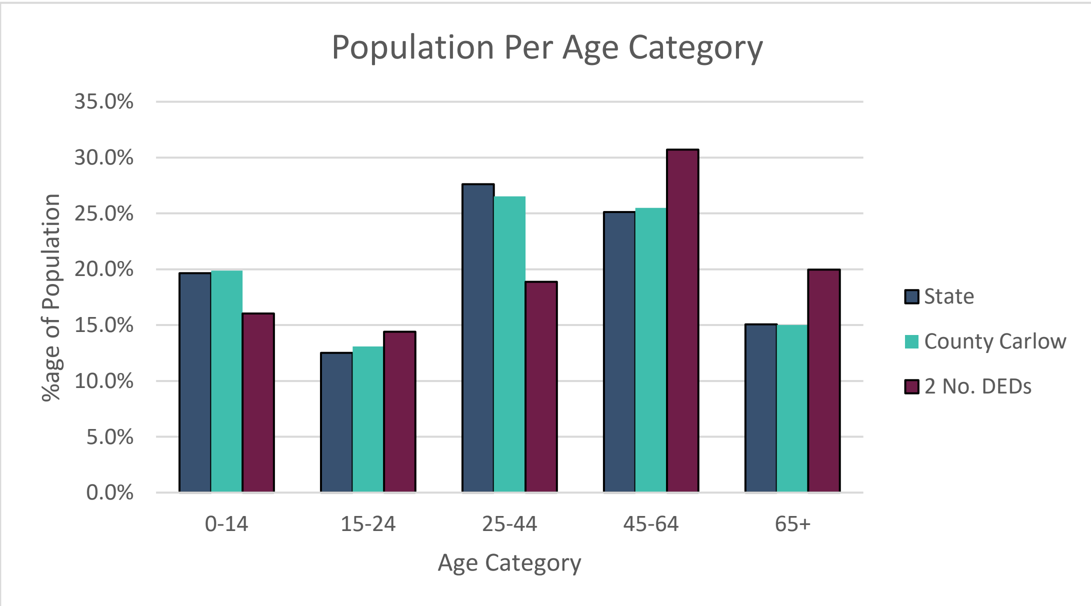

Figure 5-2 Population per Age Category in 2022 (Source: CSO)

5.3.6 Employment and Economic Activity

5.3.6.1 Economic Status of the Population Study Area

The labour force consists of those who are able to work, i.e., those who are aged 15+, out of full-time education and not performing duties that prevent them from working. In 2022, there were 2,320,297 persons in the labour force in the State. Table 5-5 shows the percentage of the total population aged 15+ who were in the labour force during the 2022 Census. This figure is further broken down into the percentages that were at work or unemployed. It also shows the percentage of the total population aged 15+ who were not in the labour force, i.e., those who were students, retired, unable to work or performing home duties.

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

Status		State	County Carlow	Population Study Area
% of population aged 15+ who are in the labour force		**61%**	**60%**	**54%**
% of which are:	At work	92%	91%	94%
	Looking	1%	1%	1%
	Unemployed	7%	8%	5%
% of population aged 15+ who are not in the labour force		**39%**	**40%**	**46%**
% of which are:	Student	29%	28%	30%
	Home duties	17%	19%	16%
	Retired	41%	38%	40%
	Unable to work	12%	14%	13%
	Other	2%	1%	1%

Table 5-5 illustrates that the percentage of the Population Study Area population within the labour force is lower than the State and County average. The largest percentage of the Population Study Area population falls within the Retired category and there are higher levels of Student and those who are At Work than reported in the State and County populations. The Population Study Area returned lower levels of those aged 15+ in the Unemployed, Home Duties, Unable to Work and Other categories. These results correlate to the Age Category breakdown and population summaries as discussed above.

5.3.6.2 Employment and Investment Potential in the Irish Wind Energy Industry

5.3.6.2.1 *Background*

A report entitled '*Jobs and Investment in Irish Wind Energy – Powering Ireland's Economy*'[1] 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

5.3.6.2.2 *Energy Targets*

The Climate Action Plan 2024 (CAP 2024) was published on the 20th of December 2023 by the Department of Communications, Climate Action, and Environment. CAP 2024 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. CAP 2024 reaffirms the commitment announced in Climate Action Plan 2023 that 80% of Ireland's electricity needs will come from renewable sources by 2030 and a target of 9 GW from onshore wind, 8 GW from solar, and at least 5 GW of offshore wind energy by 2030. It is envisaged that wind energy will provide the largest source of renewable energy in achieving this target.

5.3.6.2.3 *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

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[1] *Deloitte, Irish Wind Energy Association 2009 Jobs and Investment in Irish Wind Energy Powering Ireland's Economy. Available at:* https://windenergyireland.com/images/files/9660bd5e72bcac538f47d1b02cc6658c97d41f.pdf

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 support further employment.

The Sustainable Energy Authority of Ireland (SEAI)[2] demonstrates in their '*Wind Energy Roadmap 2011-2050*', that '*the wind energy resource represents a significant value to Ireland by 2050. This value is presented in terms of its ability to contribute to our indigenous energy needs, the benefits of enhanced employment creation and investment potential, and the ability to significantly abate carbon emissions to 2050.*' Furthermore, onshore, and offshore wind could create 20,000 direct installation and operation/maintenance jobs by 2040 and that the wind industry would also have an annual investment potential of €6-12 billion by the same year.

The 2014 report '*The Value of Wind Energy to Ireland*'[3], 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'*[4]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*'[5] details various scenarios in Europe in respect to the EU target for renewable energy. According to the 2022 WindEurope 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.'*

Irelands installed capacity for wind generation at the end of 2022 was 4.54GW[6]. The SEAI provides a provisional estimate of installed wind energy capacity in 2023 based on EirGrid data to the end of August and ESBN data to the end of September; the provisional value of installed wind capacity in Ireland in 2023 is 4.59GW.[7] The majority of the Republic of Ireland's installed wind energy capacity is located in Counties Mayo, Galway, Cork, and Kerry.

[2] *Sustainable Energy Authority Ireland (2019), https://www.seai.ie/publications/Wind_Energy_Roadmap_2011-2050.pdf*
[3] *Poyry The Value of Wind Energy to Ireland – March 2014*
[4] *WindEurope (2017) Wind Energy in Europe Scenarios for 2030 <https://windeurope.org/wp-content/uploads/files/about-wind/reports/Wind-energy-in-Europe-Scenarios-for-2030.pdf>*
[5] *WindEurope (2022) Wind Energy in Europe 2021 Statistics and the Outlook for 2022-2026 <https://windeurope.org/intelligence-platform/product/wind-energy-in-europe-2021-statistics-and-the-outlook-for-2022-2026/>*
[6] *Sustainable Energy Authority Ireland (2024) Energy in Ireland – 2023 Report*
[7] *Ibid.*

5.3.6.2.4 Economic Value

The 2009 Deloitte report, in conjunction with the Irish Wind Energy Association (now Wind Energy Ireland, WEI), entitled '*Jobs and Investment in Irish Wind Energy – Powering Ireland's Economy*'[8] 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 2009 Deloitte 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*'[9], 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 Project will, if consent is granted, contribute to the economic value that renewable energy brings to Ireland by reducing the reliance of fossil fuels in Ireland and assist in meeting our renewable energy targets as set out by the EU and in the National Climate Action Plan.

5.3.7 Land-Use

The land-use/activities within the Proposed Wind Farm comprises coniferous forestry and agriculture. Current land-use along the Proposed Grid Connection Route comprises of public road corridor, public open space, pastures, coniferous forestry, and land principally used for agriculture with significant areas of natural vegetation. Land-use in the wider landscape of the site comprises a mix of agriculture, peat cutting, quarrying, low density residential and commercial forestry.

There is 1 no. operational wind farm in Carlow to date. The nearest operational wind farm is Gortahile Wind Farm (PL Ref. 04/935), located approximately 3.1km north of the Proposed Wind Farm in County Laois. The nearest operational wind farm in County Carlow is Greenoge Wind Farm, approximately 24.6km southeast of the Proposed Project. The permitted Bilboa Wind Farm is located

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[8] *Deloitte, Irish Wind Energy Association 2009 Jobs and Investment in Irish Wind Energy Powering Ireland's Economy. Available at:* https://windenergyireland.com/images/files/9660bd5e72bcac538f47d1b02cc6658c97d41f.pdf

[9] *Baringa (2019) Wind for a Euro: Cost Benefit Analysis of Wind Energy in Ireland 2000-2020* <https://www.baringa.com/en/insights/low-carbon-futures/our-market-and-policy-studies-in-ireland/wind-for-a-euro/>

in County Carlow and is approximately 1.2km north of the Proposed Wind Farm. The permitted White Hills Wind Farm is located in County Carlow and County Kilkenny and is approximately 2.5km southwest of the Proposed Wind Farm.

5.3.7.1 Equine Industry

1 no. stud farm or equestrian facilities was identified within 10km of the Proposed Wind Farm, Ballyhane Stud is located 5.9km to the southeast of the nearest Proposed Wind Farm turbine (T05).

There have been no known studies carried out in Ireland on the impacts of wind farms on the equine industry. In 2014 Marshall Day Acoustics published a document entitled *'Summary of research of noise effects on Animals'*.[10] The Marshall Day study specifically assessed the impacts of varying levels of noise on horses in three differing behavioural settings. The three behavioural settings studied included horses in stables, breeding mares and racing horses.

Horses in Stables

The study by Marshall Day Acoustics found that horses, stabled at the Flemington Racecourse Australia at the same time as a music concert on the site, when exposed to $L_{Aeq,15min}$ of 54-70 dB showed little response to the music noise unless the noise was particularly impulsive. The horses stabled at Flemington Racecourse were thoroughbreds, and stables were located 200 metres from the concert.

Breeding Mares

A study by Le Blanc et al (1991) and summarised by Marshall Day studied the effects of simulated aircraft noise over 100 dB and visual stimuli on pregnant mares. The study focused on pregnancy success, behaviour, cardiac function, hormonal production, and rate of habitation. Le Blanc concluded the following:

> *'Le Blanc et al (1991) found that birth success of pregnant mares was not affected by F-14 jet aircraft noise. While the 'fright-flight' reaction was initially observed, the mares did adapt to the noise.'*

Racehorses

Marshall Day Acoustics concluded the following in relation to their study on the impacts of noise on racehorses:

> *'Marshall Day Acoustics have observed horses grazing in paddocks directly under the main approach path of the Christchurch International Airport where noise levels are in excess of 90 dB (LAmax) during an aircraft flyover. Although these horses are arguably "used to" the noise, there was generally little recognition by them of an aircraft passing, let alone any sign of disturbance. This tends to support the conclusions by Le Blanc et al (1991).'*

5.3.7.1.2 *Guidance*

In the absence of national policy or guidance in relation of the development of wind farms near stud farms/equestrian centres, MKO have reviewed the British Horse Society's *'Advice on Wind Turbines*

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[10] *Marshall Day Acoustics (2014) Summary of Research of Noie Effects on Animals <https://www.epa.govt.nz/assets/FileAPI/proposal/NSP000033/Hearings/3a009a795c/BoD-Volume-4-31-Siiri-Wilkening-10-March-2014-Summary-of-research-of-noise-effects-on-animals.pdf>*

and Horses – Guidance for Planners and Developers'. A copy of the guidance document is included in Appendix 5-3 of this EIAR.

The British Horse Society policy statement states the following in relating to the siting of wind turbines in the vicinity of equine businesses:

> *'The British Horse Society strongly recommends that the views and concerns of local equestrians should be recognised and taken into account when determining separation distances and that normally a minimum separation distance of 200m or three times blade tip height (whichever is greater) will be required between a turbine and any route used by horses or a business with horses.'*

On a precautionary basis, i.e., under the assumption that every inhabitable dwelling owns a horse or horses, the closest inhabitable dwelling is located approximately 724 metres (over four-times blade tip height) from the nearest proposed turbine location. As mentioned previously, the closest stud farm/equestrian facility is located approximately 5.9km from the nearest Proposed Wind Farm turbine (T05). In this instance, the proposed turbines are at a distance beyond that of the British Horse Society's recommended minimum separation distance of 200 metres as noted above. In this instance, the minimum separation distance from proposed turbines exceeds the 540 metres separation distance (based on three times the turbine blade tip height of up to 180 metres) between a turbine and any business with horses.

5.3.8 Services

The Proposed Wind Farm is located approximately 3.1 km northwest of the village of Oldleighlin, Co. Carlow, 5km northwest of Leighlinbridge, Co. Carlow, and 9.9 kilometres southeast of Castlecomer, Co. Kilkenny. Kilkenny town centre is located approximately 5.2km to the northeast of the grid connection terminus at the existing Kilkenny 110kV substation.

The main services for the Population Study Area are located within Carlow Town, 19.6 kilometres northeast of the Proposed Wind Farm, which is classified as a county town, and in Castlecomer Co. Kilkenny and Leighlinbridge Co. Carlow, located approximately 9.9km northwest of the Proposed Project and 5km southeast of the Proposed Wind Farm respectively. Both are classified as service towns. Other settlement centres in the wider region which provide retail, recreational, educational, and religious services include Oldleighlin, 3.1km to the southeast of the Proposed Wind Farm.

5.3.8.1 Education

The nearest school to the Proposed Project is the Scoil Bhride, Ardough National School, a two-teacher school located in County Laois, located approximately 2.5km north of the nearest Proposed Wind Farm turbine (T02). Scoil Molaise is located approximately 2.8km southeast of the Proposed Wind Farm. St. Leos College is located approximately 10.7km to the northeast of the Proposed Wind Farm.

The closest third-level institute to the Proposed Project site is Carlow College, St. Patricks which is located approximately 17.6km to the southwest of the Proposed Wind Farm. The primary school located closest to the Proposed Grid Connection Route is the Johnswell National School, which is located adjacent to the Proposed Frid Connection Route along the local L2627 road. The closest Secondary School to the Proposed Grid Connection Route is Kilkenny College which is approximately 4.6km to the northwest of the Proposed Grid Connection Route at its closest point. The National University of Maynooth – Kilkenny Campus is the closest third level institution to the Proposed Grid Connection Route, located 5.6km to the west.

5.3.8.2 Access and Public Transport

It is proposed to access the Proposed Project site during both the construction and operational phase via an existing agricultural site entrance off the L3037 local road along the western boundary of the Proposed Project site in the townland of Ridge. This entrance will be widened to facilitate the delivery of the construction materials and turbine components. From the main site entrance, construction traffic will access Turbine No. 1 and Turbine No. 2 at the northernmost section of the Proposed Project site via two access junctions at the same location on the L30372 local road; one is an existing access junction on the northern side of the L30372 local road and the other is a proposed access junction on the southern side of the L30372. These two access junctions are located where the Proposed Project internal site road network interacts with the L30372 local road. At this location, these junctions will provide access to the northernmost section of the site (Turbine No. 1 and Turbine No. 2) during the construction and operational stages of the Proposed Project, in the unlikely event of the delivery of a replacement turbine component or other abnormal load required for the operational maintenance of the wind farm.

The Proposed Grid Connection Route is approximately 20.1km in length. The Proposed Grid Connection Route can be accessed via the local roads that run adjacent to it, i.e., the L30371 and the L2627, as well as the R712 Regional Road. No bus routes service the Proposed Grid Connection Route.

The nearest train station to the Proposed Project site is the Muine Bheag (Bagenalstown) train station 9km southeast of the Proposed Wind Farm site along the Dublin – Waterford rail line. The nearest bus route that services the Proposed Wind Farm site is the Bus Eireann 4 Waterford Service, which stops at Seskin Road in Leighlinbridge.

5.3.8.3 Amenities and Community Facilities

There are a number of amenities and community facilities, including sports clubs, youth clubs, recreational areas, retail, and personal services located in the nearby villages of Leighlinbridge, Ballinabrannagh and Castlecomer. The towns of Kilkenny and Carlow also offer a large selection of amenities and community facilities. There are a number of GAA clubs in the areas surrounding the Proposed Project, some of which are the Oldleighlin GAA Club, Leighlinbridge GAA Club, Clara GAA Club (located adjacent to the existing Kilkenny 110kV substation) and Erin's Own (Kilkenny) GAA Club.

The varied environment of this area of County Carlow and County Kilkenny provide many opportunities for walking, cycling, and playing golf. Castlecomer Golf Club is located approximately 7.9 kilometres to the west of the Proposed Project at its closest point along the Proposed Grid Connection Route.

The Barrow Way, which caters for walkers and cyclists stretches from Mullingar to Athlone. The track along the Barrow starts at Lowtown, Co. Kildare and ends at St. Mullins, Co. Carlow and is approximately 7.5 kilometres to the east of the Proposed Wind Farm.

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

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*[11]). 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 South-East Region, in which the Proposed Project site is located, comprises Counties Carlow, Kilkenny, South Tipperary, Waterford and Wexford. This Region benefited from approximately 5% of the total number of overseas tourists to the country and approximately 6% 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*)[12]. There is no published County by County tourism breakdown for 2018 to 2022 to date). As can be observed, County Carlow had a tourism revenue of at €273 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)
Carlow	273	79
Kilkenny	613	315

[11] *Fáilte Ireland (2021) Key Tourism Facts 2019*
<https://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/4_Visitor_Insights/KeyTourismFacts_2019.pdf?ext=.pdf>

[12] *2017 Topline Tourism Performance By Region, Fáilte Ireland, August 2018 .*
https://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/2_Regional_SurveysReports/2017-topline-regional-performance-(003).pdf?ext=.pdf

Tipperary (South)	387	139
Waterford	582	255
Wexford	886	232

5.4.1.1 Tourist Attractions

There are no identified tourist attractions pertaining specifically to the site of the Proposed Project itself. The varied natural landscape and scenic amenity of this area provide many opportunities for general outdoor recreation within the wider area. County Carlow has a number of views, prospects, and scenic routes, which are identified for protection in the Carlow County Development Plan 2022-2028.[13] These include views to and from upland areas, views of heritage features, and views along river corridors.

The nearest tourist centres to the Proposed Project site are located approximately 9.8km to the northwest of the Proposed Project in Castlecomer, Co. Kilkenny and 10.2km km to the northeast of the Proposed Project in Carlow, Co. Carlow. Tourist attractions within these centres include gardens, museums, art collections and galleries, farmers markets and food outlets, heritage sites, breweries, historical sites, and touring routes to other tourism activities in Ireland.

Key tourist attractions within County Carlow include St Laserian's Cathedral, Carlow Castle, Carlow Cathedral, the Carlow Garden Trail, and the Barrow Way. Many additional tourist attractions are found in adjacent counties such as Kilkenny in County Kilkenny and Athy in County Laois.

The Discover Ireland website (www.discoverireland.ie) lists the following attractions with relation to the Proposed Project site:

- St. Laserian's Cathedral, Co. Carlow, located approximately 3.2km to the southeast of the Proposed Wind Farm.
- Arboretum Inspirational Gardens, Co. Carlow, located approximately 5.3km to the southeast of the Proposed Wind Farm.
- Dunmore Caves, Co. Kilkenny, located approximately 7.4km the west of the Proposed Grid Connection Route
- Duckett's Grove, Co. Carlow, located approximately 18.6km to the northeast of the Proposed Wind Farm.
- Altamont Gardens, Co. Carlow, located approximately 22.5km to the southeast of the Proposed Wind Farm.

The Carlow County Development Plan 2022-2028 lists the following attractions with relation to the Proposed Project site:

- Carlow Castle, located approximately 10.4km to the northeast of the Proposed Wind Farm
- Carlow Garden Trail, located approximately 10.8km to the northeast of the Proposed Wind Farm.
- Ballymoon Castle, located approximately 12km to the southeast of the Proposed Wind Farm .
- Ballyloughan Castle, located approximately 14.5km to the southeast of the Proposed Wind Farm .

[13] Carlow County Council (2022) Carlow County Development Plan 2022-2028. Available at: https://consult.carlow.ie/en/consultation/carlow-county-development-plan-2022-2028/chapter/chapter-11-tourism-and-recreation

The Kilkenny City and County Development Plan 2022-2028[14] lists a myriad of attractions for County Kilkenny, however all listed attractions are over 25km from the Proposed Project site.

Further tourism assets located up to 5km away from the Proposed Wind Farm site as listed in Chapter 14 are as follows:

- 1798 Monument:
- Clogrennane Woods:

Further tourism assets located 5-10km away from the Proposed Wind Farm site as listed in Chapter 14 are as follows:

- Rossmore Gravel Walk:
- Oisin Park:
- Barrow Way:
- Milford Mill:
- Shankhill Castle:

Further tourism assets located 10-15km away from the Proposed Wind Farm site as listed in Chapter 14 are as follows:

- Oak Park Loop:
- Arboretum Loop:
- Brownshill Portal Dolmen:
- Ballymoon Castle:
- Ballyloughan Castle:
- Clara Castle:
- Dunmore Cave:
- Castlecomer Discover Park:

Further tourism assets located 15-20km away from the Proposed Wind Farm site as listed in Chapter 14 are as follows:

- Jenkinstown Wood Loop
- Duckets Grove:
- Ducket's Grove Gate Lodge
- Ballykealy House:
- Ballytiglea Bridge:
- Kilkenny Castle
- Levitstown Mill

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'*[15], 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

[14] *Kilkenny County Council (2021) Kilkenny City and County Development Plan 2021-2027. Available at: https://www.kilkennycoco.ie/eng/services/planning/development-plans/city-and-county-development-plan/adopted-city-and-county-development-plan.html*

[15] *BiGGAR Economics (2016) Wind Farms and Tourism Trends in Scotland <https://biggareconomics.co.uk/wp-content/uploads/2021/11/BiGGAR-Economics-Wind-Farms-and-Tourism-2021.pdf>*

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 saws 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'*.[16]

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 10 no. turbines and 15% had less than 5 no. 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."*

[16] *Fáilte Ireland (2008) Visitor Attitudes on the Environment – Wind Farms* <https://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/4_Visitor_Insights/Visitor-Attitudes-on-the-Environment.pdf?ext=.pdf>

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

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

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

The report goes on to state that while there is a generally positive disposition among tourists towards wind development in Ireland, it is important also to take account of the views of the one in seven tourists who are negatively disposed towards wind farms. This requires good planning on the part of the wind farm developer as well as the Local Authority. Good planning has been an integral component of the Proposed Project throughout the site design and assessment processes. Reference has been had to the DoEHLG 2006 Guidelines and the DoEHLG's '*Draft Revised Wind Energy Development Guidelines'* released in December 2019 (hereafter referred to as Draft DoEHLG 2019 Guidelines) 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 Authority of Ireland Surveys on Opinions Towards Wind Farms

5.5.1.1 Irish National Survey of Households Near New Commercial Wind and Solar Farms

5.5.1.1.1 *Background*

In May 2023 the Sustainable Energy Authority of Ireland (SEAI) published a report on the national survey they commissioned of people's opinions of new commercial solar or wind farm projects in

Ireland.[17] In 2022, surveyors conducted in-person interviews on the doorstep across rural Ireland. The survey included 1,764 households which included 1,116 households within 5km of a new commercial wind or solar project sites, of which 219 live within 1km of a project site.

Findings

The results of this survey revealed that 67% of respondents hold positive or very positive views towards wind energy, while 73% of respondents who live less than 1km away from a Renewable Electricity Support Scheme (RESS) wind project hold positive or very positive attitudes towards wind energy, while 70% of those in the control group hold such views.

The attitude of the residents toward wind energy showed that 59% of all respondents, and 65% of respondents living less than 1km away from a RESS wind project, felt Ireland has too few wind farms, the same proportion as the control group. A few respondents feel Ireland has too many wind farms, regardless of how close they live to a new wind farm.

The results of this survey will form part of a long-term study to understand the effects of government policies under the RESS on the publics support for Irelands energy transition.

5.5.1.2 Sustainable Energy Ireland Survey 2003

5.5.1.2.1 *Background*

The first wind farm in Ireland was completed in 1992 at Bellacorrick, Co. Mayo, by mid-2007 there were 67 wind farms and in 2024 there are almost 400 wind farms on the island of Ireland. Since 1992 wind farms have elicited a range of reactions from the Irish people.[18] In response, the SEAI (formerly SEI) commissioned a survey aimed at identifying public attitudes to renewable energy and to wind energy in Ireland.[19] The results of which were published in 2003 as a national survey entitled 'Attitudes Towards the Development of Wind Farms in Ireland'. A catchment area survey was also carried out by to focus specifically on people living with a wind farm in their locality or in areas where wind farms are planned.

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:

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[17] *SEAI Irish national survey of households near new commercial wind and solar farms. Available at: <https://www.seai.ie/publications/SEAI-RESS-National-Survey.pdf>*
[18] *Fáilte Ireland (2008) Visitor Attitudes on the Environment – Wind Farms. Available at: https://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/4_Visitor_Insights/Visitor-Attitudes-on-the-Environment.pdf?ext=.pdf*
[19] *Ibid.*

> *"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.

5.5.1.2.2 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 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.

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."

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

5.5.2.1 Background

A survey of the public perception of wind power in Scotland and Ireland was carried out in 2003/2004 by researchers at the School of Geography & Geosciences, University of St. Andrews, Fife and The Macaulay Institute, Aberdeen *('Green on Green: Public Perceptions of Wind Power in Scotland and Ireland'*, Journal of Environmental Planning and Management, November 2005)[20]. The aims of the study were to ascertain the extent to which people support or oppose wind power, to investigate the reasons for these attitudes and to establish how public attitudes relate to factors such as personal experience of operational wind farms and their proximity to them.

5.5.2.1.1 *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 proximity.

5.5.2.1.2 *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

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[20] *Green on Green: Public Perceptions of Wind Power in Scotland and Ireland', Journal of Environmental Planning and Management, November 2005*
<https://www.researchgate.net/publication/227619753_'Green_on_Green'_Public_Perceptions_of_Wind_Power_in_Scotland_and_Ireland>

> *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.

Conclusions

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

5.5.3 IWEA Interactions Opinion Poll on Wind Energy 2023

In early 2023, Wind Energy Ireland (WEI) published the results of their most recent nationwide annual poll on attitudes to wind energy, the Public Attitudes Monitor.[21] The objective of the poll was to '*measure and track public perceptions and attitudes around wind energy amongst Irish adults.*'

Between 23rd November and 8th December 2022, a nationally representative sample of 1,017 Irish adults together with a booster sample of 201 rural residents participated in the survey. The 2022 results reported that 4 in 5 (80%) are now in favour of wind power which is a 6% increase on the 2021 results (54% of those in favour were 'strongly in favour'). Amongst rural residents, 4 in 5 (85%) were recorded as having favourable attitudes towards wind power. The survey has been run annually since 2017 and while there has been a marginal decrease in those in favour of wind power nationally during this time (from 85% to 80%) there has been an increase in those in favour from the rural population (from 79% to 85%).

Amongst those in favour of wind power, the majority cited the fact that Ireland was a windy country with a readily available renewable resource and environmental and climate concerns as their main

[21] https://windenergyireland.com/about-wind/more-resources/annual-wind-survey

reasons for supporting such developments. Other reasons cited for supporting wind energy developments include: 'free/cheap/costs less', 'reliable/efficient', 'economy/jobs', and view that it as a 'safe resource'.

When questioned about wind energy developments in their local area, 58% of the nationally representative sample either 'favour' or 'tend to favour' such proposals compared to 56% of the rural population reporting the same.

The Wind Energy Ireland 2023 survey follows the structure of previous national opinion polls on wind energy undertaken since 2017. The 2023 survey results are consistent with previous year's figures and thus indicate that approximately 4 out of 5 Irish adults have continued to support wind energy in recent years.

5.6 Human Health

5.6.1 Health Impacts of Wind Farms

5.6.1.1 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 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*[22]

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*[23]

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

[22] http://psew.pl/en/wp-content/uploads/sites/2/2017/01/3b041e47d7f8029dfc10fee7d3249721.pdf
[23] https://www.novoco.com/public-media/documents/awea_soundwhitepaper_121109_0.pdf

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*[24]

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)*[25]

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:

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[24] https://www.agl.com.au/content/dam/digital/agl/documents/about-agl/how-we-source-energy/coopers-gap-wind-farm/20100701-agl-nhmrc-wind-turbines-and-health.pdf

[25] https://www.agl.com.au/content/dam/digital/agl/documents/about-agl/how-we-source-energy/coopers-gap-wind-farm/caha-position-statement-health-wind-turbines.pdf

> *"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)*[26]

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.*

[26] https://www.mass.gov/doc/wind-turbine-health-impact-study-report-of-independent-expert-panel/download

> *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)*[27]

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*[28]

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

[27] https://pubmed.ncbi.nlm.nih.gov/25376420/
[28] https://www.lenus.ie/bitstream/handle/10147/621467/HSE+PHMEHG+Wind+Final+PP+Feb+2017.pdf;jsessionid=81891AFF3092083294E44EF5D4C8658E?sequence=3

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.*[29]

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 increased 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.

9. ***The Health Effects of 72 Hours of Simulated Wind Turbine Infrasound: A Double-Blind Randomized Crossover Study in Noise-Sensitive Health Adults'*** *Woolcock Institute for Medical Research, New South Wales, Australia*[30]

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

- All staff and participants were asked whether they were able to differentiate in any way between infrasound and sham infrasound (the control), and none of them were able to.

[29] https://www.who.int/europe/publications/i/item/9789289053563
[30] https://pubmed.ncbi.nlm.nih.gov/36946580/

- The study found that 72 hours of the simulated wind turbine infrasound (~90dB pk re 20 µPa) in controlled laboratory conditions did not worsen any measure of sleep quality compared with the same speakers being present but not generating infrasound (sham infrasound).
- The study found no evidence of that 72 hours of exposure to a sound level of ~90dB pk re 20 µPa of simulated wind turbine infrasound in double-blind conditions perturbed any physiological or psychological variable.
- None of the participants in the study who were exposed to infrasound developed what could be described as Wind Turbine Syndrome.
- This study suggests that the infrasound component of Wind Turbine Syndrome is unlikely to be a cause of any ill-health or sleep disruption, although this observation should be independently replicated.

5.6.2 Turbine Safety

Turbines pose no threat to the health and safety of the general public. The DoEHLG 2006 Guidelines 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 2006 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. As such, turbines are designed in such a way that ice throw/projection is not a significant risk. Furthermore, the Proposed Project site (and the State) falls within the International Energy Agency (IEA) Ice Class 1 category[31], which correlates to a **low** icing frequency.

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

5.6.3 Electromagnetic Interference

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

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

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[31] *Wind Power Icing Atlas (WIceAtlas) – IEA Ice Class 1 Category for Ireland (map). Available at:* *https://vtt.maps.arcgis.com/apps/instant/minimalist/index.html?appid=6d93b5e284104d54b4fb6fd36903e742*

The ESB document 'EMF & You' (ESB, 2017) provides further practical information on EMF.[32] Further details on the potential impacts of electromagnetic interference to telecommunications and aviation are presented in Section 15.2 of this EIAR.

5.6.4 Assessment of Effects on Human Health

As set out in the Department of Housing, Planning, Community and Local Government '*Key Issues Consultation Paper on the Transposition of the EIA Directive 2017'*, the consideration of the effects on populations and on human health should focus on health issues and environmental hazards arising from the other environmental factors, for example water contamination, air pollution, noise, accidents, disasters. The EPA Guidelines 2022 reiterates that the EIAR should assess the potential impacts on population & human health under the environmental categories addressed elsewhere in the EIAR such as air, water and soil and other health and safety issues as relevant.

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 Water, Chapter 10 Air Quality, Chapter 11 Climate, Chapter 12 Noise and Vibration and Chapter 15 Material Assets (Roads and Traffic) provide an assessment of the effects of the Proposed Project on these areas of consideration. There is the potential for negative effects on human health during the wind farm construction phase related to potential emissions to air of dust, potential emissions to land and water of hydrocarbons, release of potentially silt-laden runoff into watercourses and noise emissions. The assessments show that the residual effects 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 Project is imperceptible.

The Proposed Project 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 wells in the lands surrounding the Proposed Project site 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 Project site.

The preliminary Flood Risk Assessment (Appendix 9-1 of this EIAR) has also shown that the risk of the Proposed Project contributing to downstream flooding is also very low.

Once operational, the Proposed Project, will contribute to the offsetting of carbon emissions associated with the burning of fossil fuels. During the operational stage, the Proposed Project will have a long term moderate positive effect on air quality as set out in Chapter 10 which will contribute to a long term slight positive effect on human health.

5.6.5 Vulnerability of the Proposed Project to Natural Disaster

An assessment of the Proposed Project vulnerability to natural disasters can be found in Chapter 16 of this EIAR. A brief discussion can be found below.

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[32] https://esb.ie/docs/default-source/default-document-library/emf-public-information_booklet_v9.pdf?sfvrsn=0)

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

There is limited potential for significant natural disasters to occur at the Proposed Project site. Ireland is a geologically stable country with a mild temperate climate. The potential natural disasters that may occur are therefore limited to flooding, fire, and landslide events. The risk of 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 Project site 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 5.6.2 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 Proposed Project 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. The nearest SEVESO sites to the Proposed Project site are Grassland Fertilises (Kilkenny) Ltd. located 21.9km to the southwest of the Proposed Wind Farm site.

5.7 Property Values

There is currently only one study within the context of Ireland detailing the effect of wind farms on property values. This section provides a summary of this paper by the Centre for Economic Research on Inclusivity and Sustainable (CERIS), as well as summaries on the largest and most recent studies from the United States and Scotland.

In 2023 CERIS published a working paper entitled *'Wind Turbines and House Prices Along the West of Ireland: A Hedonic Pricing Approach'*.[33] This paper looked at wind turbine developments in Donegal, Leitrim, Sligo, Mayo, Galway, Kerry and Cork and associated property values. This working paper utilised satellite imagery to identify individual turbines and sourced its housing data from www.daft.ie; while the published price on Daft is not equivalent to the final agreed sale price, it was assumed that the listing and transaction prices are correlated. The findings of this research revealed a potential decrease in property values of -14.7% within a 0-1km radius of a wind turbine. However, the sample size of only 225 houses within this range does not adequately represent the broader landscape of Irish rural housing and the distribution of wind turbines. The author states that there are 'no significant reduction in house prices beyond 1km' and that the effects seen within the 1km band were not persistent and diminished over the operational lifetime of the turbines.

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

[33] *Centre for Economic Research on Inclusivity and Sustainability (2023) Wind Turbines and House Prices Along the West of Ireland: A Hedonic Pricing Approach.* <https://www.universityofgalway.ie/media/researchsites/ceris/files/WP-2023-01.pdf>

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 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. The findings of the study were produced in a report titled '*The Effect of Wind Farms on House Prices*' and 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 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.

In September 2023, the Energy Policy Journal published '*Commercial wind turbines and residential home values: new evidence from the universe of land-based wind projects in the United States.*[34] This study targeted urban counties in the United Stated with populations over 250,000 persons, and found that on average, after a commercial wind energy project is announced, houses located within 1mile of a proposed wind energy project experience a decrease in value of 11% relative to homes located within 3-5miles of the proposed wind energy project. The decline in property values was found to recover post construction with property value impacts becoming relatively small (~2%) and statistically insignificant 9 years or more after project announcement (roughly 5 years after operation begins). This suggests that the housing market is reacting negatively to the expectation of likely impacts (after announcement) and the heightened activity during construction, but after operation begins, those negative perceptions and related home price impacts appear to fade.

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 potential to impact property values in local areas; however, it is important to note that this impact is proven to reduce throughout the operational phase of a wind farm.

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.

5.8 Shadow Flicker

5.8.1 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.[35]

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.

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[34] Energy Policy (2023) Commercial wind turbines and residential home values: new evidence from the universe of land-based wind projects in the United States. Available at: https://www.sciencedirect.com/science/article/pii/S0301421523004226

[35] 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

"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 oktas. This is due to our geographical position off the northwest of Europe, close to the path of Atlantic low-pressure systems which tend to keep us in humid, cloudy airflows for much of the time. A study of mean cloud amounts at 12 stations over a 25-year period showed that the mean cloud amounts were at their minimum in April and their maximum in July. Cloud amounts were less by night than by day, with the mean minimum occurring roughly between 2100 and 0100 GMT and the mean maximum between 1000 and 1500 GMT at most stations." (Source: Met Éireann, www.met.ie)

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

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

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

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

At distances of greater than approximately 500 metres between a turbine and a receptor, shadow flicker generally occurs only at sunrise or sunset when the shadow cast by the turbine is longer. The current adopted '*Wind Energy Development Guidelines for Planning Authorities'* published by the Department of Environment, Heritage, and Local Government (DoEHLG) in 2006, iterates that at distances greater than 10 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.

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

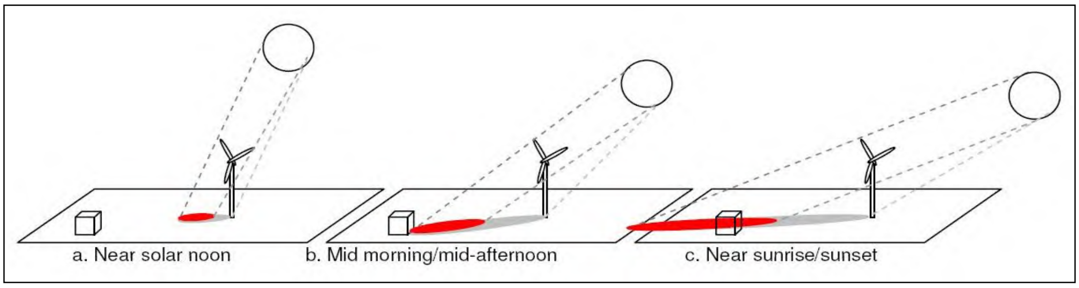


Figure 5-3 Shadow-Prone Area as a Function of Time of Day (Source: Shadow Flicker Report, Helimax Energy, December 2008)

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.

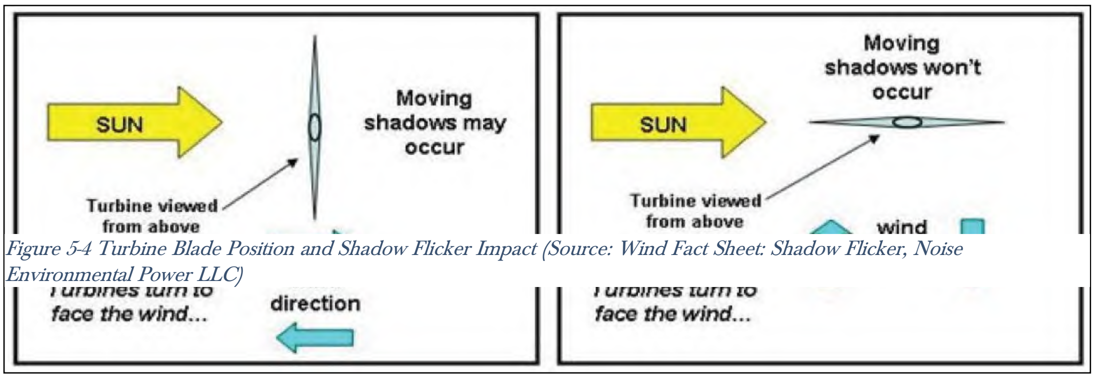


Figure 5-4 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environmental Power LLC)

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.

5.8.2 Guidance

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

The DoEHLG 2006 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 inhabitable dwellings of 724m has been achieved with the project design. There are no inhabitable dwellings located within 720m of any proposed wind turbine location.

The DoEHLG 2006 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 2006 Guidelines thresholds apply to dwellings located within 500 metres of a proposed turbine location, for the purposes of this assessment, the DoEHLG 2006 Guidelines thresholds of 30 hours per year or 30 minutes per day have been applied to all properties located within 10 rotor diameters of the proposed turbines (1,550 metre in this case) of the Proposed Wind Farm site (as per IWEA guidelines, 2012). The DoEHLG 2006 Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The adopted DoEHLG 2006 Guidelines are currently under review. The Draft DoEHLG 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 DoEHLG 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 2006 Guidelines limit (30 hours per year or 30 minutes per day), however, it should also be noted that the Proposed Wind Farm will be brought in line with the requirements of the Draft DoEHLG 2019 Guidelines, should they be adopted while this application is in the planning system, through the implementation of the mitigation measures outlined in Section 5.10.3.10.

5.8.3 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 DoEHLG 2006 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 Proposed Wind Farm site. 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 WindFarm Version 5.0.2.2 has been used to predict the level of shadow flicker associated with the Proposed Wind Farm. 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.

5.8.4 Shadow Flicker Assessment Criteria

5.8.4.1 Turbine Dimensions

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

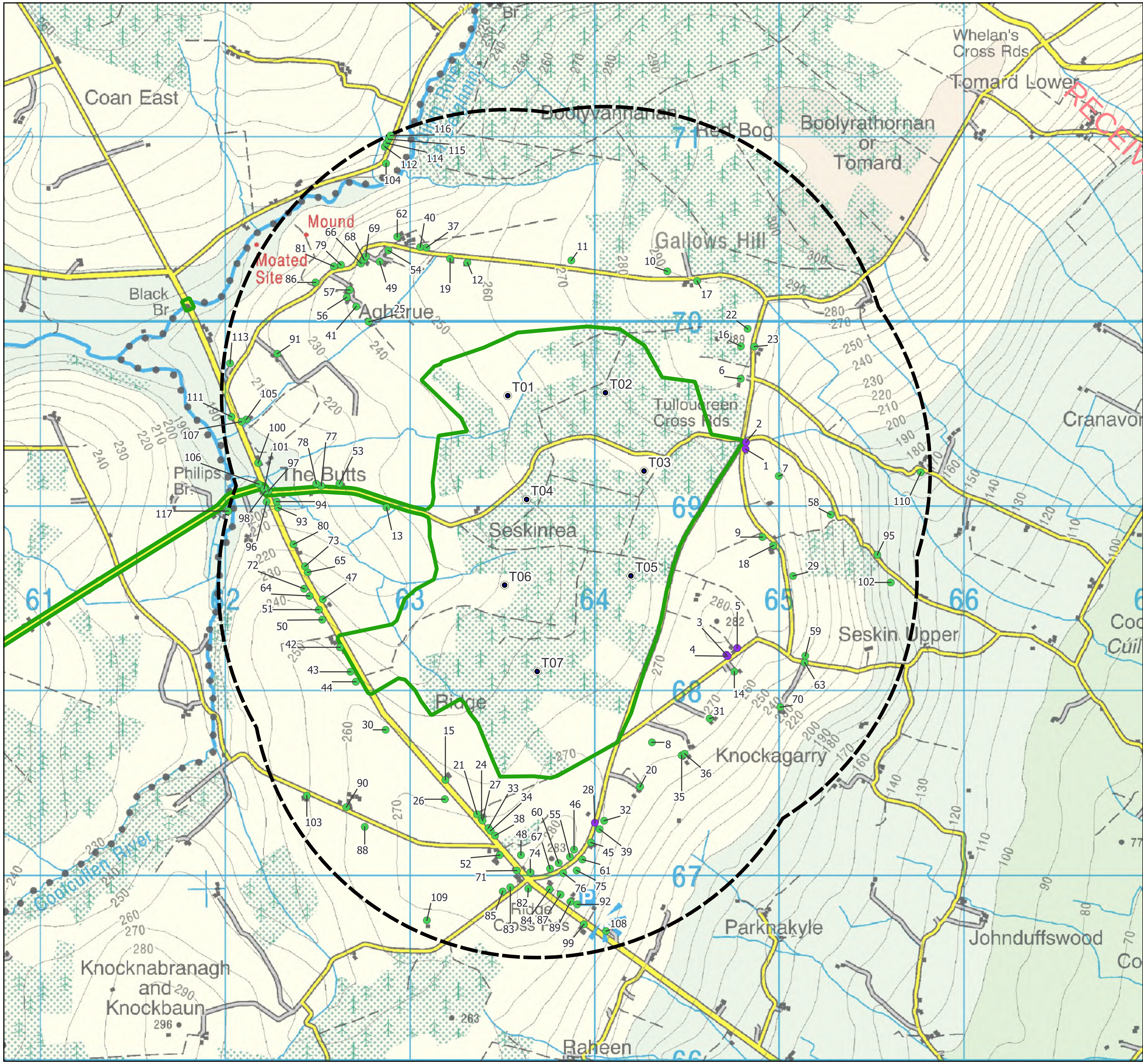
- Turbine Tip Height – Maximum height 180 metres, Minimum height 179.5 metres
- Hub Height – Maximum height 105 metres, Minimum height 102.5 metres
- Blade Length: - Maximum length 77.5 metres, Minimum length 74.5 metres

Planning permission is being sought for a turbine with a minimum tip height of 179.5m and a maximum tip height of 180m. The potential shadow flicker impacts the Proposed Wind Farm will give rise to will be no more than that predicted in this assessment using the maximum proposed rotor diameter of 155m. A comparative shadow flicker assessment is detailed in Section 5.8.6.3 below, and presents the modelling results for a median and minimum turbine parameter scenario. With the benefit of the mitigation measures outlined in Section 5.10.3.10, 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, and with the Draft DoEHLG 2019 Guidelines 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.

5.8.5 Shadow Flicker Study Area

At the outset of the project, during the constraints mapping process detailed in Chapter 3 of this EIAR, all sensitive receptors within 2km of the site were identified and mapped. This included all uninhabitable and inhabitable dwellings. In addition, a planning history search to identify properties that may have been granted planning permission, but not yet been constructed, was carried out. Any property with a valid planning permission for a dwelling house was also added to the sensitive receptors' dataset.

The Shadow Flicker Study Area is 10 times rotor diameter from each turbine as set out in the DoEHLG 2006 Guidelines. All residential properties located within 10 rotor diameters which is assumed to be 1.55 km have been included in the assessment. A significant minimum separation distance of 724m from third party dwellings has been achieved with the project design. There are 117 no. properties located within 1.55 km of the proposed turbines as detailed above, of which 111 are dwellings (including 13 planning permissions) and 6 are in derelict condition. Of the 117 no. properties, 16 are Participating Properties. The Shadow Flicker Study Area and sensitive receptor locations are shown in Figure 5-4, with all dwellings detailed in Table 5-8 in Section 5.8.6 below.



Map Legend

- EIAR Site Boundary
- Shadow Flicker Study Area - 1.55km (10x155m Rotor Diameter)
- Proposed Turbine Layout

Properties

- Derelict
- Dwelling

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Drawing Title	Shadow Flicker Study Area
Project Title	Seskin Wind Farm, Co. Carlow
Drawn By: BT	Checked By: EC
Project No.: 220246	Drawing No.: Figure 5-5
Scale: 1:20,000	Date: 2024-04-25

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5.8.5.1 Assumptions and Limitations

Due to the latitude of Ireland and the UK, shadow flicker impacts are only possible at properties 130 degrees either side to the north as turbines do not cast shadows on their southern side (ODPM Annual Report and Accounts 2004: Housing, Planning, Local Government, and the Regions Committee; Planning Policy Statement 22;). As such properties located outside of this potential shadow flicker zone will not be impacted. However, in this assessment, all 117 no. properties within 360 degrees of the Proposed Wind Farm within the Shadow Flicker Study Area were assessed for shadow flicker impact.

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

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

Each window measures one-metre-high by one-metre-wide, and tilt angle is assumed to be zero. The centre height of each window is assumed to be two metres above ground level and no screening due to trees or other buildings or vegetation is assumed. It was not considered necessary or practical to measure the dimensions of every window on every property in the Shadow Flicker Study Area. While the actual size of a window will marginally influence the incidence and duration of any potential shadow flicker impact, with larger windows resulting in slightly longer shadow flicker durations, any 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 5.10.3.10.

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 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 29.8% of the daylight hours per year. This percentage is based on Met Éireann data recorded at Kilkenny over the 30-year period from 1978-2007 (https://www.met.ie/climate/30-year-averages). The actual sunshine hours at the Proposed Wind Farm site and therefore the percentage of time shadow flicker could actually occur is 29.79% of daylight hours. Table 5-9 below lists the annual shadow flicker calculated for each property when the regional average of 29.79% 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 any property within the Shadow Flicker Study Area which may be impacted by shadow flicker.

5.8.6 Shadow Flicker Assessment Results

5.8.6.1 Daily and Annual Shadow Flicker

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

The model results assume theoretical precautionary 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 theoretical precautionary scenario. Following the detail provided above on sunshine hours, a sunshine factor of 29.79% 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 2006 Guidelines 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 2006 Guidelines recommend that shadow flicker at dwellings within 500m of a proposed turbine should not exceed a total of 30 hours per year. As outlined in Section 5.8.2, a significant minimum separation distance from any inhabitable dwelling of 724m, i.e., distance between the nearest Proposed Wind Farm turbine (T03) to the nearest dwelling (6) has been achieved with the project design. There is a derelict property located 563m to the southwest of the Proposed Wind Farm turbine (T03). However, for the purposes of this assessment, the predicted shadow flicker levels have been modelled for all receptors within 1.55km (10 times rotor diameter of 155m) of the Proposed Wind Farm turbine locations.

A total of 117 no. receptors have been modelled as part of the shadow flicker assessment, the results of which are presented in Table 5-8 below. Former residential dwellings termed as "derelict" within this assessment are defined as properties that are currently in an uninhabitable condition.

Table 5-8 Shadow Flicker Results for Seskin Wind Farm, Co. Carlow.

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker	Mitigation Strategy Required (Daily and Annual)
1	664755	669348	Derelict	563	T03	01:04:12	221:48:00	66:04:41	1,2,3,4,5,6	No*
2	664757	669384	Derelict	574	T03	01:03:00	202:04:48	60:12:11	1,2,3,4,5,6	No*
3	664651	668233	Derelict	671	T05	00:36:36	54:46:48	16:19:12	4,5,6,7	No* **
4	664658	668226	Derelict	681	T05	00:36:36	53:46:12	16:01:08	4,5,6,7	No* **
5	664710	668270	Derelict	696	T05	00:51:36	77:15:36	23:01:01	4,5,6,7	No* **
6	664729	669729	Dwelling	724	T03	01:09:36	135:22:12	40:19:44	1,2,3,4	No**
7	664935	669202	Dwelling	730	T03	00:58:48	150:03:00	44:42:09	1,2,3,4,5	Yes
8	664248	667759	Dwelling	731	T07	00:54:36	61:18:36	18:15:55	7	Yes
9	664846	668871	Dwelling	735	T03	01:06:00	148:19:12	44:11:13	3,4,5,6,7	Yes
10	664331	670311	Dwelling	738	T02	00:46:12	60:03:36	17:53:34	1,2	No**
11	663811	670370	Dwelling	740	T02	01:03:36	33:15:00	9:54:21	1,2	Yes
12	663248	670358	Dwelling	754	T01	01:12:36	80:00:36	23:50:11	1,2,3	Yes
13	662810	669032	Dwelling	760	T04	01:03:00	185:01:48	55:07:25	2,3,4,5,6,7	No**
14	664694	668142	Dwelling	764	T05	00:35:24	36:18:00	10:48:52	4,6,7	Yes
15	663129	667556	Dwelling	769	T07	00:00:00	0:00:00	0:00:00	N/A	No
16	664730	669905	Dwelling	776	T02	01:07:48	109:18:00	32:33:44	1,2,3,4	Yes
17	664492	670258	Dwelling	783	T02	00:47:24	77:58:48	23:13:54	1,2,4	Yes
18	664906	668826	Dwelling	789	T05	00:56:24	128:38:24	38:19:26	3,4,5,6,7	Yes
19	663155	670379	Dwelling	805	T01	00:39:00	55:32:24	16:32:47	1,2	Yes
20	664184	667519	Dwelling	837	T07	00:00:00	0:00:00	0:00:00	N/A	No**
21	663301	667369	Dwelling	839	T07	00:00:00	0:00:00	0:00:00	N/A	No**

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker	Mitigation Strategy Required (Daily and Annual)
22	664766	669999	Dwelling	844	T02	01:06:36	93:03:00	27:43:16	1,2,3,4	No**
23	664803	669903	Dwelling	845	T02	01:01:48	104:54:36	31:15:16	1,2,3,4	Yes
24	663325	667345	Dwelling	853	T07	00:00:00	0:00:00	0:00:00	N/A	No
25	662714	670037	Dwelling	853	T01	01:02:24	80:17:24	23:55:11	1,2,4	No**
26	663126	667451	Dwelling	854	T07	00:00:00	0:00:00	0:00:00	N/A	No
27	663330	667335	Dwelling	860	T07	00:00:00	0:00:00	0:00:00	N/A	No
28	663939	667324	Derelict	877	T07	00:00:00	0:00:00	0:00:00	N/A	No*
29	665012	668660	Dwelling	878	T05	00:42:36	82:20:24	24:31:50	3,4,5,7	Yes
30	662806	667827	Dwelling	879	T07	00:44:24	51:09:00	15:14:18	7	Yes
31	664560	667888	Dwelling	883	T05	00:39:36	63:13:48	18:50:14	6,7	Yes
32	663989	667334	Dwelling	887	T07	00:00:00	0:00:00	0:00:00	N/A	No
33	663363	667295	Dwelling	888	T07	00:00:00	0:00:00	0:00:00	N/A	No
34	663374	667280	Dwelling	899	T07	00:00:00	0:00:00	0:00:00	N/A	No
35	664409	667689	Dwelling	905	T07	00:45:00	56:17:24	16:46:11	7	Yes
36	664425	667697	Dwelling	915	T07	00:43:48	58:11:24	17:20:09	7	No**
37	663026	670439	Dwelling	915	T01	00:35:24	50:53:24	15:09:40	1,2	Yes
38	663398	667254	Dwelling	918	T07	00:00:00	0:00:00	0:00:00	N/A	No
39	663964	667288	Dwelling	919	T07	00:00:00	0:00:00	0:00:00	N/A	No
40	662993	670442	Dwelling	935	T01	00:36:36	51:54:36	15:27:53	1,2	Yes
41	662647	670120	Dwelling	952	T01	00:54:00	69:22:48	20:40:10	1,2,4	Yes
42	662559	668274	Dwelling	953	T06	00:41:24	72:45:36	21:40:35	4,6,7	No**

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker	Mitigation Strategy Required (Daily and Annual)
43	662615	668141	Dwelling	958	T06	00:42:36	79:37:12	23:43:12	6,7	No**
44	662644	668087	Dwelling	961	T06	00:42:36	70:05:24	20:52:52	6,7	Yes
45	663918	667216	Dwelling	972	T07	00:00:00	0:00:00	0:00:00	N/A	No
46	663826	667178	Dwelling	986	T07	00:00:00	0:00:00	0:00:00	N/A	No
47	662466	668534	Dwelling	988	T06	00:38:24	82:36:00	24:36:29	4,6,7	Yes
48	663538	667148	Dwelling	999	T07	00:00:00	0:00:00	0:00:00	N/A	No
49	662773	670363	Dwelling	1004	T01	00:37:48	63:01:12	18:46:29	1,2	Yes
50	662462	668423	Dwelling	1006	T06	00:38:24	82:56:24	24:42:33	4,6,7	Yes
51	662444	668478	Dwelling	1015	T06	00:37:48	81:56:24	24:24:41	4,6,7	Yes
52	663423	667148	Dwelling	1015	T07	00:00:00	0:00:00	0:00:00	N/A	No
53	662555	669161	Dwelling	1017	T04	00:39:36	138:16:12	41:11:35	1,2,4,6,7	Yes
54	662820	670424	Dwelling	1019	T01	00:36:00	59:19:48	17:40:31	1,2	Yes
55	663804	667138	Dwelling	1021	T07	00:00:00	0:00:00	0:00:00	N/A	No
56	662595	670170	Dwelling	1022	T01	00:49:12	63:39:36	18:57:55	1,2,4	Yes
57	662611	670210	Dwelling	1030	T01	00:46:48	61:49:48	18:25:13	1,2,4	No**
58	665216	668993	Dwelling	1039	T03	00:34:12	47:37:12	14:11:12	2,3,5	Yes
59	665079	668228	Dwelling	1040	T05	00:31:48	39:50:24	11:52:08	5,7	No**
60	663743	667105	Dwelling	1045	T07	00:00:00	0:00:00	0:00:00	N/A	No
61	663871	667124	Dwelling	1048	T07	00:00:00	0:00:00	0:00:00	N/A	No
62	662869	670498	Dwelling	1049	T01	00:34:48	49:17:24	14:41:04	1,2	Yes
63	665075	668191	Dwelling	1052	T05	00:32:24	40:18:00	12:00:22	5,7	Yes

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker	Mitigation Strategy Required (Daily and Annual)
64	662394	668552	Dwelling	1058	T06	00:36:00	64:20:24	19:10:05	4,6,7	Yes
65	662383	668680	Dwelling	1069	T06	00:35:24	57:52:48	17:14:36	4,6,7	Yes
66	662672	670353	Dwelling	1070	T01	00:37:12	49:39:36	14:47:40	1,2	No**
67	663696	667075	Dwelling	1071	T07	00:00:00	0:00:00	0:00:00	N/A	No
68	662689	670374	Dwelling	1072	T01	00:37:12	56:00:00	16:41:00	1,2	Yes
69	662699	670391	Dwelling	1077	T01	00:36:36	57:22:48	17:05:40	1,2	Yes
70	664943	667950	Dwelling	1077	T05	00:19:48	6:49:48	2:02:05	7	Yes
71	663516	667064	Dwelling	1084	T07	00:00:00	0:00:00	0:00:00	N/A	No
72	662364	668591	Dwelling	1086	T06	00:34:48	58:34:48	17:27:07	4,6,7	Yes
73	662369	668713	Dwelling	1086	T06	00:34:48	55:34:12	16:33:19	4,6,7	Yes
74	663589	667055	Dwelling	1089	T07	00:00:00	0:00:00	0:00:00	N/A	No
75	663840	667065	Dwelling	1099	T07	00:00:00	0:00:00	0:00:00	N/A	No
76	663767	667051	Dwelling	1101	T07	00:00:00	0:00:00	0:00:00	N/A	No
77	662457	669149	Dwelling	1115	T04	00:36:00	106:30:00	31:43:41	1,4,6,7	Yes
78	662430	669160	Dwelling	1142	T01	00:35:24	85:23:24	25:26:21	1,4,6	Yes
79	662564	670346	Dwelling	1148	T01	00:34:48	25:12:00	7:30:27	1	Yes
80	662307	668832	Dwelling	1165	T06	00:32:24	67:16:12	20:02:27	1,4,6,7	Yes
81	662525	670338	Dwelling	1174	T01	00:33:36	21:40:12	6:27:21	1	Yes
82	663578	666967	Dwelling	1177	T07	00:00:00	0:00:00	0:00:00	N/A	No
83	663481	666974	Dwelling	1179	T07	00:00:00	0:00:00	0:00:00	N/A	No
84	663694	666963	Dwelling	1182	T07	00:00:00	0:00:00	0:00:00	N/A	No

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker	Mitigation Strategy Required (Daily and Annual)
85	663440	666951	Dwelling	1206	T07	00:00:00	0:00:00	0:00:00	N/A	No
86	662426	670251	Dwelling	1209	T01	00:32:24	18:10:12	5:24:47	1	Yes
87	663753	666934	Dwelling	1215	T07	00:00:00	0:00:00	0:00:00	N/A	No
88	662692	667301	Dwelling	1257	T07	00:00:00	0:00:00	0:00:00	N/A	No
89	663806	666895	Dwelling	1261	T07	00:00:00	0:00:00	0:00:00	N/A	No
90	662593	667408	Dwelling	1268	T07	00:32:24	26:09:00	7:47:26	7	Yes
91	662218	669864	Dwelling	1269	T01	00:30:00	15:11:24	4:31:31	1	Yes
92	663843	666881	Dwelling	1281	T07	00:00:00	0:00:00	0:00:00	N/A	No
93	662223	669030	Dwelling	1297	T06	00:30:00	63:48:00	19:00:25	1,4,6	Yes
94	662216	669063	Dwelling	1315	T06	00:30:00	58:04:12	17:18:00	1,4,6	Yes
95	665469	668775	Dwelling	1340	T05	00:04:48	1:06:00	0:19:40	3	Yes
96	662161	669062	Dwelling	1366	T06	00:28:48	50:31:48	15:03:13	1,4,6	Yes
97	662171	669120	Dwelling	1377	T06	00:28:48	48:35:24	14:28:33	1,4,6	Yes
98	662155	669120	Dwelling	1392	T06	00:28:48	47:06:36	14:02:05	1,4,6	Yes
99	663880	666774	Dwelling	1393	T07	00:00:00	0:00:00	0:00:00	N/A	No
100	662115	669273	Dwelling	1401	T01	00:28:12	40:54:00	12:11:05	1,4,6	Yes
101	662147	669133	Dwelling	1403	T06	00:28:48	46:07:12	13:44:24	1,4,6	Yes
102	665541	668625	Dwelling	1408	T05	00:06:36	3:42:00	1:06:08	3	Yes
103	662379	667470	Dwelling	1417	T07	00:29:24	30:19:48	9:02:09	7	Yes
104	662808	670895	Dwelling	1420	T01	00:06:00	0:37:48	0:11:16	1	Yes
105	662051	669508	Dwelling	1422	T01	00:27:36	13:20:24	3:58:27	1	Yes

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker	Mitigation Strategy Required (Daily and Annual)
106	662119	669157	Dwelling	1431	T01	00:28:12	43:27:00	12:56:40	1,4,6	Yes
107	662025	669496	Dwelling	1449	T01	00:27:00	12:54:00	3:50:35	1	Yes
108	663999	666736	Dwelling	1455	T07	00:00:00	0:00:00	0:00:00	N/A	No
109	663029	666795	Dwelling	1475	T07	00:00:00	0:00:00	0:00:00	N/A	No
110	665704	669222	Dwelling	1499	T03	00:24:36	7:52:48	2:20:51	3	Yes
111	661971	669523	Dwelling	1501	T01	00:25:48	11:55:12	3:33:04	1	Yes
112	662801	670986	Dwelling	1504	T01	00:00:00	0:00:00	0:00:00	N/A	No
113	661963	669812	Dwelling	1514	T01	00:25:48	10:57:36	3:15:55	1	Yes
114	662811	671005	Dwelling	1517	T01	00:00:00	0:00:00	0:00:00	N/A	No
115	662822	671026	Dwelling	1532	T01	00:00:00	0:00:00	0:00:00	N/A	No
116	662832	671046	Dwelling	1546	T01	00:00:00	0:00:00	0:00:00	N/A	No
117	661933	669017	Dwelling	1550	T06	00:00:00	0:00:00	0:00:00	N/A	No

* Derelict Property

**Participating Property

Of the 117 no. properties modelled, 111 are dwellings (13 of which are Participating Properties) and 6 are in a derelict condition (3 of which are Participating Properties).

The developer has adopted the Draft DoEHLG 2019 Guidelines recommendation that no shadow flicker exceedance will occur at any property as a result of the Proposed Wind Farm.

As detailed above, of the 117 no. properties modelled:

- 13 of the dwellings are Participating Properties; and
- 6 are in derelict condition (of which 3 are Participating Properties)

These 19 no. properties will not require mitigation measures as a result.

Daily Shadow Flicker

From the remaining 98 no. properties, it is predicted that 61 of these may experience daily shadow flicker occurrences. This prediction is assuming theoretical precautionary 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 the absence of any turbine control measures.

Annual Shadow Flicker

Of the remaining 98 no. properties modelled, when the regional sunshine average (i.e., the mean number of sunshine hours throughout the year) of 29.8% is taken into account, it is also anticipated that 61 of these properties may experience annual shadow flicker occurrences. The 61 no. properties which are predicted to experience daily shadow flicker are the same properties which are anticipated to experience annual shadow flicker occurrences.

The predicted shadow flicker listed in Table 5-9 is considered conservative and the occurrence and/or duration of shadow flicker at these properties is likely to be eliminated or significantly reduced as the following items are not considered by the model:

- Receivers may be screened by topography, cloud cover and/or vegetation/built form i.e., adjacent buildings, farm buildings, garages or barns;
- Each receiver will not have windows facing in all directions onto the wind farm.
- 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*' (Danish Wind Industry Association, accessed 2010).

Section 5.9.3.4 below outlines the mitigation strategies which may be employed at the potentially affected properties to ensure that the Draft DoEHLG 2019 Guidelines are complied with at any dwelling within the 1.55km Shadow Flicker Study Area. Therefore, the developer will commit to mitigation measures that will ensure that there are no occurrences of shadow flicker for any property within the 1.55km Shadow Flicker Study Area, as a result of the Proposed Wind Farm.

5.8.6.2 Comparative Shadow Flicker Assessment

A comparative assessment was undertaken where turbines with alternative dimensions within the proposed range, as detailed in Section 1.7.3 of Chapter 1 of the EIAR and Section 4.1 of Chapter 4 of the EIAR, were modelled and compared against Scenario 1 as set out in Section 5.8.4 and Table 5-9. The three comparative modelled turbines are as follows:

- **Scenario 1 Maximum: Minimum Hub Height (102.5m) & Maximum Rotor Diameter (155m)**
- **Scenario 2 Minimum: Maximum Hub Height (105m) & Minimum Rotor Diameter (149m)**
- **Scenario 3 Median: Maximum Hub Height (105m) & Intermediate Rotor Diameter (150m)**

For all turbines modelled, the Shadow Flicker Study Area remained unchanged at 1.55km. The summary of assessment results is presented in Appendix 5-4: Comparative Shadow Flicker Assessment.

The findings of the assessment indicate that of the 98 no. properties modelled requiring mitigation strategies, daily shadow flicker exceedance is experienced at 61 no. properties for Scenario 1, at 58 no. properties for Scenario 2, and at 59 no. properties for the Scenario 3. Of the 98 no. properties, when adjusted for regional sunshine, annual shadow flicker exceedance is experienced at the same 61 no. properties for Scenario 1, 58 no. dwellings for Scenario 2, and 59 no. properties for Scenario 3. The results of this comparative assessment support the consideration that a theoretical precautionary 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).

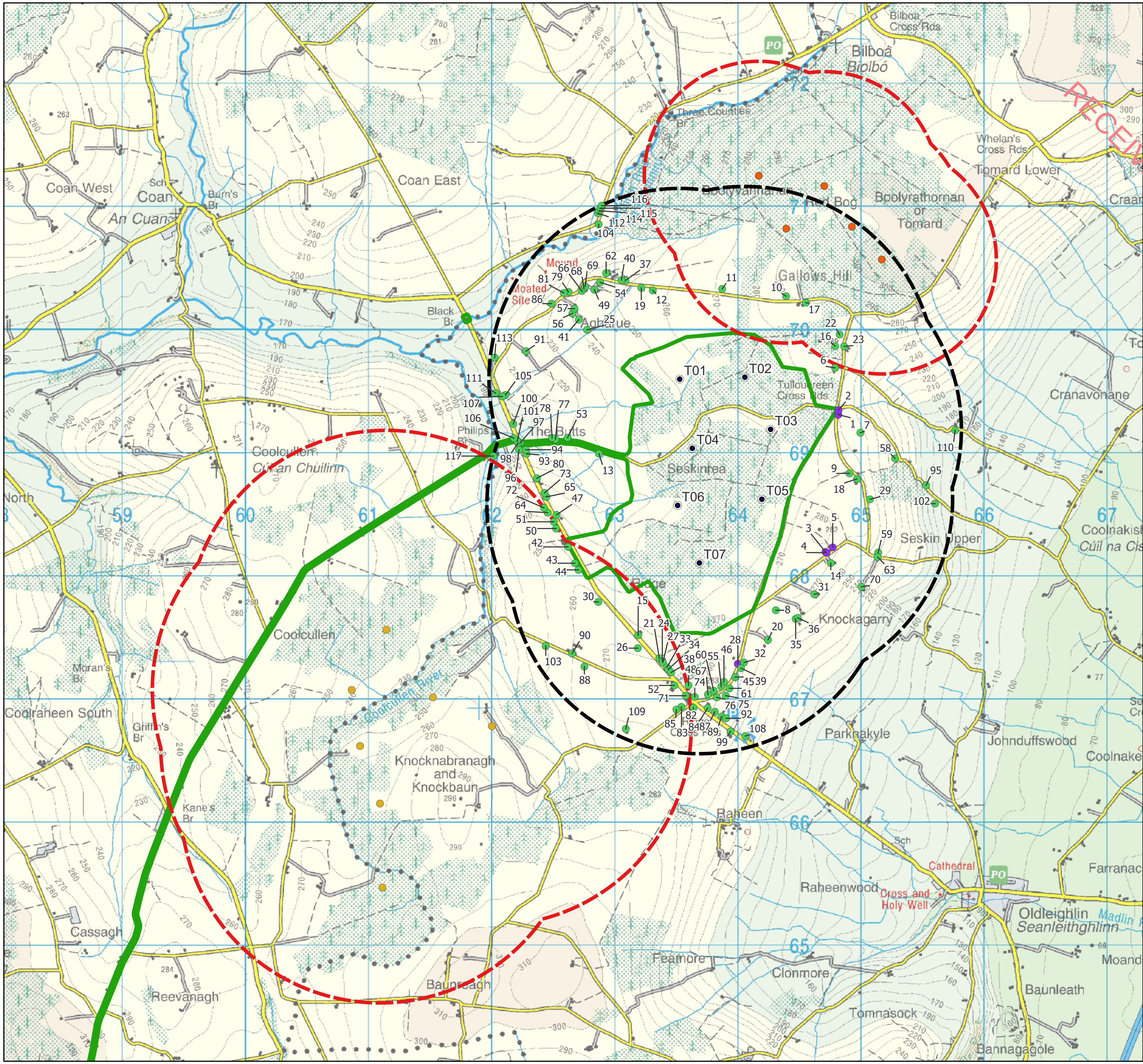
5.8.6.3 Cumulative Shadow Flicker

The cumulative assessment of shadow flicker arising from the Proposed Wind Farm and other wind farms was carried out based on the methodology, assumptions and criteria outlined in Section 5.8.3 and Section 5.8.4.

For the assessment of cumulative shadow flicker, any other existing, permitted, or proposed wind farms are considered where the project's 10 times rotor diameter shadow flicker study area is located within the Shadow Flicker Study Area of 10 times the rotor diameter for the Proposed Wind Farm. In this case, the closest wind farms are the permitted Bilboa Wind Farm located approximately 1.2km north of the Proposed Wind Farm turbine (T02) and the permitted White Hills Wind Farm located 2.1km southwest of the Proposed Wind Farm turbine (T07). As such, the 10 times rotor diameter shadow flicker study area for these permitted projects would overlap with that of the Proposed Wind Farm 10 times rotor diameter Shadow Flicker Study Area.

Of the 117 no. properties within the Shadow Flicker Study Area of the Proposed Wind Farm, 25 no. properties have the potential to experience cumulative shadow flicker impacts, when the permitted Bilboa and permitted White Hills wind farms are assessed alongside the Proposed Wind Farm. Figure 5-6 illustrates the zone of potential for cumulative shadow flicker between the Proposed Project, and Bilboa and White Hills wind farms. Mitigation strategies are outlined in Section 5.10.3.10.

The results of the cumulative shadow flicker modelling are shown in Table 5-9 below.



Map Legend

- EIAR Site Boundary
- Proposed Development Shadow Flicker Study Area - 1.55km (10x155m Rotor Diameter)
- Proposed Turbine Layout

Properties

- Derelict
- Dwelling

Cumulative Wind Farms

- Bilboa
- White Hills

Cumulative Shadow Flicker

- Bilboa Wind Farm Shadow Flicker Study Area - 930m (10x93m Rotor Diameter)
- White Hills Wind Farm Shadow Flicker Study Area - 1.62km (10x162m Rotor Diameter)

Drawing Title: Cumulative Shadow Flicker Study Area	
Project Title: Seskin Wind Farm, Co. Carlow	
Drawn By: BT	Checked By: EC
Project No.: 220246	Drawing No.: Figure 5-6
Scale: 1:30,000	Date: 2024-04-25

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Table 5-9 Cumulative Shadow Flicker Results

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Status	Nearest Proposed Turbine No. *	Distance to Nearest Turbine (metres)	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Further Assessment Required
10	664331	670311	Dwelling	T02	738	00:46:12	82:03:00	24:26:39	1,2,9	No**
15	663129	667556	Dwelling	T07	769	00:30:00	17:04:12	5:05:08	19	No
17	664492	670258	Dwelling	T02	783	00:47:24	109:39:36	32:40:10	1,2,4,9	Yes
21	663301	667369	Dwelling	T07	839	00:27:36	12:30:36	3:43:37	19	No**
24	663325	667345	Dwelling	T07	853	00:27:36	12:04:48	3:35:56	19	No
26	663126	667451	Dwelling	T07	854	00:30:36	16:39:36	4:57:48	19	No
27	663330	667335	Dwelling	T07	860	00:27:36	11:52:12	3:32:11	19	No
30	662806	667827	Dwelling	T07	879	00:44:24	91:02:24	27:07:20	7,17,19	Yes
33	663363	667295	Dwelling	T07	888	00:27:00	11:23:24	3:23:36	19	No
34	663374	667280	Dwelling	T07	899	00:27:00	11:12:00	3:20:12	19	No
38	663398	667254	Dwelling	T07	918	00:27:00	10:42:36	3:11:26	19	No
43	662615	668141	Dwelling	T06	958	00:42:36	101:39:00	30:17:00	6,7,17	No**
44	662644	668087	Dwelling	T06	961	00:42:36	85:52:48	25:35:06	6,7,17	Yes
50	662462	668423	Dwelling	T06	1006	00:38:24	94:15:00	28:04:43	4,6,7,18	Yes
51	662444	668478	Dwelling	T06	1015	00:37:48	94:30:36	28:09:22	4,6,7,18	Yes
52	663423	667148	Dwelling	T07	1015	00:26:24	10:16:12	3:03:35	19	No
64	662394	668552	Dwelling	T06	1058	00:36:00	78:25:48	23:21:56	4,6,7,18	Yes
71	663516	667064	Dwelling	T07	1084	00:25:12	9:04:48	2:42:18	19	No
72	662364	668591	Dwelling	T06	1086	00:34:48	73:54:36	22:01:08	4,6,7,18	Yes
83	663481	666974	Dwelling	T07	1179	00:26:24	9:40:48	2:53:02	19	No
85	663440	666951	Dwelling	T07	1206	00:27:00	10:25:12	3:06:15	19	No
88	662692	667301	Dwelling	T07	1257	00:45:00	55:07:12	16:25:16	17,19	No
90	662593	667408	Dwelling	T07	1268	00:45:00	114:01:12	33:58:06	7,17,18,19	Yes
103	662379	667470	Dwelling	T07	1417	00:49:12	146:13:48	43:33:52	7,16,17,18,19	Yes
109	663029	666795	Dwelling	T07	1475	00:50:24	31:44:24	9:27:21	17,19	No

**Turbines 1-7 are part of the Proposed Project. Turbines 8-12 comprise the permitted Bilboa Wind Farm, and Turbines 13-19 comprise the permitted White Hills Wind Farm.*
***Participating Property*

Cumulative Results

Of the properties with the potential for a cumulative impact to arise, Table 5-9 above illustrates that only 9 no. properties warrant further assessment, as these are the only third-party properties that are modelled to have potential impacts as a result of the Proposed Wind Farm. Table 5-10 below provides further assessment in relation to these 9 no. properties and details the results of the Proposed Wind Farm being brought in line with the Draft DoEHLG 2019 Guidelines requirement of zero shadow flicker through mitigation strategies outlined in Section 5.10.3.10. On this basis, there will be no cumulative shadow flicker impact.

As identified in Table 5-9 above, where there are daily shadow flicker occurrences, the culmination of these occurrences over a year correspond to annual shadow flicker occurrences at a given dwelling. Therefore, by presenting the maximum potential annual shadow flicker contributed by the Proposed Wind Farm after mitigation in Table 5-10 below, this also identified the culmination of daily shadow flicker occurrences over a year. As a result, Table 5-10 highlights only the cumulative annual shadow flicker occurrences.

Table 5-10 Potential Cumulative Annual Shadow Flicker Results Following Draft DoEHLG 2019 Guidelines

House ID	Max. Potential Cumulative Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Potential Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Max. Potential Annual Shadow Flicker contributed to by Proposed Wind Farm (Turbines 1-7)	Proposed Wind Farm Turbines to be controlled	Max. Potential Shadow Flicker contributed by Proposed Wind Farm (Turbines 1-7) after mitigation	Remaining Max. Potential Annual Shadow Flicker contributed by Nearby Wind Farms after Proposed Wind Farm mitigation applied (Turbines 8-19)
17	109:39:36	32:40:10	1,2,4,9	23:13:54	T1, T2, T4	0:00:00	9:26:17
30	91:02:24	27:07:20	7,17,19	15:14:18	T7	0:00:00	11:53:02
44	85:52:48	25:35:06	6,7,17	20:52:52	T6	0:00:00	4:42:15
50	94:15:00	28:04:43	4,6,7,18	24:42:33	T4, T6, T7	0:00:00	3:22:10
51	94:30:36	28:09:22	4,6,7,18	24:24:41	T4, T6, T7	0:00:00	3:44:41
64	78:25:48	23:21:56	4,6,7,18	19:10:05	T4, T6, T7	0:00:00	4:11:52
72	73:54:36	22:01:08	4,6,7,18	17:27:07	T4, T6, T7	0:00:00	4:34:01
90	114:01:12	33:58:06	7,17,18,19	7:47:26	T7	0:00:00	26:10:41
103	146:13:48	43:33:52	7,16,17,18,19	9:02:09	T7	0:00:00	34:31:43

**Turbines 1-7 are part of the Proposed Project. Turbines 8-12 comprise the permitted Bilboa Wind Farm, and Turbines 13-19 comprise the permitted White Hills Wind Farm*

5.9 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 are no inhabitable properties located within 724 metres of a proposed turbine location. There is a derelict property located approximately 563 metres from the nearest proposed turbine location. The Proposed Wind Farm site is located in an area which is currently used for commercial forestry. Commercial forestry will still be carried out at the Proposed Wind Farm site should the application be successful. Thus, the existing land use and industrial activity will be retained in the surrounding landscape. This continuation of existing activities and land use will assist in the assimilation of the Proposed Project into the current receiving environment. Current land-use along the Proposed Grid Connection Route comprises of public road corridor, public open space, pastures, coniferous forestry, and land principally used by agriculture with significant areas of natural vegetation. Land-use in the wider landscape of the site comprises a mix of agriculture, peat cutting, quarrying, low density residential and commercial forestry.

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 5.8 above refers to shadow flicker modelling, Chapter 12 of the EIAR addresses noise). A comprehensive landscape and visual impact assessment has also been carried out, as presented in Chapter 14 of this EIAR. Direct, Indirect, Cumulative and In-Combination Impacts on human beings during the construction, operational and decommissioning phases of the Proposed Project are assessed in relation to each of these key issues and other environmental factors such as traffic and dust; see Impacts in Section 5.10 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.

5.10 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 Project.

5.10.1 'Do-Nothing' Scenario

If the Proposed Project were not to proceed, the existing land use of coniferous forestry and agriculture would continue. This land-use will also continue if the Proposed Project does proceed.

If the Proposed Wind Farm were not to proceed, the opportunity to capture part of County Carlow'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.

5.10.2 Construction Phase

5.10.2.1 Health and Safety

Construction of the Proposed Project will necessitate the presence of a construction site and travel on the local public road network to and from the Proposed Project 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 Project will be constructed, operated, and decommissioned in accordance with all relevant Health and Safety Legislation, including:

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

The mitigation measures presented below are also detailed in the Construction and Environment Management Plan (CEMP) (Appendix 4-4). Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

A Health and Safety Plan covering all aspects of the construction process will address the Health and Safety requirements in detail.

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 construction 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 Effect

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

Significance of Effects

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

5.10.2.2 Employment and Investment

The design, construction and operation of the wind farm will provide employment for technical consultants, contractors, and maintenance staff. Approximately, 80-100 jobs could be created during the construction, operation, and maintenance phases of the Proposed Project. The construction phase of the wind farm will last between approximately 18 - 24 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 moderate positive impact.

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

The Proposed Project 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. Wind Energy Ireland estimates that there are over 5,000 people employed in roles related to wind energy in Ireland in 2023. This figure is anticipated to grow significantly in the coming years as the race to achieve the targets set out in the Climate Action Plan accelerates.

Rates payments for Proposed Wind Farm will contribute significant funds to Carlow 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 DoEHLG 2019 Guidelines and the Renewable Energy Support Scheme (RESS). Both sets of policy are expected to provide the Government requirements on future community benefit funds for renewable energy projects.

Should the Proposed Project 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 €240,000/year, assuming the current terms of the RESS, 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.

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.

Further details on the proposed Community Gain proposals are presented in Section 4.6 in Chapter 4 of this EIAR.

Proposed Mitigation Measures

No mitigation required.

Residual Effect

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

Significance of Effects

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

5.10.2.3 Population

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

Proposed Mitigation Measures

No mitigation required.

Residual Effects

No residual effects.

Significance of Effects

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

5.10.2.4 Land-Use

The land-use/activities within the Proposed Wind Farm comprises coniferous forestry and agriculture. Current land-use along the Proposed Grid Connection Route comprises of public road corridor, public open space, pastures, coniferous forestry, and land principally used by agriculture with significant areas of natural vegetation. Land-use in the wider landscape of the site comprises a mix of agriculture, peat cutting, quarrying, low density residential and commercial forestry.

The existing land-use of commercial forestry will continue on the site Proposed Wind Farm. However, a small section of commercial forestry within the site will be felled as part of the Proposed Wind Farm. 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 Project.

The existing land-use of road networks will continue on the Proposed Grid Connection Route. There will be no change to existing land-uses in the wider area as a result of the Proposed Grid Connection Route.

Mitigation and Monitoring

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

- The construction of the Proposed Grid Connection Route will be undertaken in a rolling construction method with 100-150m of road constructed and back filled each day providing access in the evenings and night hours along the Proposed Grid Connection Route.

Residual Effect

Based on the above assessment, there will be a permanent slight negative effect on land use.

Significance of Effects

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

5.10.2.5 Noise and Vibration

The wind turbine construction noise assessment results, detailed in Section 12.6.1 of Chapter 12, show that, under theoretical precautionary conditions, predicted construction noise levels from the Proposed Wind Farm are below the Category A Threshold Levels (lowest threshold in BS 5228) for all of the Construction Noise Assessment Locations (CNALs). For all scenarios, therefore, there would be no significant construction noise effects.

For the Proposed Grid Connection Route, the amount of required plant is relatively small, typically being based around an excavator for trenching and backfill activities. As such, construction activities in any one location will be limited in duration and adverse noise effects are anticipated to be negligible. Where construction activities occur directly beside a dwelling, the noise levels at that location are likely to be in the region of 75 – 80 dB(A) for a short period of time. It should be noted, however, that this would only occur where construction activities are directly outside the curtilage of a dwelling within approximately 20m and would result in an instant noise level increase (i.e. not considering a full construction day). Therefore, it is possible that noise levels from trenching and backfill operations may occasionally exceed the BS 5228 threshold if within 20m to a dwelling, however this would only occur for a short period of time at any one location.

At some watercourse, culvert and drain crossings there may be a requirement for Horizontal Directional Drilling (HDD). Specifically, this could be required for some small bridge or water crossings. Modelled HDD for large crossings would require the use of multiple items of plant including pumps, mud recyclers, drilling rigs and generators. Proposed plant for small crossings is a small Vermeer D36 x 50 Directional Drill. Calculations of the Vermeer DD rig, assuming a source noise level of 94 dB(A) at 1m, indicates that noise levels would be below the 65dB(A) threshold from a distance of approximately 30m. For small crossings, the work would likely be completed within 1 and 2 weeks and will therefore be short-term in duration. Where activities involving the small HDD drilling rig are within 30m of a dwelling then noise mitigation measures detailed below will be implemented.

Construction works related to distant road junction improvements may also occur outwith the CNALs considered above, in close proximity to some residential receptors. It is possible that noise from these activities may at times exceed the BS 5228 threshold, however it should be noted that this will be a short-term, temporary impact. Good practice during construction is recommended and will reduce noise levels from these short-term works to minimum levels.

Due to the large separation distances between the construction activity areas on the Proposed Wind Farm site and the nearest receptors, no significant vibration effects are anticipated. Where construction activities on the Proposed Grid Connection Route are close to residential receptors, some local vibration effects may be present, however, levels are expected to be low and of limited duration. Also, similarly to construction noise, good practice during construction is recommended and will reduce vibration levels from these short-term works to minimum levels.

Proposed Mitigation Measures

Best practice measures for noise control will be adhered to onsite during the construction phase of the Proposed Project 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;
- All 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 be 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.
- Construction activities in any one location will be limited in duration
- Trenching and backfill activities are anticipated to move along the Proposed Grid Connection Route at approximately 150m to 300m a day, therefore, the length of time when construction activities will be occurring adjacent to any given receptor is only likely to be for a few hours.
- For the majority of the time, plant and equipment will be located at greater distances from dwellings and therefore, noise levels will be lower
- Where activities involving the small HDD drilling rig are within 30m of a dwelling then there will be an erection of temporary boarding alongside the drilling rig or the use of 'acoustic blanket panels' to hang from heras fencing or similar. This should be installed as close to the drilling rig as is practicable and fitted so as to interrupt any direct line of site between the drilling rig and the closest residential receptors (examples of appropriate products include Echo Noise Defender and Soundex DeciBloc).

Residual Effect

Predicted construction noise and vibration levels are below the assessment criteria at all receptors, for all phases of construction. Due to the low background noise levels at some locations, elements of construction noise could be audible at the closest residential receptor for certain periods during the construction phases. However, with or without the good practice construction mitigation measures outlined above there would be **no significant residual effects**.

Significance of Effects

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

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

Potential dust emission sources during the construction phase of the Proposed Project 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 be imperceptible and short-term in duration.

An increase in dust and exhaust emissions has the potential to cause a nuisance to Sensitive Receptors in the immediate vicinity of the Proposed Project site. The entry and exit of construction vehicles from the Proposed Wind Farm 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 have a short-term, slight, negative impact on air quality. The potential dust impacts that may occur during the construction phase of the Proposed Project are further described in Chapter 10: Air Quality.

Proposed Mitigation Measures

The majority of aggregate material for the construction of roads and turbine bases will be sourced locally, such as from Kilcarrig Quarries Ltd. in the townland of Powerstown, Co. Carlow, approximately 11.1km to the Proposed Project site, therefore limiting the distance needed to transport this material to the Proposed Project. Truck wheels will be washed to remove mud and dirt before leaving. 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 Proposed Grid Connection Route will be small, ranging from 100-150 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 Effect

Once the above mitigation measures are implemented for the construction phase of the Proposed Project, there will be a short-term slight negative residual effect on air quality.

Significance of Effects

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

5.10.2.7 Traffic

It is envisaged that large wind turbine components will be delivered to the Proposed Project site, from Waterford Port, via the N29, N25, N9, M9, N78 and R448. The proposed turbine transport route from Waterford Port to the Proposed Project site is shown on Figure 4-24.

From Waterford Port in Waterford City, the turbines will be transported northwest via the N29, N25, N9, and the M9 out of Waterford. The turbines will travel 96km north along the M9 before exiting onto the N78. The turbines will travel east along the N78 for approximately 11km before passing through the town of Athy, Co. Kildare. After exiting Athy, the turbines will turn south and continue along the N78 for a further 22km before exiting onto the L1834. After approximately 2km on the L1834, the turbines will continue straight onto the L1835 for approximately 5km before entering the townland of Ridge in Co. Carlow. The turbines will continue straight on the L3037 for approximately 2km before turning left into the Proposed Project site entrance.

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 temporary slight negative impact on local road users.

Due to the nature of the Proposed Grid Connection Route, the proposed works will be transient in nature along the public road network in which the works are proposed. As such, deliveries of construction materials will utilise the surrounding road network along the Proposed Grid Connection Route as it moves along the public road network in which it's proposed. 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 temporary slight negative impact.

A complete Traffic and Transportation Assessment (TTA) of the Proposed Project has been carried out by Alan Lipscombe Traffic and Transport Consultants. The full results of the TTA are presented in Section 15.1 of this EIAR.

Proposed Mitigation Measures

A detailed **TMP**, included as Appendix 15-2 of this EIAR, will be finalised and confirmatory detailed provisions in respect of traffic management agreed with the road's authority and An Garda Síochána prior to construction works commencing. The TMP will be developed and implemented to ensure any impact is short-term in duration and slight in significance during the construction of the Proposed Project.

Residual Effect

During the 18–24-month construction stage of the Proposed Project, it is forecast that the additional traffic that will appear on the public road network serving the Proposed Wind Farm site and during the construction of the Proposed Grid Connection Route will have a slight to moderate and temporary negative effect on existing road users, which will be minimised with the implementation of the mitigation measures included in the proposed Traffic Management Plan included as Appendix 15-2.

Significance of Effects

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

5.10.2.8 Property Values

As noted in Section 5.7 above, the conclusions from available international literature indicate that during the construction phase there is potential for a short-term slight negative impact on property values, suggesting that property values react negatively to the expectation of likely impacts and construction of a wind farm.

Proposed Mitigation Measures

All mitigation relevant to property values, outlined above and the corresponding chapters: Chapter 10 Air, Chapter 12 Noise and Vibration, Chapter 14 Landscape, and Chapter 15 Material Assets, will be implemented in order to reduce insofar as possible, impacts on property values at properties located in the vicinity of Proposed Project construction works. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

Residual Effect

Following the implementation of the above mitigation measures, there will be a short-term negative imperceptible effect from the construction phase of the Proposed Project on property values.

Significance of Effects

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

5.10.2.9 Tourism

Given that there are currently no tourism attractions or amenity walkways located within the Proposed Project site there are no impacts associated with the construction phase of the Proposed Project. It is not considered that the Proposed Project 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 Project into this environment.

The Proposed Project site has some rural aesthetic qualities given the relative lack of buildings and infrastructure present in and around the site. It is mostly flat agricultural farmland fields and commercial forestry areas, defined by vegetated field boundaries and forestry tracks. However, these views are common throughout the local area and due to the intensive agricultural land-use, it is noted that the landscape has been subject to substantial levels of human interference and modification. Views from within the Proposed Project site are generally contained given the surrounding flat landscape and treelines and hedgerows present.

Proposed Mitigation Measures

With regard to tourist attractions and amenity use surrounding the Proposed Project site, traffic management safety measures will be in place, where required. Please see Section 5.10.2.7 for Traffic mitigation measures and Chapter 15 Material Assets for mitigation measures relating to the Proposed Project site.

Residual Effect

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

Significance of Effects

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

5.10.2.10 Major Accidents and Natural Disasters

A risk register has been developed which contains all potentially relevant risks identified during the construction phase of the Proposed Project. Seven risks (Critical Infrastructure Emergencies, Severe Weather, Flooding, Utility Emergencies, Traffic Incident, Contamination, and Fire/Gas Explosion) specific to the construction phase have been identified and are presented in Chapter 16 Major Accidents and Natural Disasters. As outlined in Section 16.4.1 of this EIAR, the scenario with the highest risk score in terms of the occurrence of major accident and/or disaster during construction is identified as 'Contamination' of the Proposed Project site and risk of 'Fire/Explosion' during construction.

Mitigation Measures

- The Proposed Project is designed and will be constructed in line with current best practice and, as such, mitigation against the risk of major accidents and/or disasters will be embedded through the design. In accordance with the provision of the European Commission '*Guidance on the preparation of Environmental Impact Assessment Reports'* 2017, a Risk Management Plan will be prepared and implemented on site to ensure an effective response to disasters or the risk of accidents. The plan will include sufficient preparedness and emergency planning measures.
- Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures which details all proposed mitigation and monitoring measures for the construction, operation and decommissioning of the Proposed Project.
- Potential effects associated with contamination during construction, operation and decommissioning are addressed fully in Chapter 8 Land Soil and Geology and Chapter 9 Water of this EIAR. The mitigation measures outlined therein to protect environmental receptors as well as the procedures and measures described in the CEMP will ensure that the risk from these sources is low.
- A CEMP has been prepared for the Proposed Project and is included in Appendix 4-4 of this EIAR. Upon a grant of planning permission for the Proposed Project, the CEMP will be updated prior to the commencement of the development. The CEMP will be a live document maintained by the contractor that will work to ensure that potential risks of major accident and/or disaster are identified, avoided, and mitigated, as necessary. Refer to Appendix 4-4 for the CEMP that sets out the minimum standards to be employed by the contractor.

Residual Effect

The impact assessment concludes that the risk of a major accident and/or disaster during the construction phase of the Proposed Project is considered **'low'** in accordance with the '*Guide to Risk Assessment in Major Emergency Management'* (DoEHLG, 2010). It is considered that when the mitigation and monitoring measures outlined in the CEMP (Appendix 4-4) are implemented there will not be significant residual effect(s) associated with the construction of the Proposed Project.

Significance of Effects

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

5.10.2.11 Shadow Flicker

Shadow flicker, which occurs during certain conditions due to the movement of wind turbine blades, as described in Section 5.8 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 Project.

5.10.2.12 Residential Amenity

The potential for impacts on residential amenity are discussed in Section 5.9 above. There is the potential for impacts on residential amenity during the construction phase of the Proposed Project due to air, traffic, noise, and vibration emissions due to additional traffic and plant machinery. This will have a short-term slight negative impact.

Proposed Mitigation Measures

All mitigation as outlined above and the corresponding chapters: Chapter 10 Air Quality, Chapter 12 Noise and Vibration, Chapter 14 Landscape, and Chapter 15 Material Assets, will be implemented in order to reduce insofar as possible, impacts on residential amenity at properties located in the vicinity of Proposed Project construction works. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

Residual Effects

Following the implementation of the above mitigation measures, there will be a short-term negative imperceptible effect from the construction phase of the Proposed Project.

Significance of Effects

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

5.10.3 Operational Phase

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

5.10.3.1 Health and Safety

It is not anticipated that the operation of the Proposed 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. This will have a potential long-term, slight impact on health and safety during the operation phase.

Proposed Mitigation Measures

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

Access to the turbines is through a door at the base of the structure, which will be locked at all times outside maintenance visits. Furthermore, signs will also be erected at suitable locations across the Proposed Project site as required for the ease and safety of operation of the wind farm. These signs include:

- Buried cable route markers at 50m (maximum) intervals and change of cable route direction;
- Directions to relevant turbines at junctions;
- "No access to Unauthorised Personnel" at appropriate locations;
- Speed limits signs at site entrance and junctions;
- "Warning these Premises are alarmed" at appropriate locations;
- "Danger HV" at appropriate locations;
- "Warning – Keep clear of structures during electrical storms, high winds or ice conditions" at site entrance;
- "No unauthorised vehicles beyond this point" at specific site entrances; and
- Other operational signage required as per site-specific hazards.
- The onsite 38kV substation, which will be operated by ESB will be locked and fenced off from public access. The substation will be operational remotely and manually 24 hours per day, 7 days a week. Supervisory operational and monitoring activities will be carried out remotely using a SCADA system, with the aid of computers connected via a telephone modem link
- For operational and inspection purposes, substation access is required.
  - Servicing of the substation equipment will be carried out in accordance with the manufacturer's specifications, which would be expected to entail the following:
    - Six-month service – three-week visit
    - Annual service – six-week visit
    - Weekly visits as required

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

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 Health and Safety Plan for the operational phase will be completed in accordance with the most up to date health and safety legislation in force at the time of operation and will be submitted to the relevant local authority prior to the operational phase of the Proposed Wind Farm.

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

Residual Effect

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

Significance of Effects

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

5.10.3.2 Employment and Investment

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

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

Rates payments for the Proposed Project will contribute significant funds to Carlow County Council, which will be redirected to the provision of public services within Co. Carlow. 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.

Should the Proposed Project 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 €240,000/year, assuming the current terms of the RESS, 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.

Proposed Mitigation Measures

No mitigation required.

Residual Effect

With the implementation of the above schemes, there will be a long-term slight positive effect on local communities.

Significance of Effects

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

5.10.3.3 Population

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

Proposed Mitigation Measures

No mitigation required.

Residual Effect

No residual effects.

Significance of Effects

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

5.10.3.4 Land-Use

The permanent footprint of the Proposed Project site, including turbines, roads etc., will occupy only a small percentage (2%) of the site defined for the purposes of this EIAR. The main land-use at the Proposed Project site is commercial forestry and agriculture.

Throughout the duration of the operational phase, any commercial forestry and agriculture-related activity on the site will continue to co-exist with the Proposed Project. The Proposed Project will have no impact on other land-uses within the wider area.

Proposed Mitigation Measures

As detailed in the Biodiversity Management and Enhancement Plan (BMEP) (Appendix 6-4) hedgerow, shrub and treelines will be replanted within the three biodiversity enhancement areas (Table 3-1 in Appendix 6-4). There is an extensive network of existing linear landscape features in the wider area that will be retained, and the proposed replanting will enhance connectivity across the Proposed Wind Farm site and wider landscape.

Broadleaved native tree species will be planted throughout the Proposed Wind Farm site which will add to the overall species diversity present within the site. It is proposed to plant Oak, Alder, Birch and Rowan trees; please see Appendix 6-4 for further details on tree replanting. Any tree, hedge or shrub that is removed, uprooted, destroyed or that becomes seriously damaged, defective diseased or dead shall be replaced in the same location with another plant of the same species and size as that originally planted. All such replacements shall be carried out within the first planting season following the loss.

Residual Effects

Due to the small footprint of the Proposed Project infrastructure on a site scale and even more so on a local scale, the residual effect is considered to be a permanent slight negative direct effect on land use and activities during the operational phase.

Significance of Effects

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

5.10.3.5 Noise and Vibration

A baseline assessment of the existing background noise conditions was carried out, the results of which are presented in Chapter 12 of the EIAR. A noise assessment of the operational phase of the Proposed Project has also been carried out through modelling of the development using noise prediction software. The Site-Specific Noise Limits have been derived to take account of the proportion of the noise limit that has been allocated to, or could theoretically be used by, other wind farm developments in proximity to the Proposed Wind Farm.

The Site-Specific Noise Limits were compared to the predictions of the Proposed Wind Farm operating on its own, and the results, based on the precautionary scenario candidate turbine for the Proposed Wind Farm (Vestas V150), are summarised in Table 12-14 for the daytime and Table 12-15 for the night-time in Chapter 12 of this EIAR: Noise & Vibration. More details on the calculation of the Site-Specific Noise Limits and predictions for the other two candidate wind turbines is provided in Appendix 12-2 and show very similar predictions and outcomes when compared to the V150.

The Stage 3 assessment shows that the predicted wind turbine noise levels from the Proposed Wind Farm on its own meet the Site-Specific Noise Limits at NALs 1-3, 7-14, 16-18 for both daytime and night time periods and as such there would be **no significant effects** at those receptors. At NAL15 a small exceedance of the Site-Specific Noise Limit was predicted during the daytime at 6 ms^{-1} (0.8 dB). There would therefore be a potential **significant effect** at NAL15. Mitigation in the form of low noise mode operation is proposed for specific wind speed and direction, for the candidate turbine.

The BESS predictions show that the operational noise levels are significantly below the BS 8233 guideline noise levels. Accordingly, there would be **no significant effects**. Full details of the modelling and assessment can be found in Appendix 12-3.

Proposed Mitigation Measures

Please see Chapter 12 Section 12.7 for noise and vibration mitigation and monitoring proposed for the Proposed Project. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of mitigation and monitoring measures for the proposed for the Proposed Project.

Residual Effects

Based on the above assessment and the identified mitigation measures in Section 12.7 in Chapter 12 of this EIAR, there will be **no significant residual effect** from operational turbine and BESS noise

Please see Chapter 12 Noise and Vibration for details.

Significance of Effects

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

5.10.3.6 Traffic

The impacts on the surrounding local highway network will be negligible given that there will only be an average of approximately 1 to 2 trips made to the Proposed Wind Farm site by car or LGVs per day, with less than that required for the Proposed Grid Connection Route. The effects of the maintenance traffic on the surrounding highway network will therefore be imperceptible.

Proposed Mitigation Measures

Due to the very low volumes of traffic forecast to be generated during this stage no mitigation measures are required.

Residual Effect

As the traffic impact of the Proposed Project will be imperceptible during the operational stage, there will be no residual effects during this stage.

Significance of Effects

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

5.10.3.7 Property Values

As noted in Section 5.7 above, conclusions from available international literature vary, therefore for the Proposed Wind Farm it has been determined that there is potential for long-term slight negative impact on property values.

Proposed Mitigation Measures

All mitigation relevant to property values, outlined above and the corresponding chapters: Chapter 10 Air, Chapter 12 Noise and Vibration, Chapter 14 Landscape, and Chapter 15 Material Assets, will be implemented in order to reduce insofar as possible, impacts on property values at properties located in the vicinity of the Proposed Project once operational. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

Residual Effect

With the implementation of the above referenced mitigation measures, there would be a long-term imperceptible negative effect from the Proposed Project.

Significance of Effects

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

5.10.3.8 Tourism

Given that there are currently no tourism attractions or amenity walkways located within the Proposed Project 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 Project 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 Project into this environment.

Proposed Mitigation Measures

No mitigation required.

Residual Effects

Based on the above there will be no residual effects on tourism.

Significance of Effects

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

5.10.3.9 Major Accidents and Natural Disasters

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

Proposed Mitigation Measures

- The Proposed Project will be designed and built in line with current best practice and, as such, mitigation against the risk of major accidents and/or disasters will be embedded through the design. In accordance with the provision of the European Commission '*Guidance on the preparation of Environmental Impact Assessment Reports'* 2017, a Risk Management Plan will be prepared and implemented on site to ensure an effective response to disasters or the risk of accidents. The plan will include sufficient preparedness and emergency planning measures.
- Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures which details all proposed mitigation and monitoring measures for the construction, operation and decommissioning of the Proposed Project.
- The Proposed Project will also be subject to a fire safety risk assessment in accordance with Chapter 19 of the Safety, Health and Welfare at Work Acts 2005 to 2014, which will assist in the identification of any major risks of fire on site, and mitigation of the same during operation.

Residual Effect

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

Significance of Effects

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

5.10.3.10 Shadow Flicker

As detailed in Section 5.8.6.1, of the 117 no. properties modelled:

- 13 of the dwellings are Participating Properties; and
- 6 are in derelict condition (of which 3 are Participating Properties)

These 19 no. properties will not require mitigation measures as a result.

Of the remaining 98 no. properties, assuming theoretical precautionary 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.), it is predicted that 61 no. properties may experience daily shadow flicker occurrences as a result of the Proposed Project. This will result in a potential long-term moderate negative impact on sensitive receptors.

Proposed Mitigation Measures

Where daily shadow flicker exceedances have been predicted at buildings by the modelling software, a site visit will be undertaken firstly to determine the level of occurrence, existing screening, and window orientation. Upon commissioning of the Proposed Project, 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.).*
1. *Recording the house number, time and duration of site visit and the observation point GPS coordinates.*
2. *Recording the nature of the sensitive receptor, its orientation, windows, landscaping in the vicinity, any elements of the built environment in the vicinity, vegetation.*
3. *In the event of shadow flicker being noted as occurring the details of the duration (times) of the occurrence will be recorded.*

Screening Measures

In the event of an occurrence of shadow flicker exceeding guideline threshold values of 30 minutes per day at a residential receptor, 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 will be fitted with shadow flicker control units to allow the turbines to be controlled to prevent the occurrence of shadow flicker at properties surrounding the wind farm. The shadow flicker control units will be added to any required turbines and are not cost prohibitive.

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

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

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

These measures will be utilised at the Proposed Project site to prevent incidences of shadow flicker values at any house. Therefore, the Proposed Project will be brought in line with the requirements of the Draft DoEHLG 2019 Guidelines should they be adopted during the planning application process for this development.

Should a complaint be received within 12 months of commissioning of the wind farm, field investigation/monitoring will be carried out by the wind farm operator at the affected property. With the permission of the homeowner, the wind farm developer will log the date, time and duration of shadow flicker events occurring on at least five different days from within the dwelling. 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 Effects

The implementation of the above mitigation measures, where necessary, will ensure that there will be no shadow flicker experienced at properties within 10 rotor diameters from the Proposed Project as proposed by the Draft DoEHLG 2019 Guidelines.

Planning permission is being sought for a turbine with a minimum tip height of 179.5m and a maximum tip height of 180m. The potential shadow flicker impact that the turbines will give rise to will be no more than that predicted in this assessment using the maximum proposed rotor diameter of 155m. With the benefit of the mitigation measures outlined in this section, any turbine to be installed onsite will be able to comply with the Draft DoEHLG 2019 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.

Based on the above, there will be no residual effect on human health from shadow flicker.

Significance of Effects

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

5.10.3.11 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 show that the Proposed Project will be capable of meeting all required guidelines in relation to noise thresholds and the shadow flicker thresholds set out in the DoEHLG 2006 Guidelines and the Draft DoEHLG 2019 Guidelines.

The visual impact of the Proposed Project is addressed comprehensively in Chapter 14 of this EIAR. An assessment of roadside screening was carried out for roads within 3 kilometres of the proposed turbine locations, with both the methodology and findings of this described in Section 14.3.4.1 of this EIAR. 'Little/No Screening' was recorded for approximately a fifth (19.9%) of the surveyed roads and was the least common class recorded. 'Partial/Intermittent' screening was recorded for 33% pf the surveyed roads and 'Full Screening' was recorded for 47.1% of the roads surveyed, which suggests that the ZTV is not a true reflection of the actual likely visibility of the Proposed turbines. Given the separation distance of the residential properties from the proposed turbines, and the level of existing screening in the area, the Proposed Project 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 Project. Full details are provided in Section 2.7 of the EIAR (in Chapter 2: Background to the Proposed Project) and Section 15.2 of the EIAR (in Chapter 15: Material Assets – Other Material Assets). Copies of scoping replies received are presented in Appendix 2-1 of the EIAR. The Proposed Project will have no impact on telecommunications.

Proposed Mitigation Measures

As detailed above, the closest proposed turbine, Proposed Wind Farm turbine T03 is 724m from the nearest inhabitable 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 Project works, including along the proposed turbine and construction materials haul route and the Proposed Grid Connection Route.

Residual Effects

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

Significance of Effects

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

5.10.3.12 Renewable Energy Production and Reduction in Greenhouse Gas Emissions

As detailed in Section 11.3.2.8 of Chapter 11 Climate, the EPA reported a provisional total of national greenhouse gas emissions for 2022 to be 60.76 million tonnes carbon dioxide equivalent ($MtCO_2eq$); with overall electricity generation in Ireland increasing by 2.1% and renewable electricity generation increasing by 3.6%.[36] The increase in renewables, combined with decreases in coal, oil, and peat use,

[36] *Ireland's Provisional Greenhouse Gas Emissions 1990-2022 (June 2023)* <https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/2023-EPA-Provisional-GHG-Report_Final_v3.pdf>

resulted in the emissions intensity of power generation in Ireland in 2022 decreasing by 4.8%; i.e., 331 gCO_2/kWh in 2022 as compared with 348 gCO_2/kWh in 2021. In 2022 the energy industry, transport and agriculture sectors accounted for 74.1% of total greenhouse gas emissions. Agriculture was the single largest contributor to overall emissions, being responsible for 38.4% of emissions. Transport and the energy industry accounted for 19.1% and 16.6% of total Irish emissions respectively. The EPA report highlights that whilst emissions are beginning to reduce, transformative measures will be needed to meet National Climate ambitions.

Ireland will therefore have to meet even more demanding climate change and renewable energy supply obligations in order to play its part in achieving the European climate and energy ambitions. As announced in December 2022, the Irish Government have pledged to generate 80% of the country's electricity supply from renewable sources by 2030.[37] The development of additional indigenous wind energy generating capacity, such as that proposed from the Proposed Wind Farm, will help to reduce carbon emissions and improve Ireland's security of energy supply.

The Proposed Project will offer significant benefits in terms of renewable energy production and reductions in greenhouse gas emissions and other air pollutants. In this regard, it will have a long-term moderate positive impact. The carbon loss and savings due to the Proposed Project are discussed in Section 11.5.2 of Chapter 11 of this EIAR.

5.10.3.13 Interference with Communication Systems

Wind turbines, like all large structures, have the potential to interfere with broadcast signals, by acting as a physical barrier or causing a degree of scattering to microwave links. The alternating current, electrical generating and transformer equipment associated with wind turbines, like all electrical equipment, also generates its own electromagnetic fields, and this can interfere with broadcast communications. The most significant effect at a domestic level relates to a possible flicker effect caused by the moving rotor, affecting, for example, radio signals. The most significant potential effect occurs where the wind farm is directly in line with the transmitter radio path. This interference can be overcome by the installation of deflectors or repeaters.

As part of the scoping and consultation exercise undertaken by MKO, the national and regional broadcasters and fixed and mobile phone operators were contacted regarding potential interference from the Proposed Project. Full details are provided in of Chapter 2: Background to the Proposed Project and Section 15.2 (Telecommunications and Aviation) of Chapter 15: Material Assets. Copies of the scoping responses received are presented in Appendix 2-1 of the EIAR.

Responses were received from Ajisko Limited, Broadcasting Authority of Ireland, BT Communications Ireland, Commission for Communications Regulation, Eir, Enet, Imagine Group, Integrated Media Solutions, Lighthouse Networks Limited, RTE Transmission Network, St. Canices Credit Union Limited, Three Ireland Limited, Towercom, and Vodafone Ireland. Enet flagged one planned link in could potentially be affected by the Proposed Project. Full details are provided in Section 15.2 of the EIAR (in Chapter 15: Material Assets – Other Material Assets). This could have a potential negative, moderate, long-term effect on users of the planned communication link.

Proposed Mitigation Measures

Following the scoping and consultation exercise undertaken by MKO, Enet and the Applicant agreed mitigation options regarding potential interference with their planned link to be implemented in the Proposed Project. These include the decommissioning of the potentially affected line and installation of

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[37] *Department of the Environment, Climate and Communications (2022) Climate Action Plan 2023 <https://www.gov.ie/en/publication/7bd8c-climate-action-plan-2023/>*

2 no. new lines redirected around the Proposed Wind Farm. Full details are provided in Section 15.2 of the EIAR (in Chapter 15: Material Assets – Other Material Assets). Copies of scoping replies received are presented in Appendix 2-1 of the EIAR. Further detail on the actions taken to ameliorate any potential interference, including micro-siting of turbines can be found in Chapter 3 and Chapter 14.

Residual Effects

Following the implementation of the mitigation measures above, there will be no residual effect from the Proposed Project on communication systems.

Significance of Effects

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

5.10.4 Decommissioning Phase

The wind turbines proposed as part of the Proposed Project are expected to have a lifespan of approximately 35 years. Following the end of their useful life, the wind turbines may be replaced with a new set of turbines, subject to planning permission being obtained, or the Proposed Wind Farm site will be decommissioned fully as described in Chapter 4 and the accompanying decommissioning plan in Appendix 4-7.

The Proposed Grid Connection Roue and the onsite 38kV substation will remain in place as it will form part of the national electricity grid under the control of ESB / EirGrid. The battery energy storage system will remain in place.

The works required during the decommissioning phase are described in Section 4.10 in Chapter 4 of this EIAR. Any impact and consequential effect that occurs during the decommissioning phase will be similar to that which occurs during the construction phase, however to a lesser extent.

5.10.5 Cumulative and In-Combination Effects

For the assessment of cumulative impacts, any other existing, permitted or Proposed Project (wind energy or otherwise) have been considered where they have the potential to generate an in-combination or cumulative impact with the construction and operational phases of the Proposed Project. Further information on projects considered as part of the cumulative assessment are given in Section 2.5 and Section 2.9 of this EIAR. The impacts with the potential to have cumulative impacts on population and human health, in particular noise, air and climate, shadow flicker, traffic, telecommunications, and visual impacts are addressed in their relevant chapters of this EIAR.

5.10.5.1 Health and Safety

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

5.10.5.2 Employment and Economic Activity

There are two existing and/or permitted wind energy developments within the Population Study Area. Any permitted projects along with the Proposed Project will contribute to short term employment during construction stages. All wind farms, including the Proposed Project, will provide the potential for long-term employment resulting from maintenance operations. This results in a long-term, moderate positive impact.

The commercial forestry activities on the Proposed Project site provides between 3-6 months of employment, either for harvesting or replanting per year. These activities can continue while the proposed wind farm is under construction and operating, resulting in a long-term moderate positive cumulative impact.

5.10.5.3 Tourism and Amenity

There are no key identified tourist attractions pertaining specifically to the Proposed Project itself. As mentioned previously, wind farms are an existing feature in the surrounding landscape, which will assist in the assimilation of the Proposed Project into this environment. A detailed assessment of cumulative landscape and visual effects resulting from the Proposed Wind Farm is provided in Section 14.6 of Chapter 14 of this EIAR and likely cumulative landscape effects are assessed in the landscape character assessment tables in *Appendix 14-2: LCA Assessment Tables*, and likely cumulative visual effects are assessed in the photomontage assessment tables in *Appendix 14-3: Viewpoint Assessment Tables*.

Given the Proposed Project's relative isolation and remoteness, it is considered that the Proposed Project will support the development of the wider area, attracting local and new visitors to the area which could be uncovered as part of a wider regional strategy.

5.10.5.4 Land-Use

Existing land-uses (commercial forestry, agriculture, etc.) will continue in conjunction with the Proposed Project and all other existing and permitted wind farms (as shown in Figure 2-1 of this EIAR). Therefore, there will be no significant cumulative impact on land-use.

5.10.5.5 Property Values

As noted in Section 5.7 above, the conclusions from available international literature indicate that the presence of wind farms will result in a short-term imperceptible negative effect on property values. It is on this basis that it can be concluded that there would be a short-term imperceptible negative cumulative impact from the Proposed Project.

5.10.5.6 Shadow Flicker

As noted in Section 5.8.8 above, the cumulative shadow flicker model results show that there is potential for cumulative shadow flicker to be experienced at 25 no. properties assessed due to the permitted Bilboa Wind Farm and permitted White Hills Wind Farm in conjunction with the Proposed Project. Of these 25 no. properties, shadow flicker as a result of the Proposed Project may be experienced at 9 no. properties. This has potential to be a moderate, negative, long-term effect on these sensitive receptors and would therefore require mitigation to reduce this to zero, as per the Draft DoEHLG 2019 Guidelines.

Proposed Mitigation Measures

Table 5-10 lists the 9 no. properties at which a shadow flicker mitigation strategy may be necessary to ensure no cumulative shadow flicker is experienced. Where the Proposed Wind Farm is modelled to contribute to the annual shadow flicker experienced by any of the 9 no. properties, the relevant Proposed Wind Farm turbines will be programmed to switch off for the appropriate time to prevent any shadow flicker experience at these locations.

Residual Effect

Following the implementation of the above mitigations measures, the Draft DoEHLG 2019 Guidelines requirement of no shadow flicker experienced on inhabitable dwellings as a result of the Proposed Wind Farm will be achieved. Therefore, there will be no residual effect from shadow flicker on human health.

Significance of Effects

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