5. POPULATION AND HUMAN HEALTH

5.1 Introduction

This Chapter of the Environmental Impact Assessment Report (EIAR) identifies, describes and assesses the potential significant, direct and indirect effects of the Proposed Development (Wind Farm Site and Grid Connection), 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, May 2022). The full description of the Proposed Development is provided in Chapter 4 of this EIAR.

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

There are 15 no. residential dwellings located within one kilometre of any proposed wind turbine location. A minimum separation distance of 751m from the wind turbine (T06) to the nearest point of any occupied, residential dwelling (H492) has been achieved with the project design.

5.2 Statement of Authority

This section of the EIAR has been prepared by Shaun Doolin and reviewed by Eoin O'Sullivan, both of whom are Environmental Scientists with MKO. Shaun was an Environmental Scientist with MKO with a B.A. (Hons) in Geography and M.Sc. (Hons) in Environmental Science from Trinity College Dublin. Shaun has over 2 years' experience in private practice, where he has completed numerous assessments for EIAs and has experience composing a variety of EIAR chapters; particularly the preparation of population and human health assessments and reports for EIAs relating to wind energy. Eoin O'Sullivan is a Project Director with MKO; with over 15 years' experience in the environmental sector. Eoin has wide experience in the project management of large-scale infrastructural projects, including the management and productions of Environmental Impact Statements (EISs)/EIARs, particularly within the wind energy sector. Eoin also has extensive experience in the preparation of population and human health assessments and reports for EIAs.

5.2.1 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Population and Human Health Chapter of the EIAR.

5.3 Population

5.3.1 Receiving Environment

Information regarding population and general socio-economic data were sourced from the Central Statistics Office (CSO), the Clare County Development Plan 2023 – 2029 and Fáilte Ireland. The study included an examination of the population and employment characteristics of the Study Area defined below. This information was sourced from the Census of Ireland 2022, the Census of Ireland 2016, the

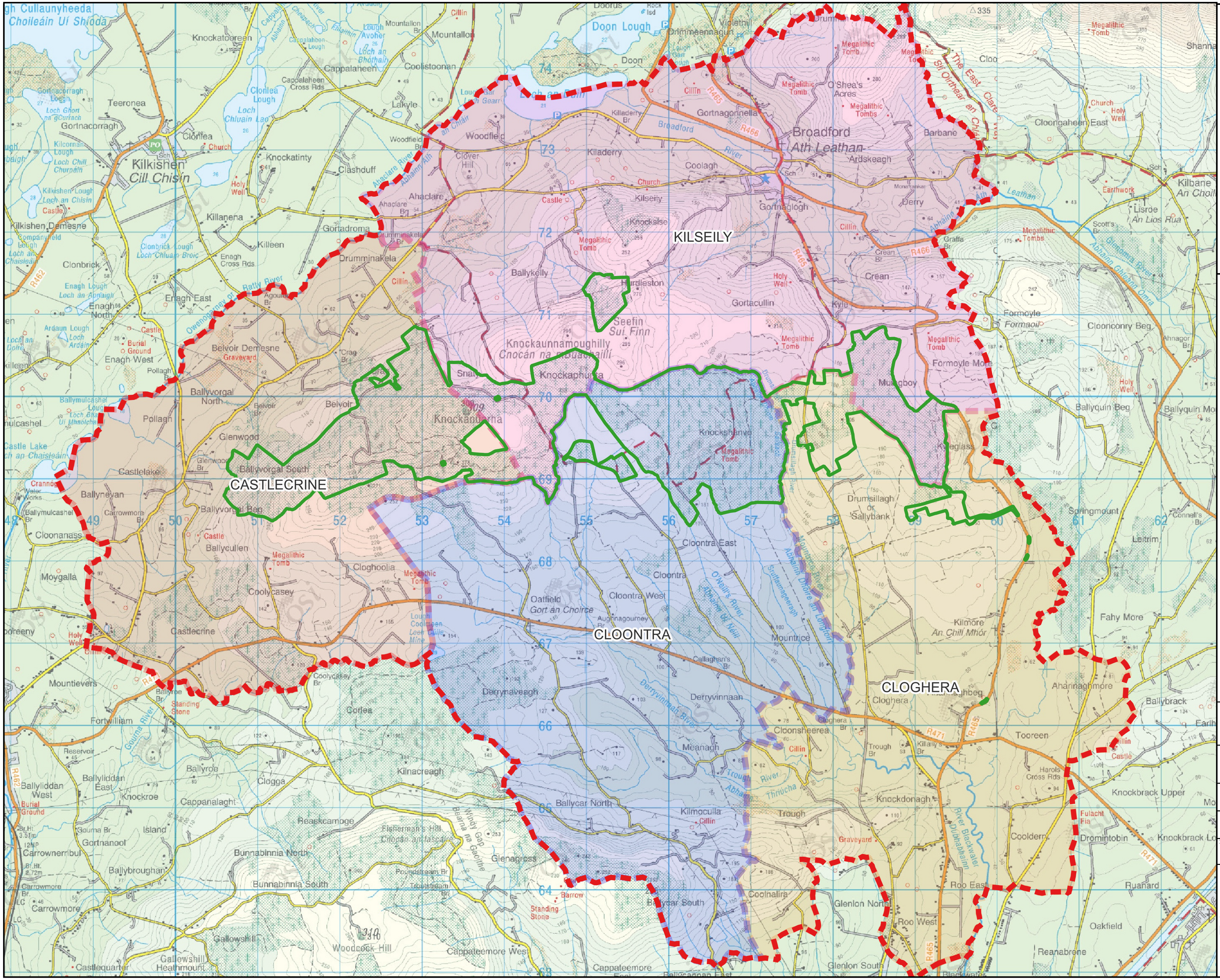
Census of Agriculture 2020 and from the CSO website, www.cso.ie. Fáilte Ireland's EIAR Guidelines for the Consideration of Tourism and Tourism Related Projects (July 2023) was also considered in this assessment. Census information is divided into State, Provincial, County, Major Town and Electoral Division (ED) level.

The Proposed Development is located in a number of townlands as listed in Table 1-1 of Section 1.1 of this EIAR. Current land-use on the Wind Farm Site comprises coniferous forestry, biodiversity areas under Coillte management and third-party lands currently being used for agriculture and forestry. Current land-use along the Grid Connection comprises of public road corridor and coniferous forestry. Land-use in the wider landscape comprises a mix of agriculture, low density residential and commercial forestry. The Wind Farm Site is located approximately 3 km south of Broadford, 3.5 km southeast from Kilkishen, and 4 km northeast from Sixmilebridge, Co. Clare. The Grid Connection will originate from the proposed onsite 110kV electrical substation and will be connected to the national grid via an underground 110kV electrical cabling to Ardnacrusha 110kV electrical substation. The site location is shown in Figure 1-1 of Chapter 1 of this EIAR.

In order to assess the population in the vicinity of the Wind Farm Site, the Study Area for the population section of this EIAR was defined in terms of the Electoral Divisions (EDs) within which the proposed wind turbines were located, as well as EDs within close proximity of the proposed wind turbines. The Wind Farm Site lies within the Castlecrine, Kilseily, Cloontra and Cloghera EDs as shown in Figure 5-1. All of these EDs will collectively be referred to hereafter as the Population Study Area for this chapter. The Population Study Area has a total population of 2,207 as of 2022 and comprises a total land area of approximately 91 km² (Source: CSO Census of the Population 2022).

In order to assess the population along the Grid Connection route, a review of properties and planning applications in the vicinity of the Grid Connection was carried out. (The active construction area for the Grid Connection will be small, ranging from 150 to 300 metres in length at any one time, and it will be transient in nature as it moves along the route.

The findings of the population review indicated that where development occurs along the Grid Connection the lands nearby comprise one-off dwellings, farm dwellings and associated farm buildings and thus the population is very sparse, with the exception of where the route passes through the village of Ardnacrusha.



Map Legend

- Wind Farm Site Study Boundary
- Population Study Area Boundary

Population Study Area

- Castlecrine DED
- Cloghera DED
- Cloontra DED
- Kilseily DED

N

Drawing Title	
Population Study Area	
Project Title	
Knockshanvo Wind Farm	
Drawn By: SD	Checked By: EOS
Project No.: 200513	Drawing No.: Figure 5-1
Scale: 1:60,000	Date: 2024-08-01

MKO

Planning and Environmental Consultants

Tuam Road, Galway Ireland, H91 VW84
+353 (0) 91 735611
email:info@mkoireland.ie
Website: www.mkoireland.ie

5.3.2 Population Trends

In the period 2016 to 2022, the population of Ireland increased by 8.1%. Between 2016 and 2022, the population of Co. Clare increased by 7.7% to 127,938 persons. Population statistics for the State, County Clare and the Population Study Area have been obtained from the CSO and are presented in Table 5-1. The ED within the Population Study Area with the highest population recorded in the 2022 Census was Kilseily ED, with a population of 819. The lowest population recorded in the 2022 Census was in Cloontra ED, with a population of 307.

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

Area	Population		% Population Change
	2016	2022	2016-2022
State	4,761,865	5,149,139	8.1%
County Clare	118,817	127,938	7.7%
Population Study Area	2,055	2,207	7.4%

The data presented in Table 5-1 shows that the population of the Population Study Area increased by 7.4% between 2016 and 2022. When the population data is examined in closer detail, it shows that the rate of population change within the Population Study Area has been unevenly distributed between the EDs. The population of Cloontra ED and Kilseily ED increased by a relatively large 13.7% and 11.1%, respectively. The population of Castlecrine ED increased by a moderate 6%. While the population of Cloghera ED saw a slight increase of 0.9% in the period 2016 and 2022.

5.3.3 Population Density

The population densities recorded within the State, County Clare 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.ie)

Area	Population Density (Persons per km^2)		% change in Population Density
	2016	2022	2016-2022
State	67.76	73.27	+8.1%
County Clare	34.44	37.08	+7.7%
Population Study Area	22.55	24.22	+7.4%

The population density of the Population Study Area recorded during 2022 was 24.22 persons per km^2. This figure is lower than the national population density of 73.27 persons per km^2, and the county population density of 37.08 persons per km^2 recorded for County Clare.

The population densities of the EDs within the Population Study Area during 2022 are relatively similar between ED and are lower than the State and County population densities. Kilseily ED, which includes the town of Broadford recorded the highest population density within the Population Study Area, of 29.45 persons per km^2. Cloghera ED has a population density of 28.22 persons per km^2. Castlecrine ED recorded a population density of 26.1 persons per km^2. Cloontra ED is the only ED with a population density lower than that of the Population Study Area, with 13.01 persons per km^2.

5.3.3.1 Household Statistics

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

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

Area	2016		2022	
	No. of Households	Avg. Size (persons)	No. of Households	Avg. Size (persons)
Republic of Ireland	1,702,289	2.75	1,841,152	2.74
County Clare	43,469	2.69	46,553	2.67
Population Study Area	658	3.17	709	3.15

The figures in Table 5-3 show that the number of households within the State, County and Population Study Area have increased. However, the average household size only slightly decreased in the State, County and Population Study Area overall. Cloontra ED recorded the largest household size in both 2016 and 2022, with an average household size of 3.4 and 3.52, respectively. All remaining EDs recorded an average household size of between 3.04 and 3.22 for both the 2016 and 2022 Census.

5.3.3.2 Age Structure

Table 5-4 presents the percentages of the State, County Clare and the 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	19.66%	12.52%	27.62%	25.12%	15.08%
County Clare	19.54%	12.41%	24.02%	27.10%	16.93%
Population Study Area	21.34%	14.68%	21.21%	29.54%	13.23%

As per the County population percentages, the highest population percentage in the Population Study Area occurs within the 45-64 range age category, at 29.54%. 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 65+ range age category, at 13.23%. This is lower than both the State and County population percentages, with this age category being considered one of the more sensitive age categories to change. The population percentage of the Population Study Area is greater in the 0-14 and 15-24 age categories when compared with the State and County population percentages, indicating a younger population when compared to the State and County.

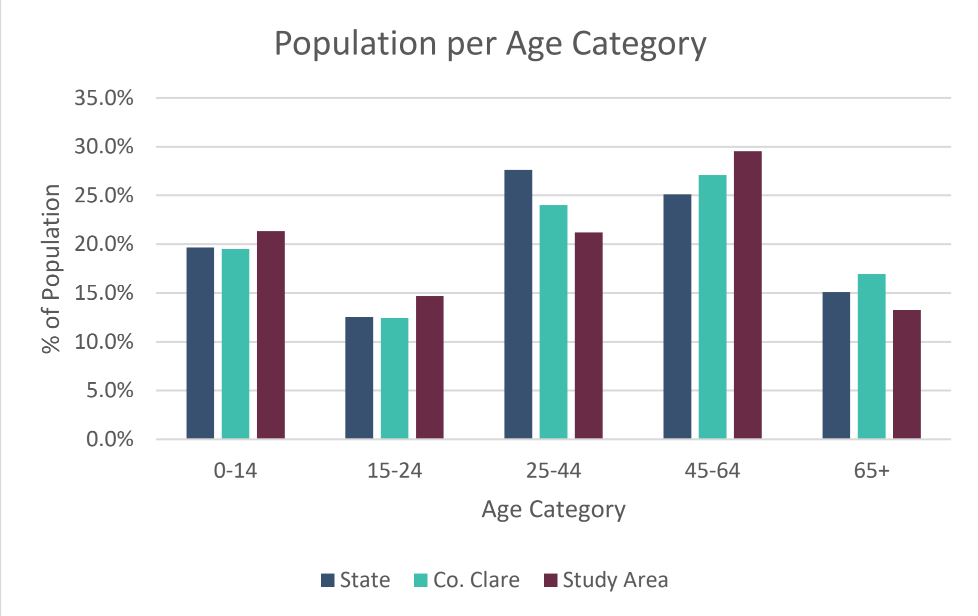


Figure 5-2 Population per Age Category in 2022 (Source: CSO)

5.3.4 Employment and Economic Activity

5.3.4.1 Economic Status

The labour force consists of those who can work, i.e., those who are aged 15+, out of full-time education and not performing duties that prevent them from working, as defined by the Central Statistics Office during the 2022 Census.

In 2022, there were 2,531,099 persons in the labour force in the State. Table 5-5 shows the percentage of the total population aged 15+ who were in the labour force during the 2022 Census. This figure is further broken down into the percentages that were at work, seeking first time employment or unemployed. It also shows the percentage of the total population aged 15+ who were *not* in the labour force, i.e., those who were students, retired, unable to work or performing home duties.

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

Status		Republic of Ireland	County Clare	Population Study Area
% of population aged 15+ who are in the labour force		**61.2%**	**59.4%**	**62.7%**
% of which are:	At work	91.6%	91.9%	95.3%
	First time job seeker	1.4%	1.3%	0.8%
	Unemployed	7.1%	6.8%	3.9%
% of population aged 15+ who are not in the labour force		**38.8%**	**40.6%**	**37.3%**
% of which are:	Student	28.6%	28.0%	37.7%

Status		Republic of Ireland	County Clare	Population Study Area
	Home duties	17.0%	15.7%	17.8%
	Retired	41.0%	43.8%	35.5%
	Unable to work	11.8%	10.7%	7.6%
	Other	1.7%	1.8%	1.4%

Overall, the principal economic status of those within the labour force living in the Population Study Area is similar to that recorded at State and County level. Of those who were not in the labour force during the 2022 Census, the highest percentage of the population in the Population Study Area was in the 'Student' category, which differs from figures recorded at national and County level that show 'Retired' as the highest category.

5.3.4.2 Employment and Investment Potential in the Irish Wind Energy Industry

5.3.4.2.1 *Background*

The Sustainable Energy Authority of Ireland estimates, in their *Wind Energy Roadmap 2011-2050*[1], that onshore and offshore wind could create 20,000 direct installation and operation/maintenance jobs by 2040 and that the wind industry would also have an annual investment potential of €6-12 billion by the same year.

A 2014 report *The Value of Wind Energy to Ireland*[2], 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, 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.

Siemens, in conjunction with Wind Energy Ireland (WEI), published a report in 2014 titled *An Enterprising Wind: An economic analysis of the job creation potential of the wind sector in Ireland*[3], which concluded, *'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 goes on to consider 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

[1] *Sustainable Energy Authority of Ireland 2011, Wind Energy Roadmap to 2050 Available at: https://www.seai.ie/publications/Wind_Energy_Roadmap_2011-2050.pdf*

[2] *Poyry Management Consulting: The Value of Wind Energy to Ireland': A report to Irish Wind Energy Association 2014. Available at: https://windenergyireland.com/images/files/9660bd6b05ed16be59431aa0625855d5f7dca1.pdf*

[3] *Siemens, IWEA 2014 An Enterprising Wind: An economic analysis of the job creation potential of the wind sector in Ireland. Available at: https://www.esri.ie/system/files/media/file-uploads/2015-07/BKMNEXT250.pdf*

- Electricity Grid Network Employment
- Potential Wind Turbine Manufacturing Employment

WEI released a report in March 2021 titled *Our Climate Neutral Future Zero by 50* [4] in light of the Government's announcement of new, ambitious energy targets in the same month. The report outlines the potential for 50,000 jobs to be created in the renewable energy industry in order to meet the build out requirements to achieve a Net -Zero carbon emissions by 2050. The report estimates that at least 25,000 jobs will be in the onshore and offshore wind energy sector.

KPMG released a report with WEI in April 2021 titled *Economic impact of onshore wind in Ireland*[5] which states that the wind sector currently supports 5,130 jobs (not including employment in grid development) with a '*with a strong foothold in rural Ireland*…[…]… *through its direct and indirect activities and employment, the sector supports payment of labour incomes totalling €225 million'.*

Statistics obtained from WEI[6] (accessed in July 2024) indicate that as of May 2022, there were over 5,585 Megawatts (MW) of wind energy capacity installed on the island of Ireland. Of this, 4,332.5 MW was installed in the Republic of Ireland, with 1,276 MW installed in Northern Ireland. The majority of the Republic of Ireland's installed wind energy capacity is located in Counties Mayo, Galway, Cork and Kerry.

5.3.4.2.2 Economic Value

A 2009 Deloitte report in conjunction with the Irish Wind Energy Association (now Wind Energy Ireland, WEI) titled *Jobs and Investment in Irish Wind Energy – Powering Ireland's Economy*[7] states that the construction and development of wind energy projects across the island of Ireland would involve approximately €14.75 billion of investment from 2009 up to 2020, €5.1 billion of which would be retained in the Irish economy (€4.3 billion invested in the Republic of Ireland and €0.8 billion in Northern Ireland).

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

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

A 2019 report by Baringa, *Wind for a Euro: Cost-benefit analysis of wind energy in Ireland 2000-2020*, has analysed the financial impact for end consumers of the deployment of wind generation in Ireland over the period 2000-2020. The report calculates how the costs and benefits for consumers would have differed if no wind farms had been built. The analysis indicated that the deployment of 4.1 GW of wind generation capacity in Ireland between 2000 and 2020 (2018-2020 results being projective) will result in a total net cost to consumers, over 20 years, of €0.1bn (€63 million to be exact), which equates to a cost of less than €1 per person per year since 2000. Further cost benefit analysis noted that wind

[4] *Wind Energy Ireland, MaREI March 2021 Our Climate Neutral Future Zero by 50. Available at: https://windenergyireland.com/images/files/our-climate-neutral-future-0by.50-final-report.pdf*
[5] *KPMG, Wind Energy Ireland April 2021 Economic impact of onshore wind in Ireland. Available at: https://windenergyireland.com/images/files/economic-impact-of-onshore-wind-in-ireland.pdf*
[6] *Wind Energy Ireland, Wind Stats. Available at: https://windenergyireland.com/about-wind/the-basics/facts-stats*
[7] *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*

energy has delivered €2.3 billion in savings in the wholesale electricity market. As such, the economic benefit of renewable energy to consumers is greater than what would have been if Ireland did not invest in wind power.

The April 2021 KPMG report discussed above states that by 2030, the onshore wind industry along will bring an Additional Gross Value (GVA) of €550 million per annum to the Irish economy, will contribute €305 million total payment in incomes across the supply chain and has the potential to contribute approximately €100 million to local authority rates, if 2030 targets are reached. Furthermore, it is estimated that €2.7 billion in capital would be invested in the country through to 2030 if Climate Action Plan targets are reached.

If the Proposed Development is consented, it will likely be built out towards the end of the decade, thus contributing to the 2030 targets, providing approximately 80-100 jobs during the construction, operational and maintenance phases overall. Throughout its lifetime, the Proposed Development will also contribute an estimated €6 million in Community Funding for the local area.

5.3.4.2.3 *Energy Targets*

The Climate Action Plan 2024[8] (CAP 2024) was published in December 2023 by the Department of Communications, Climate Action and Environment. Following on from Climate Action Plans 2019,2021 and 2023, CAP 2024 sets out the roadmap to deliver on Ireland's climate ambition. It aligns with the legally binding economy-wide carbon budgets and sectoral ceilings that were agreed by Government in July 2022 following the Climate Action and Low Carbon Development (Amendment) Act 2021, which commits Ireland to a *legally binding target of net-zero greenhouse gas emissions no later than 2050, and a reduction of 51% by 2030.* CAP 2024 seeks to build on the progress made under Climate Action Plan 2023 by delivering policies, measurements and actions that will support the achievement of Irelands carbon budgets, SECs, and 2030 and 2050 climate targets.

In July 2021, the Government of Ireland passed the Climate Action and Low Carbon Development (Amendment) Bill 2021 into law, which commits the country to move to a climate resilient and climate neutral economy by 2050. This Act will manage the implementation of a suite of policies to assist in achieving this these annual targets. The Act includes the following key elements, among others:

- Places on a statutory basis a 'national climate objective', which commits to pursue and achieve no later than 2050, the transition to a climate resilient, biodiversity-rich, environmentally sustainable and climate-neutral economy.
- Embeds the process of carbon budgeting into law, the Government are required to adopt a series of economy-wide five-year carbon budgets, including sectoral targets for each relevant sector, on a rolling 15-year basis, starting in 2021.
- Actions for each sector will be detailed in the Climate Action Plan, updated annually.
- A National Long Term Climate Action Strategy will be prepared every five years.
- Government Ministers will be responsible for achieving the legally binding targets for their own sectoral area with each Minister accounting for their performance towards sectoral targets and actions before an Oireachtas Committee each year.
- Strengthens the role of the Climate Change Advisory Council, tasking it with proposing carbon budgets to the Minister.

Provides that the first two five-year carbon budgets proposed by the Climate Change Advisory Council should equate to a total reduction of 51% emissions over the period to 2030, in line with the Programme for Government commitment.

[8] *Department of the Environment, Climate and Communications (2023) Climate Action Plan 2024. Available at:* https://www.gov.ie/en/publication/79659-climate-action-plan-2024/#new-approach-to-the-2024-annex-of-actions

In order to achieve these targets, Ireland's dependency on fossil fuels needs to drop. MaREI forecast that 25 GW of renewable electricity capacity is needed by 2050, compared with 4.5GW that is currently available today[9].

5.3.4.2.4 *Renewable Energy Production and Reduction in Greenhouse Gas Emissions*

In July 2023, the EPA published '*Ireland's Provisional Greenhouse Gas Emissions 1990-2022*[10] which indicates that Ireland's greenhouse gas emissions have decreased by 1.9% on 2021 levels to 60.76 million tonnes carbon dioxide equivalent (Mt CO_2eq). A substantial decrease in Residential sector emissions, combined with emissions decreases from Industry, Agriculture and Electricity generation outweighed increased emissions from the Transport sector. The overall emissions reduction, while welcome, falls short of the reductions required to achieve National and new EU targets. There were substantial reductions in coal, oil and peat used in electricity generation (-16%, -29% and -25% respectively). Renewable electricity generation increased from 35% in 2021, to 39% in 2022. Overall emissions from the Energy Industries sector only declined by 1.8% in 2022 however, as use of natural gas increased by 13%. The report states that the provisional estimates of greenhouse gas emissions for the period 1990-2021 indicate that Ireland will exceed its 2022 annual limit set under the EU's Effort Sharing Regulation (ESR) by 3.72 Mt CO_2eq, without the use of flexibilities. It is imperative now more than ever that every effort is made to reach 2030 energy targets. The carbon loss and savings due to the Proposed Development are discussed in Chapter 11 of this EIAR.

5.3.5 Land-Use

The predominant land use within the Study Area is agriculture. Land-use on the Wind Farm Site comprises coniferous forestry, biodiversity areas under Coillte management and third-party lands currently being used for agricultural and forestry. Current land-use along the Grid Connection comprises of public road corridor and coniferous forestry. Land-use in the wider landscape comprises a mix of agriculture, low density residential and commercial forestry. The total area farmed within the 4 no. DEDs around the Wind Farm Site measures approximately 5,929 hectares, comprising 65% of the Population Study Area, according to the CSO Census of Agriculture 2020.

The Wind Farm Site boundary measures approximately 1,072 hectares, while the total development footprint within the Wind Farm Site measures approximately 18.5 hectares. Therefore, the development footprint of the Wind Farm Site consists of approximately 2% of the Wind Farm Site boundary and 0.02% of the Population Study Area.

Table 5-6 shows the breakdown of farmed lands within the 4 no. EDs of the Population Study Area. There are 181 farms located within the Population Study Area, with an average farm size of 32.25 hectares. The total farmed area within the Population Study Area is 5,929 hectares, which equates to 65% of the Population Study Area's land. The median age of the holder of the farm within the Population Study Area is 58 years.

CSO data for 2022 reports that 54 private households within the Population Study Area reported farming as their socio-economic group, which equates to approximately 7.6% of the Population Study Area households. A total of 2,438 private households reported farming as their socio-economic group for Co. Clare, which equates to 5.2% of the households in the county. As demonstrated, farming in the Population Study Area is almost 1.5 times the rate of farming in Co. Clare and corresponds to the rural location and land-use of the surrounding area of the Wind Farm and Grid Connection.

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[9] *Wind Energy Ireland, MaREI March 2021 Our Climate Neutral Future Zero by 50. Available at: https://windenergyireland.com/images/files/our-climate-neutral-future-0by50-final-report.pdf*
[10] *EPA July 2023 Ireland's Final Greenhouse Gas Emissions. Available at: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/2023-EPA-Provisional-GHG-Report_Final_v3.pdf*

Table 5-6 Farm Size and Classification within the Population Study Area in 2020 (Source: CSO)

DED	No. of holdings	Average Size of Holding (hectares)	Median age of holder	Livestock units	Average farmed (hectares)
Castlecrine	40	28.4	58.5	1,265	1,134.3
Cloghera	49	38.2	58	2,660	1,873.4
Cloontra	36	28.8	59.5	539	1,038
Kilseily	56	33.6	56	1,900	1,883.3
Total	181	32.25 (average)	58 (average)	6,364	5,929
Size of 4 DEDs			9,113.1 hectares		
Total Area Farmed within 4 DEDs			5,929 hectares		
Farmland as % of DEDs			65%		

5.3.6 Services

The Wind Farm Site is located approximately 3 km south of Broadford, 3.5 km southeast from Kilkishen, and 4 km northeast from Sixmilebridge. All three centres provide retail, recreational, educational, and religious services.

The Grid Connection includes for underground 110kV electrical cabling from the proposed onsite 110kV electrical substation within the Wind Farm Site to the Ardnacrusha 110kV electrical substation in the townlands of Castlebank and Ballykeelaun, County Clare, measuring approximately 9.2km in length. Retail, recreational, educational, and religious services are provided within the vicinity of the proposed Grid Connection route.

5.3.6.1 Education

The closest primary school to the proposed Wind Farm Site is Broadford & Kilbane National School located approximately 3 km to the north. Kilkishen National School and Kilmurry National School are located 3.6 km northwest and west of the proposed Wind Farm Site, respectively. The closest primary school to the proposed Grid Connection route is Parteen National School, located approximately 1.1km south of Ardnacrusha substation.

The nearest secondary schools to the proposed Wind Farm Site are St. Joseph's Secondary School and St. Caimin's Community School, located approximately 9.5 km northwest and 11.1 km southwest in Tulla and Shannon, respectively. The nearest secondary school to the proposed Grid Connection route is St. Munchin's College, located approximately 2.5km south of Ardnacrusha substation.

The Limerick Institute of Technology and University of Limerick are the nearest third-level institutions to the Proposed Development, located approximately 10 km south of the proposed Wind Farm Site (approximately 3.8 km southwest of the proposed Grid Connection route) and 10.9 km south of the proposed Wind Farm Site (approximately 4.6 km southeast of the proposed Grid Connection route).

5.3.6.2 Access and Public Transport

It is proposed to access the Wind Farm Site via a newly proposed access track off the R465 Regional Road to the east of the site. This entrance will be created to facilitate the delivery of the construction materials and turbine components. Internal roads within the proposed Wind Farm Site will cross the L-3042, while tertiary roads also intersecting the proposed Wind Farm Site in the west. There is a public car park located approximately 600m west of the proposed Wind Farm Site, which is managed by the 12 O'Clock Hills walking group and is accessed from the Crag Local Road.

There is one local bus service, Local Link – Limerick Clare which provides transport from Limerick City to Ennis, via Broadford on a daily basis. The 318 Bus from Limerick City to Ennis passes along the R465 Regional Road to the west of the Proposed Development site four times per day, Monday to Sunday. The 346 Bus Éireann bus also runs from Limerick City to Whitegate, along the R465 via Broadford, once a week, on a Saturday. The nearest train station to the proposed Wind Farm Site is the Sixmilebridge train station approximately 4.8 km to the southwest, providing connections between Limerick City and Ennis.

5.3.6.3 Amenities and Community Facilities

The Sunyata Buddhist Centre is located approximately 90m from the north-western boundary of the Wind Farm Site and 891m from the nearest proposed turbine (T02). Amenities and community facilities, including GAA and other sports clubs, youth clubs, and recreational areas are located in Broadford, Kilkishen and Sixmilebridge.

As outlined in in Section 4.2.10 of Chapter 4 of this EIAR, part of the Proposed Development design will include for amenity walkways, picnic areas and viewpoints. Existing site roads will be upgraded and new roads gravel pathways, will be developed and promoted for recreational activities. These dedicated areas will provide a safer visitor experience and open the site up to locals, tourists, trail runners etc.

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, total tourism revenue generated in Ireland was approximately €9.5 billion, an increase on the €9.1 billion revenue recorded in 2018. Overseas tourist visits to Ireland in 2019 grew by 0.7% to 9.7 million ('Key Tourism Facts 2019, Fáilte Ireland, March 2021).

Ireland is divided into seven tourism regions. Table 5-7 shows the total revenue and breakdown of overseas tourist numbers to each region in Ireland during 2019 ('Key Tourism Facts 2019', Fáilte Ireland, March 2021).

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

Region	Total Revenue (€m)	Total Number of Overseas Tourists (000s)
Dublin	€2,210m	6,644
Mid East/Midlands	€348m	954
South-East	€261m	945
South-West	€970m	2,335

Region	Total Revenue (€m)	Total Number of Overseas Tourists (000s)
Mid West	**€472m**	**1,432**
West	€653m	1,943
Border	€259m	768
Total	**€5,173m**	**15,021**

The Mid-West region, in which the Proposed Development is located, comprises Counties Clare, Limerick and Tipperary. This Region benefited from approximately 9.5% of the total number of overseas tourists to the country and approximately 9.1% of the total income generated by oversees tourists in Ireland in 2019.

The most recent county by county breakdown figures for overseas tourist numbers and revenue are for the year 2017 and is reproduced in Table 5-8 (*2017 Topline Tourism Performance By Region, Fáilte Ireland, August 2018*)[11]. As can be observed, County Limerick has the highest tourism revenue within the region during 2017 at €261 million, while County Clare has the highest number of oversees tourists, with 749 million oversees tourists during the study period.

Table 5-8 Overseas Tourism to Mid-West Region during 2017 (Source: Fáilte Ireland)

County	Revenue Generated by Overseas Tourists (€m)	No. of Overseas Tourists (000s)
Clare	158	749
Limerick	261	647
Tipperary*	65	192

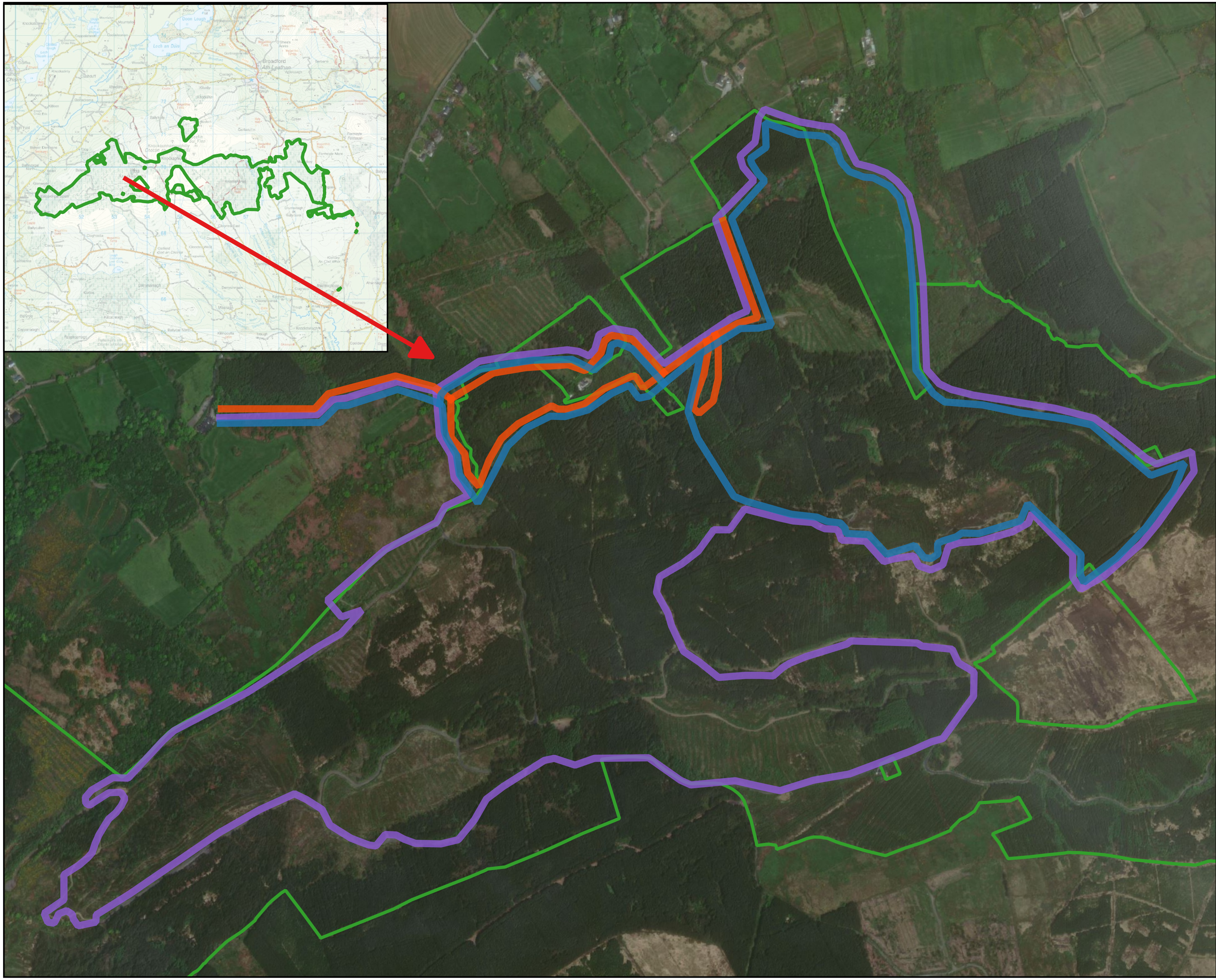
*Figures represent the sum of Tipperary North and Tipperary South.

5.4.1.1 Tourist Attractions

The 12 O'Clock Hills hiking trails are a locally valuable recreational amenity and could be considered as a tourist attraction pertaining to the Wind Farm Site. The 12 O'Clock Hills is a hill walking facility situated approximately 5 km southeast of Kilkishen Village. Belvoir Trailhead is the most popular starting point as it has a spacious carpark within the townland of Belvoir Demesne, with capacity for 80 no. cars. The facility offers three choices of trails which are fully waymarked with red, blue and purple arrowheads to facilitate self-guiding, ranging from 5 km, 8.5 km, or 13 km looped trails (Figure 5-3). A section of the 180 km East Clare Way loop trail also intersects the centre on the proposed Wind Farm Site.

The Sunyata Buddhist Centre is located approximately 90m from the northwestern boundary of the proposed Wind Farm Site. The retreat centre offers residential retreats and a wide variety of other events to those who wish to learn about Buddhism, mindfulness and meditation.

[11] *2017 Topline Tourism Performance By Region, Fáilte Ireland, August 2018 Available at:* https://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/2_Regional_SurveysReports/2017-topline-regional-performance-(003).pdf?ext=.pdf



Drawing Title: Existing 12 O'Clock Hill Trails	
Project Title: Knockshanvo Wind Farm	
Drawn By: SD	Checked By: EOS
Project No.: 200513	Drawing No.: Figure 5-3
Scale: 1:12,500	Date: 2024-08-01

MKO
Planning and Environmental Consultants
Tuam Road, Galway Ireland, H91 VW84
+353 (0) 91 735611
email:info@mkoireland.ie
Website: www.mkoireland.ie

The nearest tourist centres are located between 10 km and 12 km from the proposed Wind Farm Site, at Bunratty, Limerick City and Killaloe. Tourist attractions within these centres include: Bunratty Castle and Folk Park, King John's Castle, and Killaloe River Cruises.

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

- Cliffs of Moher, which is one of Ireland's top visitor attractions and a designated UNESCO Geo Park.
- The Burren National Park, which includes:
  - Caherconnell Stone Fort, the only fort in The Burren scientifically excavated and developed for tourism;
  - Aillwee Burren Experience, which also has the largest and most varied collection of birds of prey in Ireland;
  - Poulnabrone dolmen, the oldest date megalithic monument in Ireland.
- Several Coillte Sites that are accessible to the public, which include:
  - Doon near Broadford;
  - Gradan's Wood;
  - Cahermurphy near Lough Graney;
  - Kilrush (Vandaleur Walled Gardens); and
  - Ballycuggaran on the shores of Lough Derg.
- Craggaunowen, featuring recreations of homesteads, animals and artefacts that existed in Ireland over a 1000 years ago.
- Shannon Dolphin and Wildlife Foundation (SWDF), which was established to develop and provide educational awareness and conservation of the Shannon dolphins and other wildlife in the region.

5.4.1.2 Tourist Attitudes to Wind Farms

5.4.1.2.1 *Scottish Tourism Survey 2016*

BiGGAR Economics undertook an independent study in 2016, entitled *'Wind Farms and Tourism Trends in Scotland'*, to understand the relationship, if any, that exists between the development of onshore wind energy and the sustainable tourism sector in Scotland. In recent years the onshore wind sector and sustainable tourism sector have grown significantly in Scotland. However, it could be argued that if there was any relationship between the growth of onshore wind energy and tourism, it would be at a more local level. The study therefore considered the evidence at a local authority level and in the immediate vicinity of constructed wind farms.

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

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

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

5.4.1.2.2 *Fáilte Ireland Surveys 2007 and 2012*

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

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

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

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

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

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

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

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

The report goes on to state that while there is a generally positive disposition among tourists towards wind development in Ireland, it is important also to take account of the views of the one in seven tourists who are negatively disposed towards wind farms. This requires good planning on the part of the wind farm developer as well as the Local Authority. Good planning has been an integral component of the Proposed Development throughout the site design and assessment processes. The Department of the Environment, Heritage and Local Government's *'Planning Guidelines on Wind*

Energy Development 2006' was followed 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 Human Health and Public Perception of Wind Energy

5.5.1 Health Impacts of Wind Farms

5.5.1.1 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 generally not supported these statements. There is currently no published credible scientific evidence to positively link wind turbines with adverse health effects. The main publications supporting the view that there is no evidence of any direct link between wind turbines and health are summarised below.

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

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

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

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

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

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

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

The report found, amongst other things, that:

"Wind Turbine Syndrome" symptoms are the same as those seen in the general population due to stresses of daily life. They include headaches, insomnia, anxiety, dizziness, etc.

- *Low frequency and very low-frequency 'infrasound' produced by wind turbines are the same as those produced by vehicular traffic and home appliances, even by the beating of people's hearts. Such 'infrasounds' are not special and convey no risk factors.*
- *The power of suggestion, as conveyed by news media coverage of perceived 'wind-turbine sickness', might have triggered 'anticipatory fear' in those close to turbine installations."*

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

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

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

4. ***Position Statement on Health and Wind Turbines',*** *Climate and Health Alliance, (February 2012)*

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

"To date, there is no credible peer reviewed scientific evidence that demonstrates a direct causal link between wind turbines and adverse health impacts in people living in proximity to them. There is no evidence for any adverse health effects from wind turbine shadow flicker or electromagnetic frequency. There is no evidence in the peer reviewed published scientific literature that suggests that there are any

adverse health effects from infrasound (a component of low frequency sound) at the low levels that may be emitted by wind turbines."

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

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

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

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

CAHA notes that:

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

This, it states, is in contrast to the health impacts of fossil fuel energy generation.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The HSE position paper determines that current scientific evidence on adverse impacts of wind farms on health is weak or absent. Further research and investigative processes are required at a larger scale in order to be more informative for identifying potential health effects of exposure to wind turbine effects. They advise developers on making use of the Draft Revised Wind Energy Development Guidelines (2019), as a means of setting noise limits and set back distances from the nearest dwellings.

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

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

For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB Lden. The GDG recognise the potential for increased risk of annoyance at levels below this value but cannot determine whether this 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. ***Infrasound Does Not Explain Symptoms Related to Wind Turbines:*** *Finnish Government's Analysis, Assessment and Research Activities (VN TEAS), 2020*

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

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

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

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

The report notes:

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

As a result:

> *'These findings do not support the hypothesis that infrasound is the element in turbine sound that causes annoyance. Instead, they suggest that people who have health symptoms which they associate with wind turbine sound are not likely to have these symptoms because they*

perceive turbine sound more annoying than controls, at least in laboratory settings. It is more likely that these symptoms are triggered by other factors such as symptom expectancy'.

5.5.2 Turbine Safety

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

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

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

5.5.3 Electromagnetic Interference

The provision of underground electric cables of the capacity proposed (110kV) for the Grid Connection is common practice throughout the country and installation to the required specification does not give rise to any specific health concerns.

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

The ESB document 'EMF & You' (ESB, 2017)[12] provides further practical information on EMF such as routing transmission lines as far from existing residences as is reasonably possible, optimising the phasing of adjacent lines, and incorporating stakeholder input during the consultation process. Further details on the potential impacts of electromagnetic interference to telecommunications and aviation are presented in Section 14.2 of this EIAR.

5.5.4 Assessment of Effects on Human Health

As set out in the Department of Housing, Planning, Community and Local Government Key Issues Consultation Paper on the '*Transposition of 2014 EIA Directive (2014/52/EU) in the Land Use Planning and EPA Licencing Systems'* (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.

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

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

Chapter 8 Land, Soils & Geology, Chapter 9 Hydrology & Hydrogeology, Chapter 10 Air, Chapter 11 Climate, Chapter 12 Noise & Vibration and Chapter 15 Material Assets (Roads and Traffic) provide an assessment of the effects of the Proposed Development on these areas of consideration. There is the potential for negative effects on human health during the Wind Farm and Grid Connection construction phase related to potential emissions to air of dust, potential emissions to land and water of hydrocarbons, release of potentially silt-laden runoff into watercourses and noise emissions. The assessments however show that the residual 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 Development is imperceptible.

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

As set out in Chapter 9, potential health effects are associated with negative effects on public and private water supplies and potential flooding. There are no mapped public or group groundwater scheme protection zones in the area of the Wind Farm Site or Grid Connection.

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

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

5.5.5 Vulnerability of the Project to Major Accidents and Natural Disasters

An assessment of the Proposed Development's vulnerability to major accidents and natural disasters can be found in Chapter 16 of this EIAR. A brief discussion can be found below.

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

There is limited potential for significant natural disasters to occur at the Proposed Development. Ireland is a geologically stable country with a mild temperate climate. The potential natural disasters that may occur are therefore limited to flooding, and fire and landslide events. The risk of peat instability and failure (landslide) occurring on the Wind Farm Site and Grid Connection during the construction, operation or decommissioning phase is addressed in the Geotechnical and Peat Stability Assessment Report included in Appendix 8-1 of this EIAR which concludes that the Proposed Development has an acceptable margin of safety and is suitable for the Wind Farm and Grid Connection.

The risk of flooding is addressed in Chapter 9 and was found to be very low at the Wind Farm Site due to the elevated and sloping nature of the site and the high density of mountain streams which flow rapidly downslope. The risk of flooding along the Grid Connection route is generally low. However, there are areas along the Grid Connection route which may be prone to flooding, principally along the Blackwater River. Due to the depth of the underground cabling route, this will have no effect during the operational phase of the Proposed Development. During the construction phase, works along the underground electrical cabling route may have to be postponed following heavy rainfall events which could cause flooding in this area.

The risk of fire is addressed in Chapter 16, where it is considered that the risk of significant fire occurring, affecting the Wind Farm Site and Grid Connection and causing the Proposed Development to have significant environmental effects is limited because the Proposed Development will be designed, built and operated in line with current best practice. Further, in accordance with Chapter 19 of the Safety, Health and Welfare at Work Acts 2005 as amended, the Proposed Development will be subject to a fire safety risk assessment which will assist in the identification of any major risks of fire on site.

As described earlier, there are no significant sources of pollution in the Wind Farm or Grid Connection with the potential to cause environmental or health effects. Also, the spacing of the turbines and distance of turbines from any properties limits the potential for effects on human health. The issue of turbine safety is addressed in Section 5.5.2 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 Development is not regulated or connected to or close to any site regulated under the Control of Major Accident Hazards Involving Dangerous Substances Regulations i.e., SEVESO sites and so there is no potential effects from this source.

5.5.6 Sustainable Energy Ireland Survey 2023

In 2022, the Sustainable Energy Authority of Ireland (SEAI) carried out a national survey looking at the attitudes to commercial wind and solar farms in Ireland. The findings of the survey were published in May 2023. The objective of the survey was to understand the impacts of commercial wind and solar farms on people who live in their nearby areas, to inform an equitable and socially sustainable energy transition.

Key findings from the research are:

- Most households close to new wind or solar power projects have positive attitudes to the project close to them.
- Across rural Ireland, general levels of support for wind and solar energy projects remain very high, regardless of whether people live close to new projects or far away.
- A large majority of the public living in rural areas supports government policies that secure financial benefits for households and communities close to new renewable energy infrastructure projects through 'Community Benefit Funds'.
- Most people feel like they and their communities can have a say in the planning process. However, many still feel that the planning process is unfair, and that more effort should be made with community engagement and careful siting of projects.

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

Background

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

Study Area

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

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 not in my back yard (NIMBY) effect, the report states that where NIMBY-ism does occur, it is much more pronounced in relation to proposed wind farms than actual wind farms. The Scottish survey found that while positive attitudes towards wind power were observed among those living in proximity to both the proposed and existing wind farm sites, people around the proposed site were less convinced than those living in proximity to the existing site. Retrospective questioning regarding pre- and post-construction attitudes at the existing site found that attitudes remained unchanged for 65% of respondents. Of the 24% of people who altered their attitudes following experience of the wind farm, all but one became more positive. The report states:

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

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

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

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

5.5.7 IWEA Interactions Opinion Poll on Wind Energy

In December 2022, Wind Energy Ireland published the results of their most recent nationwide annual poll on attitudes to wind energy, the *Public Attitudes Monitor*.[13] The results of the opinion poll were published via Wind Energy Ireland, the representative body for the Irish wind industry. The objective of the poll was to 'measure and track public perceptions and attitudes around wind energy amongst Irish adults.'

Between 23rd November – 8th December 2022, a representative sample of 1,017 Irish adults together with a supplementary booster sample of 201 rural residents participated in an online survey. The 2022 results reported that 53% of the nationally representative sample 'strongly favour', 27% 'tend to favour' and 15% 'neither favour nor oppose' wind power. Of the rural population surveyed 55% 'strongly favour', 30% 'tend to favour' and 12% 'neither favour nor oppose' 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%), the highest level of support recorded amongst rural residents since tracking commenced.

Amongst those in favour of wind power, the majority cited the availability of wind energy and environmental concerns as their main reasons for supporting such developments. Other reasons cited for supporting wind energy developments were helping the environment, and the cost effectiveness/cost saving nature of wind power.

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

The IWEA December 2022 survey follows the structure of previous national opinion polls on wind energy undertaken since 2017. The 2022 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.

5.5.7.1 Conclusions

The overall conclusions drawn from the survey findings and from the authors' review of the above studies show that local people become more favourable towards wind farms after construction, that the

[13] *Wind Energy Ireland December 2022 Public Attitudes Monitor. Available at: https://windenergyireland.com/images/Final_WEI_Annual_Attitudes_Survey_2022.pdf*

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.

5.6 Property Values

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

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

The main conclusion of this study is as follows:

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

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

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

Both LBNL studies note that their results do not mean that there will never be a case of an individual home whose value goes down due to its proximity to a wind farm – however if these situations do exist, they are considered to be statistically insignificant. Therefore, although there have been claims of significant property value impacts near operating wind turbines that regularly surface in the press or in local communities, strong evidence to support those claims has failed to materialise in all the major U.S. studies conducted thus far.

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

- Overall, the analysis found that the county-wide property market drives local house prices, not the presence or absence of wind farms.

- The econometric analysis established that construction of wind farms at the five sites examined across England and Wales has not had a detectable negative impact on house price growth within a five-kilometre radius of the sites.

A study issued in October 2016 'Impact of wind Turbines on House Prices in Scotland'[14] (2016) was published by Climate Exchange and is provided in Appendix 5-2 of this EIAR. 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.

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

- No evidence of a consistent negative effect on house prices: Across a very wide range of analyses, including results that replicate and improve on the approach used by Gibbons (2014), we do not find a consistent negative effect of wind turbines or wind farms when averaging across the entire sample of Scottish wind turbines and their surrounding houses. Most results either show no significant effect on the change in price of properties within 2km or 3km or find the effect to be positive.
- Results vary across areas: The results vary across different regions of Scotland. Our data does not provide sufficient information to enable us to rigorously measure and test the underlying causes of these differences, which may be interconnected and complex.

Although there have been no empirical studies carried out in Ireland on the impacts of wind farms on property prices, the literature described above demonstrates that at an international level, wind farms have not impacted property values in the local areas. It is a reasonable prediction based on the available international literature, that the Proposed Development will not impact on the property values in the Population Study Area.

5.7 Residential Amenity

Residential amenity relates to the human experience of one's home, derived from the general environment and atmosphere associated with the residence. The quality of residential amenity is influenced by a combination of factors, including site setting and local character, land-use activities in the area and the relative degree of peace and tranquillity experienced in the residence. The closest occupied dwelling is located 751 metres (H492) from a proposed turbine location (T06).

When considering the amenity of residents in the context of a proposed wind farm, there are four main potential effects of relevance: 1) Shadow Flicker, 2) Noise, 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 below 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. The potential effects on telecommunications assessed in Chapter 15 of this EIAR. Effects on residential amenity during the construction, operational and decommissioning phases of the Proposed Development are assessed in relation to each of these key issues and other environmental factors such as traffic and dust; see Effects in Section 5.9 below. The effect on residential amenity is then derived from an overall judgement of the combination of effects due to shadow flicker, changes to land-use and visual amenity, noise, traffic, dust, telecommunications and general disturbance.

[14] *Heblicjh, Dr. S. et al 2016, Impact of wind turbines on house prices in Scotland. Available at: https://www.climatexchange.org.uk/media/1359/cxc_wind_farms_impact_on_house_prices_final_17_oct_2016.pdf*

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[15].

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

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

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

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

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

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

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

Shadow flicker often only occurs at sunrise or sunset when the turbine's shadow is longer at distances greater than approximately 500 meters between a turbine and a receptor. At distances greater than ten rotor diameters from a turbine, the potential for shadow flicker is very low *('Wind Energy Development Guidelines for Planning Authorities',* DoEHLG, 2006). Figure 5-4 illustrates the shadow cast by a turbine at various times during the day, where the red shading represents the area where shadow flicker may occur. When the sun is high in the sky, the length of the shadow cast by the turbine is significantly shorter.

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

[15] 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

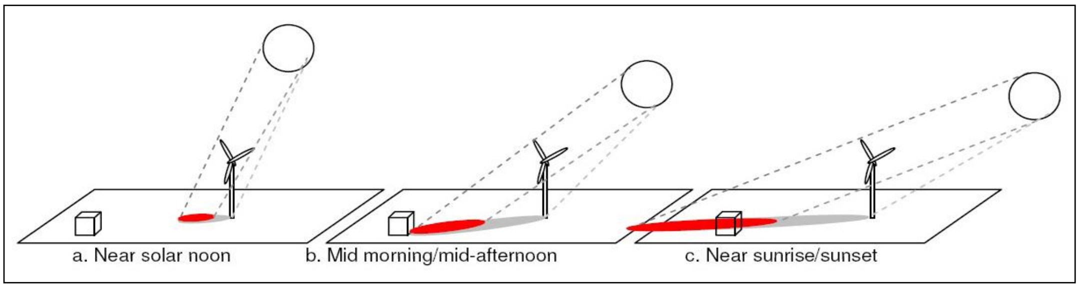


Figure 5-4 Shadow-Prone Area as a Function of Time of Day (Source: Shadow Flicker Report, Helimax Energy, December

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

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

At distance, the turbine blades do not cover the sun but only partly mask it, substantially weakening the shadow. This impact occurs first with the shadow from the blade tip, the tips being thinner in section than the rest of the blade. The shadows from the tips extend the furthest and so only a very weak occurrence of shadow flicker 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 5-5.

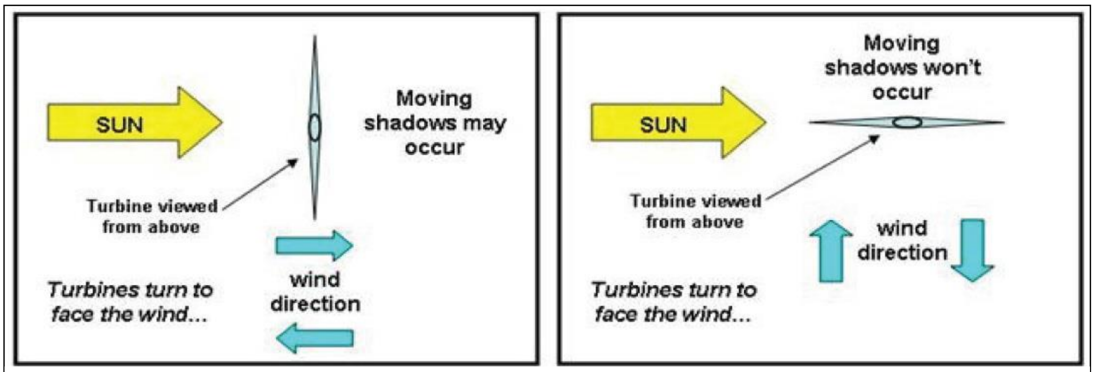


Figure 5-5 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environmental Power LLC)

7. *Rotation of turbine blades:*

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

5.8.2 Guidance

The relevant Irish guidance for shadow flicker is derived from the '*Wind Energy Development Guidelines for Planning Authorities*' (Department of the Environment, Heritage and Local Government ((DoEHLG), 2006) and the '*Best Practice Guidelines for the Irish Wind Energy Industry'* (Irish Wind Energy Association, 2012). The 2006 DoEHLG Guidelines state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The DoEHLG 2006 Wind Energy Guidelines (WEGs) 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 occupied dwellings of 751m has been achieved with the project design. There are 15 No. dwellings located within 1 km of any proposed wind turbine location.

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

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

Although the DoEHLG thresholds apply to dwellings located within 500 metres of a proposed turbine location, for the purposes of this assessment, the guideline thresholds of 30 hours per year or 30 minutes per day have been applied to all properties located within ten rotor diameters (i.e., assumed at 1,630 metres as a worst-case scenario) of the proposed turbines within the Wind Farm Site (as per IWEA guidelines, 2012).

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

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

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

The assessment herein is based on compliance with the current DoEHLG Guidelines limit (30 hours per year or 30 minutes per day). However, it should also be noted the Proposed Development is also in line with the requirements of the 2019 draft guidelines, should they be adopted while this application is in the planning system, and FuturEnergy Ireland's zero shadow flicker policy through the implementation of the mitigation measures outlined in Section 5.9.3.6.

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 Department of the Environment, Heritage and Local Government (DoEHLG) guidelines state that careful site selection, design and planning, and good use of relevant software can help avoid the possibility of shadow flicker in the first instance, all of which have been employed at the 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 ReSoft WindFarm Version 5.0.22 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 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 185 metres, Minimum height 179.5 metres
- Hub Height: Maximum height 110.5 metres, Minimum height 102.5 metres
- Blade Length: Maximum length 81.5 metres, Minimum length 74.5 metres.

A comparative assessment was undertaken where turbines with alternative dimensions within the proposed size range as detailed above were modelled and compared in order to determine which combination of dimensions would cause the largest effects of shadow flicker (i.e., precautionary scenario) on dwellings.

In determining potential effects of shadow flicker, it is the swept path of the blade that dictates the shadow. The longer the blade, the greater the swept path and corresponding shadow. The shorter the blade, the smaller the swept path and corresponding shadow. Within the proposed turbine range, the dimensions that allow for the longest blade are as follows:

- **Scenario 1:** Tip height of 184m, hub height of 102.5m and rotor diameter of 163m (81.5m blade length) (i.e., lowest hub height and longest blade length).

Details on the precautionary shadow flicker assessment can be found in Section 5.8.5 below.

While these dimensions have been used for the purposes of this assessment, the actual turbine models to be installed on the Wind Farm Site will be the subject of a competitive tender process and could include turbines with alternative dimensions within the proposed size range. Therefore, in order to verify that a precautionary approach has been taken in this assessment, 2 no. additional comparative shadow flicker scenarios have also been modelled to predict the potential effects of shadow flicker for the following turbine dimensions:

- **Scenario 2:** Tip height of 179.5m, hub height of 105m and rotor diameter of 149m (74.5m blade length) (i.e., lowest tip height and shortest blade length).
- **Scenario 3:** Tip height of 185m, hub height of 110.5m and rotor diameter of 149m (74.5m blade length) (i.e., highest hub height and shortest blade length).

Details on the comparative shadow flicker assessment can be found in Section 5.8.6 below.

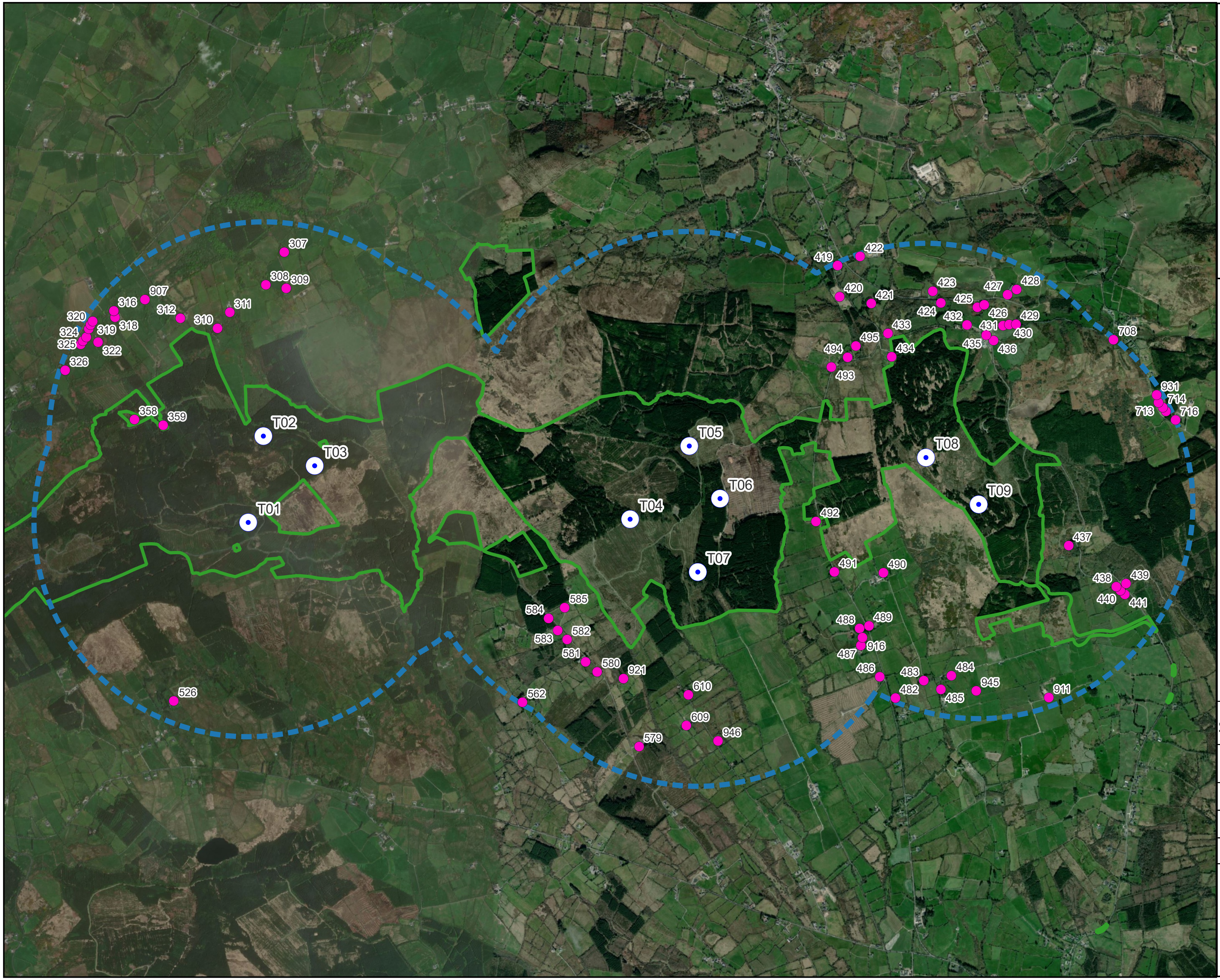
Regardless of the make or model of the turbine eventually selected for installation on site, its dimensions will be within the proposed range. The potential shadow flicker impact it will give rise to will be no more than that predicted in this assessment. With the benefit of the mitigation measures outlined in Section 5.9.3.6 below, any turbine to be installed onsite will comply with the DoEHLG 2006 guidelines thresholds of 30 minutes per day or 30 hours per year, or with the revised guidelines if required, through the use of turbine control software. Any references to the turbine dimensions in this shadow flicker assessment should be considered in the context of the above and should not be construed as pre-determining the exact dimensions of the wind turbine to be used on the Wind Farm Site.

5.8.4.2 Study Area

The Study Area for the shadow flicker assessment is ten times rotor diameter from each turbine as set out in the Wind Energy Development Guidelines for Planning Authorities', DoEHLG, 2006. All residential properties located within ten rotor diameters which is assumed to be 1.63 kilometres have been included in the assessment. 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.

There is a total of 78 No. residential dwellings located within a distance of 10 rotor diameters (assessed at 1.63km) from the proposed turbine locations.

The locations of all dwellings within the Study Area are shown in Figure 5-6, with all dwellings detailed in Table 5-9 in Section 5.8.5 below.



Map Legend

- Wind Farm Site Study Boundary
- Proposed Turbine Layout [9]
- Shadow Flicker Study Area (1.63km Turbine Buffer)
- Dwellings within 1.63km of the Proposed Turbine Layout [78]

N

Drawing Title

Shadow Flicker Study Area

Project Title

Knockshanvo Wind Farm

Drawn By	Checked By
SD	EOS
Project No.	Drawing No.
200513	Figure 5-6
Scale	Date
1:37,500	2024-08-01

MKO
Planning and Environmental Consultants
Tuam Road, Galway Ireland, H91 VW84
+353 (0) 91 735611
email:info@mkoireland.ie
Website: ww.mkoireland.ie

5.8.4.3 Assumptions and Limitations

Due to the latitude of Ireland and the UK, shadow flicker impacts are only possible at properties 130 degrees either side 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; Draft Revised Wind Energy Development Guidelines 2019). As such properties located outside of this potential shadow flicker zone will not be impacted. However, in this assessment, all 78 no. properties within 360 degrees of the Wind Farm Site within the Study Area were assessed for shadow flicker impact.

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

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

Each window measures one-metre-high by one-metre-wide, and tilt angle is assumed to be zero. The centre height of each window is assumed to be two metres above ground level and no screening due to trees or other buildings or vegetation is assumed. It was not considered necessary or practical to measure the dimensions of every window on every property in the Study Area. While the actual size of a window will marginally influence the incidence and duration of any potential shadow flicker impact, with larger windows resulting in slightly longer shadow flicker durations, any additional incidences or durations of shadow flicker over and above those predicted in this assessment can be countered by extending the mitigation strategies outlined in Section 5.9.3.6.

The use of computer models to predict the amount of shadow flicker that will occur is known to produce an over-estimate of possible impact, referred to as the precautionary assumptions 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 30.56% of the daylight hours per year. This percentage is based on Met Éireann data recorded at Shannon Airport over the 30-year period from 1991 to 2020 (www.met.ie). The actual sunshine hours at the proposed Wind Farm Site and therefore the percentage of time shadow flicker could actually occur is 30.56% of daylight hours. Table 5-9 below lists the annual shadow flicker calculated for each property when the regional average of 30.56% sunshine is taken into account, to give a more accurate annual average shadow flicker prediction. Table 5-9 below also outlines whether a shadow flicker mitigation strategy is required for each property to mitigate potential exceedances of the daily and/or annual threshold figure.

5.8.5 Shadow Flicker Assessment Results

5.8.5.1 Daily and Annual Shadow Flicker

The ReSoft WindFarm Version 5.0.22 computer software was used to model the predicted daily and annual shadow flicker levels in significant detail, identifying the predicted daily start and end times, maximum daily duration and the individual turbines predicted to give rise to shadow flicker.

The model results assume worst-case conditions, including:

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

The maximum daily shadow flicker model is based on the assumption that daylight hours consist of 100% sunshine. This is a conservative assumption which represents a worst-case scenario. Following the detail provided above on sunshine hours, a sunshine factor of 30.56% 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 guideline daily threshold of 30 minutes per day and annual threshold of 30 hours per year. If there is a predicted exceedance of the threshold limits at any property, the turbines that contribute to the exceedance are also identified.

The DoEHLG WEGs (2006) recommend that shadow flicker at dwellings should not exceed a total of 30 hours per year. As outlined in Section 5.1, a significant minimum separation distance from any occupied dwelling of 751m, i.e., distance between nearest turbine (T06) to the nearest occupied dwelling (H492) has been achieved with the project design. However, for the purposes of this assessment, the guideline threshold has been applied to all residential properties within 1.63 km of the proposed turbine locations.

The turbine dimensions that have been modelled using a precautionary approach are as follows:

- **Scenario 1:** Tip height of 184m, hub height of 102.5m and rotor diameter of 163m (81.5m blade length) (i.e., lowest hub height and longest blade length).

A total of 78 no. residential buildings have been included in the shadow flicker assessment, the results of which are presented in Table 5-9 below.

Table 5-9 Shadow Flicker Results for Knockshanvo Wind Farm, Co. Clare.

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Adjustment (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (30.56%) (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
307	553581	671476	1409	T02	00:00:00	0:00:00	0:00:00	N/A	No	No
308	553441	671227	1151	T02	00:46:48	20:58:12	6:24:27	T02, T03	Yes	No
309	553596	671200	1138	T02	00:23:24	9:28:12	2:53:37	T02	No	No
310	553073	670896	891	T02	01:18:00	92:20:24	28:12:54	T02, T03	Yes	No
311	553167	671018	976	T02	01:12:36	82:13:12	25:07:22	T02, T03	Yes	No
312	552790	670973	1097	T02	01:03:00	40:30:36	12:22:41	T02, T03	Yes	No
316	552284	671029	1484	T02	00:27:36	14:34:48	4:27:18	T02	No	No
318	552293	670980	1446	T02	00:28:12	14:58:48	4:34:38	T02	No	No
319	552123	670949	1565	T02	00:26:24	12:32:24	3:49:54	T02	No	No
320	552107	670923	1564	T02	00:26:24	12:22:48	3:46:58	T02	No	No
321	552093	670892	1559	T02	00:26:24	12:12:36	3:43:51	T02	No	No
322	552164	670791	1447	T02	00:28:12	13:39:00	4:10:15	T02	No	No
323	552075	670829	1543	T02	00:26:24	12:18:00	3:45:30	T02	No	No
324	552049	670801	1553	T02	00:26:24	11:58:12	3:39:27	T02	No	No
325	552032	670774	1555	T02	00:26:24	11:46:48	3:35:58	T02	No	No
326	551914	670577	1589	T02	00:25:48	10:54:36	3:20:01	T02	No	No
358	552441	670202	989	T02	00:39:36	46:19:12	14:09:12	T01, T02, T03	Yes	No
359	552660	670159	767	T02	00:50:24	58:42:36	17:56:21	T01, T02, T03	Yes	No
419	557791	671374	1609	T08	00:00:00	0:00:00	0:00:00	N/A	No	No

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Adjustment (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (30.56%) (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
420	557806	671136	1389	T08	00:25:12	13:03:00	3:59:15	T08	No	No
421	558047	671085	1244	T08	00:13:12	3:00:00	0:55:00	T08	No	No
422	557962	671443	1611	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
423	558515	671178	1266	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
424	558577	671089	1182	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
425	558854	671056	1208	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
426	558907	671075	1244	T08	00:00:00	0:00:00	0:00:00	N/A	No	No
427	559084	671152	1386	T08	00:12:00	2:42:00	0:49:30	T08	No	No
428	559153	671191	1453	T08	00:07:48	1:12:36	0:22:11	T08	No	No
429	559149	670927	1224	T08	00:31:12	27:26:24	8:23:04	T08	Yes	No
430	559096	670925	1194	T08	00:31:12	25:07:12	7:40:32	T08	Yes	No
431	559049	670917	1163	T08	00:30:36	23:28:12	7:10:17	T08	Yes	No
432	558776	670922	1056	T08	00:05:24	0:28:48	0:08:48	T08	No	No
433	558174	670858	988	T08	00:43:48	18:59:24	5:48:09	T08, T09	Yes	No
434	558203	670680	810	T08	01:12:36	54:25:48	16:37:53	T08, T09	Yes	No
435	558922	670844	1038	T08	00:31:48	22:18:36	6:49:01	T08	Yes	No
436	558978	670804	1029	T08	00:36:36	31:51:00	9:43:55	T08	Yes	No
437	559550	669244	754	T09	00:12:00	5:51:00	1:47:15	T09	No	No
438	559911	668931	1220	T09	00:33:36	26:01:12	7:57:02	T09	Yes	No
439	559986	668955	1273	T09	00:34:12	34:04:12	10:24:37	T09	Yes	No

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Adjustment (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (30.56%) (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
440	559943	668902	1262	T09	00:32:24	24:14:24	7:24:24	T09	Yes	No
441	559976	668872	1306	T09	00:31:12	22:32:24	6:53:14	T09	Yes	No
482	558231	668084	1604	T09	00:00:00	0:00:00	0:00:00	N/A	No	No
483	558447	668217	1404	T09	00:00:00	0:00:00	0:00:00	N/A	No	No
484	558657	668254	1320	T09	00:00:00	0:00:00	0:00:00	N/A	No	No
485	558577	668149	1437	T09	00:00:00	0:00:00	0:00:00	N/A	No	No
486	558112	668245	1512	T09	00:27:36	30:10:48	9:13:18	T07	No	No
487	557968	668484	1361	T07	00:31:12	28:55:12	8:50:12	T07	Yes	No
488	557958	668613	1304	T07	00:31:48	22:50:24	6:58:44	T07	Yes	No
489	558030	668633	1245	T09	00:30:36	19:32:24	5:58:14	T07	Yes	No
490	558140	669037	892	T09	00:33:00	56:19:12	17:12:32	T06, T07, T09	Yes	No
491	557766	669043	1034	T06	01:06:00	119:38:24	36:33:24	T04, T06, T07, T09	Yes	Yes
492	557626	669427	751	T06	01:15:00	191:00:00	58:21:40	T04, T05, T06, T07, T08, T09	Yes	Yes
493	557744	670602	996	T08	01:04:12	101:37:48	31:03:13	T05, T06, T08, T09	Yes	Yes
494	557867	670675	968	T08	01:20:24	108:12:36	33:03:51	T05, T06, T08, T09	Yes	Yes
495	557930	670762	1003	T08	01:24:36	95:42:36	29:14:41	T05, T06, T08, T09	Yes	No
526	552740	668062	1472	T01	00:00:00	0:00:00	0:00:00	N/A	No	No

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Adjustment (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (30.56%) (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
562	555393	668052	1616	T04	00:00:00	0:00:00	0:00:00	N/A	No	No
579	556281	667715	1401	T07	00:00:00	0:00:00	0:00:00	N/A	No	No
580	555962	668283	1079	T07	00:00:00	0:00:00	0:00:00	N/A	No	No
581	555873	668359	1094	T07	00:22:48	11:12:36	3:25:31	T07	No	No
582	555733	668529	1033	T04	00:37:48	48:57:36	14:57:36	T07	Yes	No
583	555661	668598	1010	T04	00:36:00	35:12:00	10:45:20	T06, T07	Yes	No
584	555592	668690	977	T04	00:34:48	44:41:24	13:39:19	T06, T07	Yes	No
585	555714	668771	838	T04	00:39:00	51:31:48	15:44:43	T06, T07	Yes	No
609	556640	667875	1171	T07	00:00:00	0:00:00	0:00:00	N/A	No	No
610	556656	668108	937	T07	00:00:00	0:00:00	0:00:00	N/A	No	No
708	559890	670809	1619	T09	00:21:36	13:12:36	4:02:11	T09	No	No
713	560232	670332	1573	T09	00:26:24	13:33:36	4:08:36	T09	No	No
714	560266	670294	1584	T09	00:26:24	12:56:24	3:57:14	T09	No	No
715	560289	670265	1592	T09	00:26:24	12:31:48	3:49:43	T09	No	No
716	560362	670199	1631	T09	00:25:12	11:25:48	3:29:33	T09	No	No
907	552521	671115	1375	T02	00:30:00	18:21:00	5:36:25	T02	No	No
911	559398	668088	1564	T09	00:00:00	0:00:00	0:00:00	N/A	No	No
916	557980	668544	1345	T09	00:31:12	24:02:24	7:20:44	T07	Yes	No
921	556162	668231	989	T07	00:00:00	0:00:00	0:00:00	N/A	No	No
931	560219	670390	1591	T09	00:26:24	13:54:36	4:15:01	T09	No	No

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Adjustment (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (30.56%) (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daily Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
945	558846	668139	1419	T09	00:00:00	0:00:00	0:00:00	N/A	No	No
946	556881	667758	1294	T07	00:00:00	0:00:00	0:00:00	N/A	No	No

Of the 78 no. properties modelled, it is predicted that 31 no. properties may experience daily shadow flicker in excess of the DoEHLG WEGs (2006) threshold of 30 minutes per day. This prediction is assuming worst-case conditions (i.e., 100% sunshine on all days where the shadow of the turbines passes over a house, wind blowing in the correct direction, no screening present, etc.) and in the absence of any turbine control measures.

Of the 78 no. properties modelled, when the regional sunshine average (i.e., the mean amount of sunshine hours throughout the year) of 30.56% and is taken into account, the DoEHLG total annual guideline limit of 30 hours is predicted as being exceeded at 4 no. of the properties.

It is worth noting that in reality, the 'estimated actual' shadow flicker is considered conservative and likely to be significantly less than predicted in Table 5-9 as the following items are not considered by the model:

- Receivers may be screened by cloud cover and/or vegetation/built form i.e., hedging, adjacent buildings, farm buildings, garages or barns;
- Each receiver will not have windows facing in all directions onto the wind farm;
- At distances, greater than 500-1000m *'the rotor blade of a wind turbine will not appear to be chopping the light but the turbine will be regarded as an object with the sun behind it. Therefore, it is generally not necessary to consider shadow casting at such distances*[16]'.

Section 5.9.3.6 outlines the mitigation strategies which will be employed at the potentially affected properties if it is required to ensure the daily shadow flicker threshold will not be exceeded.

5.8.6 Comparative Shadow Flicker Assessment

A comparative assessment was undertaken where turbines with alternative dimensions within the proposed size range as detailed in Section 4.1 were modelled and compared against the scenario with the largest potential magnitude of impact as set out in Section 5.8.4 and Table 5-9. The two comparative modelled turbines are as follows:

- **Scenario 2:** Tip height of 179.5m, hub height of 105m and rotor diameter of 149m (74.5m blade length) (i.e., lowest tip height and shortest blade length).
- **Scenario 3:** Tip height of 185m, hub height of 110.5m and rotor diameter of 149m (74.5m blade length) (i.e., highest hub height and shortest blade length).

For all turbines modelled, the Study Area remained unchanged at 1.63km. The assessment results are presented in Appendix 5-3: Comparative Shadow Flicker Assessment.

The findings of the assessment indicate that of the 78 no. properties modelled, daily shadow flicker exceedance is experienced at 31 no. properties for the scenario with the largest potential magnitude of impact (lowest hub height and longest blade turbine) (as detailed in Section 5.8.4 and Table 5-9), at 20 no. properties for Scenario 2 (lowest tip height and shortest blade turbine), and at 22 no. properties for Scenario 3 (highest hub height and shortest blade turbine). All properties that are predicted to experience daily shadow flicker exceedances under the two comparative modelled turbines are also predicted to experience daily shadow flicker exceedances under the modelled precautionary turbine Scenario 1.

Of the 78 no. properties modelled, when adjusted for regional sunshine, annual shadow flicker exceedance is experienced at 4 no. properties (H491, H492, H493, H494) for the precautionary

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

Scenario 1 (as detailed in Section 5.8.4 and Table 5-9), and at 1 no. property (H492) for comparative Scenario 2 and Scenario 3. The results of this comparative assessments support the consideration that a scenario with the largest potential magnitude of impact is a combination of the minimum hub height and the maximum rotor diameter (therefore providing the maximum possible tip height), as modelled in Scenario 1. In summary, Scenario 1 will affect more properties pre-mitigation, whereas it will be the same for all scenarios post-mitigation as the software will ensure no impacts.

5.8.7 Cumulative Shadow Flicker

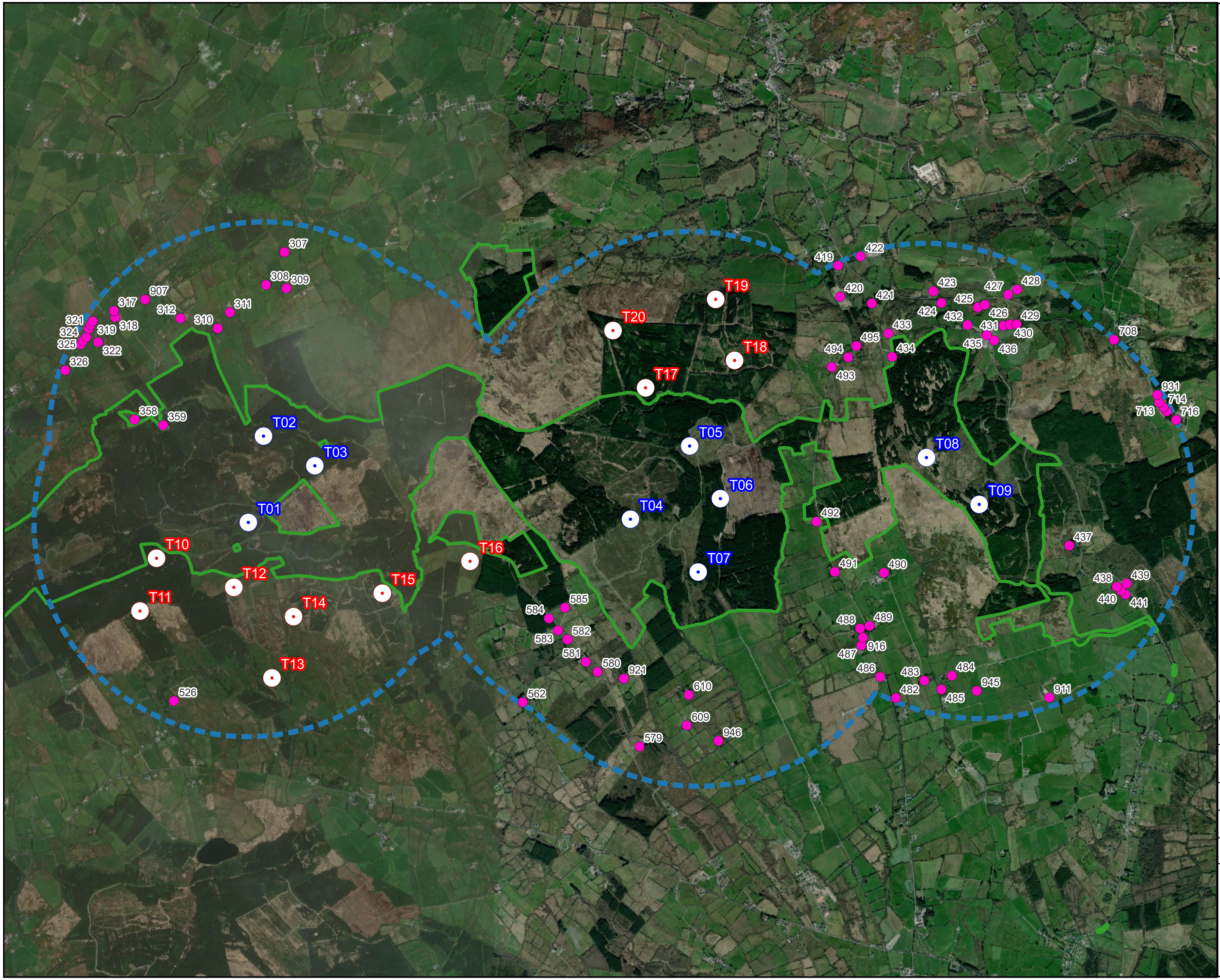
The cumulative assessment of shadow flicker generated by the Proposed Development and other existing, permitted and proposed wind farms, whose 10 rotor diameters shadow flicker assessment area overlaps with that of the Proposed Development, was carried out based on the methodology, assumptions and criteria outlined in Section 5.8.3 and Section 5.8.4. The wind farm included in the cumulative shadow flicker assessment is the proposed Oatfield Wind Farm (Turbines numbers 10 to 20 in the model; refer to Figure 5-7). Oatfield Wind Farm is located to the south and north of the Proposed Development.

As presented in Section 5.8.6 above, a combination of the minimum hub height and the maximum rotor diameter (Scenario 1) is used to predict the precautionary extent of shadow flicker effects. Therefore, the turbine dimensions for Scenario 1, as outlined above, were used for the Proposed Development in the cumulative shadow flicker assessment.

A precautionary approach was taken to model cumulative shadow flicker effects, as the EIAR for the proposed Oatfield wind farm indicates that the precautionary turbine dimensions within their proposed turbine range is as follows:

- Tip height of 180m, hub height of 105m and rotor diameter of 150m.

A total of 78 No. residential buildings have been included in the cumulative shadow flicker assessment, the results of which are presented in Table 5-10 below.



Map Legend

Wind Farm Site
Study Boundary

Cumulative Wind Farms

Proposed Knockshanvo
Wind Farm (T01 - T09)

Proposed Oatfield
Wind Farm (T10 - T20)

Shadow Flicker Study Area
(1.63km Turbine Buffer)

Dwellings within 1.63km
of the Proposed
Turbine Layout [78]

N

Drawing Title	
Cumulative Shadow Flicker Assessment Map	
Project Title	
Knockshanvo Wind Farm	
Drawn By: SD	Checked By: EOS
Project No.: 200513	Drawing No.: Figure 5-7
Scale: 1:37,500	Date: 2024-08-01

MKO
Planning and Environmental Consultants
Tuam Road, Galway Ireland, H91 VW84
+353 (0) 91 735611
email:info@mkoireland.ie
Website: www.mkoireland.ie

Table 5-10 Cumulative Shadow Flicker Results

House no.	ITM Coordinates (Easting)	ITM Coordinates (Northing)	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
358	552441	670202	T02	989	00:39:36	73:19:48	22:24:23	T01, T02, T03, T10, T12	Yes
359	552660	670159	T02	767	00:50:24	76:43:48	23:26:43	T01, T02, T03, T10	Yes
420	557806	671136	T08	1389	00:38:24	51:56:24	15:52:14	T08, T18, T19	Yes
421	558047	671085	T08	1244	00:32:24	35:26:24	10:49:44	T08, T18, T19	No
433	558174	670858	T08	988	00:43:48	50:36:36	15:27:51	T08, T09, T18, T19	Yes
434	558203	670680	T08	810	01:12:36	88:07:12	26:55:32	T08, T09, T18, T19	Yes
493	557744	670602	T08	996	01:04:12	181:31:12	55:27:52	T05, T06, T08, T09, T17, T18, T19	Yes
494	557867	670675	T08	968	01:20:24	179:12:36	54:45:31	T05, T06, T08, T09, T18, T19	Yes
495	557930	670762	T08	1002	01:24:36	147:31:12	45:04:32	T05, T06, T08, T09, T18, T19	Yes
582	555733	668529	T04	1033	00:37:48	62:36:36	19:07:51	T07, T15	Yes
583	555661	668598	T04	1010	00:36:36	49:55:12	15:15:12	T06, T07, T15	Yes
584	555592	668690	T04	977	00:47:24	60:25:12	18:27:42	T06, T07, T15	Yes
585	555714	668771	T04	837	01:18:00	120:08:24	36:42:34	T06, T07, T15, T16	Yes
582	555733	668529	T04	1033	00:37:48	62:36:36	19:07:51	T07, T15	Yes

Of the 78 no. properties modelled, when the regional sunshine average of 30.56% and is taken into account in the cumulative shadow flicker assessment, the DoEHLG WEGs (2006) threshold of 30 hours per year is predicted to be exceeded at 4 no. properties (H493, H494, H495 and H585). 2 no. of these properties (H493 and H494) are predicted to exceed the annual threshold when modelled for the Proposed Development layout alone, with an additional 2 no. properties (H495 and H585) predicted to exceed the annual threshold when modelled cumulatively alongside the proposed Oatfield wind farm layout. Scenarios 2 and 3 are predicted to affect fewer properties and when mitigation is taken into account as set out in Section 5.9.3.6 there will be no significant cumulative effects from any of the scenarios.

5.9 Likely Significant Effects and Associated Mitigation Measures

The likely effects on the population and human health are assessed using the criteria as set out in the *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (EPA, May 2022) and described in section 1.7 of Chapter 1. The below assessment evaluates the effect (where there is the potential for an effect to occur) on health and safety, employment and investment, population, land-use, property values, tourism, noise, dust, traffic, and shadow flicker during the construction, operation and decommissioning phases, as a result of the Proposed Development.

5.9.1 'Do-Nothing' Scenario

If the Proposed Development was not developed, the Wind Farm Site and Grid Connection will continue to function as they do at present, with no changes made to the current baseline as set out in Section 5.3 above. The effect of this is considered neutral in the context of the EIAR. If the Proposed Development were not to proceed, the opportunity to capture an even greater part of County Clare's valuable renewable energy resource would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions. The opportunity to generate local employment and investment and to diversify the local economy would also be lost.

5.9.2 Construction Phase

5.9.2.1 Population

5.9.2.1.1 *Population Trends*

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

5.9.2.1.2 *Employment and Investment*

The design, construction and operation of the Proposed Development will provide employment for technical consultants, contractors, and maintenance staff. Approximately, 80-100 jobs will be created during the construction, operation, and maintenance phases of the Proposed Development. During construction, additional employment will be created in the region through the supply of services and materials to the Proposed Development. The construction phase of the Proposed Development will last between approximately 18 – 24 months. The majority of construction workers and materials will be sourced locally where available, thereby helping to sustain employment in the construction trade. This will have a Short-term Significant Positive effect.

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 will result in local retailers and businesses experiencing a Short-term Positive effect on their cash flow. This will have a Short-term Slight Positive Indirect effect.

The Proposed Development will result in some skilled people coming into the area, bringing specialist skills for both the construction and operational phases that could result in the transfer of these skills into the local workforce, thereby having a Long-term Positive effect on the local skills base. Up-skilling and training of local staff in the particular requirements of the wind energy industry is likely to lead to additional opportunities for those staff as additional wind farms are constructed in Ireland. This will have a Long-term Moderate Positive Indirect effect. As discussed in Section 5.3.4 above, the wind sector currently supports 5,130 jobs (not including employment in grid development) with a 'strong foothold in rural Ireland'.

5.9.2.1.3 *Land-use*

The current land-use of coniferous forestry, biodiversity areas under Coillte management and third-party lands currently being used for agricultural and forestry will continue around the footprint of the proposed Wind Farm Site. However, a small section of commercial forestry within the site will be felled as part of the Wind Farm development. Whilst there will be a change of land use in these areas to facilitate the development of the wind turbines and infrastructure, it will be minor, consisting of approximately 2% of the Wind Farm Site boundary.

The current land-use of public road corridor and coniferous forestry 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.

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

5.9.2.1.4 *Services*

There will be no effect on current education, public transport or community facility services due to the Proposed Development.

5.9.2.2 Tourism

Pre-Mitigation Effects

The 12 O'Clock Hills hiking trails and a section of the East Clare Way are located partially within the footprint of the proposed Wind Farm Site. The 12 O'Clock Hills trails include a 4 km Red Loop which takes in heritage sites and Fairyland, an 8 km Blue Loop which takes in heritage sites, the 12 O'Clock Hills and Fairyland, and a 13 km Purple Loop which includes a hill climb of 250m. A car park with the capacity for 80 no. cars is located approximately 600m west of the proposed Wind Farm Site.

There will be an increase in construction vehicular activity in the vicinity of the proposed Wind Farm Site during the construction phase. Temporary diversions will occur along access trails during the construction phase, which will be specified as required. The summit of the 12 O'Clock Hills will remain open during the construction phase, with the exception of an estimated 10 days while the turbines are being erected due to safety procedures mandated by the turbine manufacturer. Whilst this will have a Temporary Slight Negative effect, this is an acceptable and unavoidable part of the Proposed Development.

There are no tourism or amenity sites within or in the vicinity of the Grid Connection route. The proposed Grid Connection route is not a scenic route, nor is it a critical route for accessing tourism amenities. As the construction of the Grid Connection is a short-term activity, it is considered that this will have no effect on tourism in the local area.

Proposed Mitigation Measures

Signage indicating the designated pedestrian route along the hiking trails will be in place during the construction phase of the development. Likewise, appropriate construction site warning signage and health and safety signage will be in place along the hiking trails and on the approach to the construction site at all times during the construction phase to ensure that any potential impacts pertaining to existing amenity access is mitigated against. Furthermore, all health and safety procedures as detailed in Section 5.9.2.3 will be strictly adhered to ensure not only the safety of construction staff but any users of the hiking trails during the construction phase.

Residual

With the implementation of the above mitigation measures, there will be a Temporary Slight Negative residual effect on tourism due to the presence of construction activities along the hiking trails in the area.

Significance of Effects

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

5.9.2.3 Human Health and Public Perception of Wind Energy

5.9.2.3.1 *Health and Safety*

Pre-Mitigation Effects

Construction of the Proposed Development will necessitate the presence of a construction site. Construction sites and the machinery used on them pose a potential health and safety hazard to construction workers if site rules are not properly implemented. This will have a Short-term potential Significant Negative effect.

Proposed Mitigation Measures

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

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

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

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. All construction, delivery and security staff will hold Safepass registration cards.. Construction operatives will hold a valid Construction Skills Certificate Scheme card. The developer will be 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. Safety Notice 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 Wind Farm Site and Grid Connection. One 38kV overhead line crosses the Wind Farm Site in a southeast to northwest direction, from Limerick City to Tulla. One 400kV overhead line intersects the northwestern boundary of the Wind Farm Site, travelling from Moneypoint in the direction of Dublin.

Owing to the scale and scope of the Proposed Development a Project Supervisor Design Process (PSDP) and Project Supervisor Construction Stage (PSCS) will 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 will 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 will 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 Development.

Significance of Effects

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

5.9.2.4 Property Values

As noted in Section 5.6 above, the conclusions from available international literature indicate that property values are not impacted by the positioning of wind farms near houses. As the construction of the Proposed Development is a short-term activity, it is considered that this phase will have no effect on property values in the local area.

5.9.2.5 Residential Amenity

Potential effects on residential amenity during the construction phase of the Proposed Development could arise primarily due to noise, dust and traffic. The likely significant effects and associated mitigation measures related to noise, dust and traffic during the construction phase of the Proposed Development have been described below, concluding that there will be no significant effects.

5.9.2.5.1 *Noise*

Pre-Mitigation Effects

There will be an increase in noise levels in the vicinity of the Wind Farm Site and Grid Connection during the construction phase, as a result of heavy machinery and construction work. These effects will be short-term in duration. The noisiest construction activities associated with the Wind Farm Site are excavation, pouring of the turbine bases and the extraction of stone from the borrow pits. Excavation of a base can be completed in one to two days however, and the main concrete pours will be conducted in one continuous pour, which is done within a matter of hours.

Construction noise at any given noise sensitive location will be variable throughout the construction phase, depending on the activities underway and the distance from the main construction activities to the receiving properties. The potential noise effects that will occur during the construction phase of the Proposed Development are further described in Chapter 12 of this EIAR. It is concluded that the assessed levels of noise during the construction phase of the Proposed Development are within the construction noise criterion as outlines in Chapter 12 of this EIAR. Therefore, it is concluded that there will be No Significant noise effect associated with the construction of the Proposed Development, with the exception of individual blast events at certain borrow pits, which will be audible at certain locations, which may result in Slight Short term negative effects.

With regard to the proposed Grid Connection route; construction works will give rise to noise, that without mitigation, will have Brief to Temporary Significant Negative effects in nature.

Proposed Mitigation Measures

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

- No plant used on site will be permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools will be fitted with suitable silencers.
- Machinery and vehicles that are used intermittently will be shut down during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate close to Noise Sensitive Locations (NSL's) outside of general construction hours will be surrounded by an acoustic enclosure or portable screen.
- During the course of the construction programme, supervision of the works will ensure compliance with the limits detailed in Section 12.3.2 using methods outlined in British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations will be restricted to between 7:00hrs and 19:00hrs Monday to Saturday. However, to ensure that optimal use is made of good weather periods or at critical periods within the programme (i.e. concrete pours, turbine component deliveries) it will be necessary on occasion to work outside of these hours.

Where rock breaking is employed in relation to the proposed borrow pit locations, the following are the mitigation measures that will be employed, where necessary, to mitigate noise emissions from these activities:

- Fit suitably designed muffler or sound reduction equipment to the rock breaking tool to reduce noise without impairing machine efficiency.
- Ensure all leaks in air lines are sealed.
- Use a dampened bit to eliminate ringing.
- Erect acoustic screen between compressor or generator and noise sensitive area. When possible, line of sight between top of machine and reception point will be obscured.
- Enclose breaker or rock drill in portable or fixed acoustic enclosure with suitable ventilation.

Where blasting is employed in relation to the proposed borrow pit locations, the following are the mitigation measures that will be employed, where necessary, to mitigate noise emissions from these activities:

- Restriction of hours within which blasting can be conducted (e.g. 09:00 – 18:00hrs).
- Notification to nearby residents before blasting starts (e.g. 24-hour written notification).
- The firing of blasts at similar times to reduce the 'startle' effect.
- On-going circulars informing people of the progress of the works.
- The implementation of an onsite documented complaints procedure.
- The use of independent monitoring by external bodies for verification of results.

- Trial blasts in less sensitive areas to assist in blast designs and identify potential zones of influence.

Residual Effect

Following the implementation of the above mitigation measures, there will be a Temporary to Short-term Not Significant Negative residual effect due to an increase in noise levels during the construction phase of the Proposed Development.

Significance of Effects

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

5.9.2.5.2 Dust

Pre-Mitigation Effects

Potential dust emission sources during the construction phase of the Proposed Development include upgrading of existing access tracks and construction of new access roads, turbine foundations and substation, temporary construction compounds, laying of underground cabling and all other infrastructure works. The entry and exit of construction vehicles from the Wind Farm site are predicted to 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 effects will not be Significant and will be relatively Short-term in duration.

Proposed Mitigation Measures

The majority of aggregate material for the construction of roads and turbine bases will be sourced from the proposed borrow pits located within the main site of the proposed Wind Farm Site therefore limiting the distance needed to transport this material to the Wind Farm Site. Truck wheels will be washed to remove mud and dirt before leaving the Wind Farm Site. All plant and materials vehicles for the Proposed Development shall be stored in dedicated areas within the Wind Farm Site. 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 as set out in Chapter 15 Material Assets.

In periods of extended dry weather, dust suppression will be implemented along haul roads to ensure dust does not cause a nuisance. 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 by the environmental clerk of works, as the application of too much water may lead to increased runoff.

The active construction area along the proposed Grid Connection route options will be small, ranging from 150-300m in length at any one time. All construction machinery will be maintained in good operational order while on-site, minimising any emissions including dust that are likely to arise. Aggregate materials for the construction of the Grid Connection 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

Short-term Imperceptible Negative effect

Significance of Effects

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

5.9.2.5.3 *Traffic*

Pre-Mitigation Effects

It is intended that the port of entry for large turbine components will be Shannon Foynes, County Limerick. Vehicles delivering large turbine components to the Wind Farm Site will depart from Shannon Foynes Port and the turbine components will be transported east via the N69 National Secondary Road to the outskirts of Limerick City before exiting onto the R510 Regional Road and transported northeast through Limerick City on the R526 Regional Road and continuing north along the R463 and R465 Regional Roads to the Wind Farm Site entrance.

The proposed route is also illustrated on Figure 4-16. A Traffic and Transportation Assessment (TTA) of the Proposed Development has been carried out by Alan Lipscombe Traffic and Transport Consultants. The full results of the TTA are presented in Section 15.1 of this EIAR.

The delivery route for general construction traffic including site staff and heavy goods vehicles (HGVs) delivering general construction materials to the site may vary depending on the location of the suppliers used for concrete and other materials required to construct the Proposed Development. Based on the location of suppliers in the vicinity of the Proposed Development (as described in Chapter 15 Material Assets of the EIAR), it is estimated that concrete and general construction traffic will all travel on one of the following routes (as shown in Figure 15-2a of this EIAR).

All deliveries of turbine components and other construction materials to the Wind Farm Site and Grid Connection will only be by way of the proposed transport routes outlined in. The number of construction vehicles that will be generated during the construction phase of the Proposed Development are outlined as part of the traffic and transport assessment in Section 15.1 of this EIAR.

The types of vehicles that will be required to negotiate the local network, carrying turbine components, represent abnormal size loads and a detailed assessment of the geometry of the proposed route was therefore undertaken. This will have a Temporary Slight Negative effect on local road users.

Traffic associated with the construction phase of the Grid Connection will be predominantly comprised of LGV's and small excavators. With regard to the Grid Connection route, there is the potential for short term nuisance to local road users along the section of cabling route located along the public road network, giving rise to a Temporary Slight Negative effect.

Proposed Mitigation Measures

A **Traffic Management Plan (TMP)**, incorporating all the mitigation measures set out in the CEMP, is included in Chapter 15 of this EIAR. The TMP will be finalised and confirmatory detailed provisions in respect of traffic management agreed with the roads' authority and An Garda Síochána prior to construction works commencing on the Proposed Development. The detailed TMP includes the following:

- **Traffic Management Coordinator** – a competent Traffic Management Co-ordinator will be appointed for the duration of the project and this person will be the main point of contact for all matters relating to traffic management .
- **Delivery Programme** – a programme of deliveries will be submitted to the relevant County Councils (Clare and Limerick) in advance of deliveries of turbine components to site. Liaison with the Local Authorities and Transport Infrastructure Ireland (TII) will be carried out where required regarding requirements such as

delivery timetabling. The programme will ensure that deliveries are scheduled in order to minimise the demand on the local network and minimise the pressure on the access to the site.

- **Temporary traffic management measures during construction of Wind Farm Site at access junctions during construction** – Temporary measures including signage at access Junctions B at Sallybank, C and D at Snaty.
- **Temporary traffic management measures during construction of Grid Connection** – Including signage and implementation of temporary traffic diversions.
- **Temporary traffic signs and traffic management measures for the construction phase of the proposed temporary transition compound on the N69** – As part of the traffic management measures temporary traffic signs will be put in place at the access points for the transition zone located on the N69. All measures will be in accordance with the "Traffic Signs Manual, Section 8 – Temporary Traffic Measures and Signs for Road Works" (DoT now DoTT&S) and "Guidance for the Control and Management of Traffic at Roadworks" (DoTT&S). Construction staff (flagman) will be present at key junctions during peak delivery times. This will include a request to TII / LC&CC for a temporary speed reduction for the 85 day construction period.
- **Information to locals** – Locals in the area will be informed of any upcoming traffic related matters e.g. temporary lane/road closures (where required) or delivery of turbine components at night, via letter drops and posters in public places. Information will include the contact details of the Project Co-ordinator, who will be the main point of contact for all queries from the public or local authority during normal working hours. An "out of hours" emergency number will also be provided.
- **A Pre and Post Construction Condition Survey** – Where required by the Local Authorities, a pre-condition survey of roads associated with the Proposed Development will be carried out immediately prior to construction commencement to record an accurate condition of the road at the time. A post construction survey will be carried out after works are completed to ensure that any remediation works are carried out to a satisfactory standard. The timing of these surveys will be agreed with the local authority. All road surfaces and boundaries will be re-instated to pre-development condition, as agreed with the Local Authority Engineers.
- **Liaison with the relevant local authority** - Liaison with the County Councils and An Garda Síochána will be carried out during the delivery phase of the large turbine vehicles, when an escort for all convoys will be required. Once the surveys have been carried out and "prior to commencement" status of the relevant roads established, (in compliance with the provisions of the CEMP), the relevant Roads Sections will be informed of the names and contact numbers for the Project Developer/Contractor Site Manager as well as the Site Environmental Manager.
- **Implementation of temporary alterations to road network at critical locations** – at locations highlighted in section 15.1.8. In addition, in order to minimise the impact on the existing environment during turbine component deliveries the option of blade adaptor trailers will also be used where deemed practicable.
- **Identification of delivery routes** – These routes will be agreed with the County Councils and adhered to by all contractors.
- **Delivery times of large turbine components** - The management plan will include the option to deliver the large wind turbine plant components at night in order to minimise disruption to general traffic during the construction stage.
- **Travel plan for construction workers** – While the assessment above has assumed the worst case in that construction workers will drive to the site, the construction company will be required to provide a travel plan for construction staff, which will include the identification of routes to / from the site.
- **Additional measures** - Various additional measures will be put in place in order to minimise the effects of the development traffic on the surrounding road network including wheel washing facilities on site and sweeping / cleaning of local roads as required.

- **Re-instatement works** - All road surfaces and boundaries will be re-instated to pre-development condition, as agreed with the local authority engineers.

Prior to commencement of any works, the occupants of dwellings in the vicinity of the proposed works will be contacted and the scheduling of works will be made clear. Local access to properties will also be maintained throughout any construction works and local residents will also be supplied with the number of the works supervisor in order to ensure that disruption will be kept to a minimum.

Deliveries of concrete and aggregate materials that cannot be source from the onsite borrow pits will. will be sourced from local quarries which will reduce the distance of these deliveries, thereby reducing the effect to traffic and transport in the wider area.

Residual Effect

Once the traffic management plan is implemented for the construction phase of the Proposed Development, there will be a Short-term Imperceptible Negative residual effect on local road users.

Significance of Effects

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

5.9.2.6 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 effects associated with the construction phase of the Proposed Development.

5.9.3 Operational Phase

The effects set out below relate to the operational phase of the Proposed Development including the period when turbines are being commissioned.

5.9.3.1 Population

5.9.3.1.1 *Population Trends*

The operational phase of the Proposed Development will have no effect on the population of the Population Study Area with regards to changes to trends, population density, household size or age structure. The age category with the highest population percentage in the Population Study Area would be considered to be less sensitive to change when compared to other age categories.

5.9.3.1.2 *Employment and Investment*

The operational phase will present an opportunity for local mechanical-electrical contractors and craftspeople to become involved with the maintenance and operation of the Proposed Development. On a long-term scale, the Proposed Development will create approximately 2-4 jobs during the operational phase relating to the maintenance and control of the Wind Farm Site, having a Long-term Slight Positive effect.

Rates payments for the Wind Farm Site will contribute significant funds to Clare 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 developments are nearing completion which will have a bearing on the establishment of future community benefit funds, the draft updated Wind Energy Guidelines and the Renewable Energy Support Scheme (RESS), the terms and conditions for which were published in December 2022. Both sets of policies are expected to provide the Government requirements on future community benefit funds for renewable energy projects. We will fully take into account these two important policies when finalised as we present the FuturEnergy Ireland approach to community benefit.

FuturEnergy Ireland expects that for each megawatt hour (MWh) of electricity produced by the wind farm, the project will contribute €2 into a community fund for the RESS period i.e., first 15 years of operation and €1 per MWh for the remaining lifetime of the wind farm. If this commitment is improved upon in upcoming Government Policy, the contribution rate will be adjusted accordingly. This commitment is beyond the 15 years and exceeds the requirements of the latest Climate Action Plan 2024.

If this project is constructed as currently designed, we estimate that a total of approximately 6 million euro will be available in the local area for community funding over the lifetime of the project. The above figure is indicative only and will be dependent on the generation capacity of the wind farm which is influenced by a number of factors including:

1. *Number of wind turbines.*
2. *Capacity and availability of energy production of those turbines.*
3. *Quantity of wind.*

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

5.9.3.1.3 *Land-use*

The development footprint of the Wind Farm Site, including turbines, roads, etc., will occupy only approximately 2% of the total Wind Farm Site boundary. The predominant land-use of coniferous forestry, biodiversity areas under Coillte management and third-party lands currently being used for agricultural and forestry in the Wind Farm Site will continue to co-exist with the Proposed Development. Land use along the Grid Connection comprises of public road corridor and coniferous forestry. There will be no change to existing land-uses as a result of the Grid Connection. The Proposed Development will have no effect on other land-uses within the wider area.

5.9.3.1.4 *Services*

There will be no effect on current education, public transport or community facility services due to the Proposed Development.

5.9.3.2 Tourism

Currently, there are 3 no. looped walks as part of the 12 O’Clock Hills trailheads, and a section of the East Clare Way within the proposed Wind Farm Site. A car park with the capacity for 80 no. cars is located approximately 600m west of the proposed Wind Farm Site and is associated with the 12 O’Clock Hills group.

As part of the Proposed Development design, an additional amenity pathway approximately 1.4 km in length will be included to assist with diverting the existing 12 O'Clock Hills Blue and Purple loop trails away from the public road network and onto forested lands which are safer for pedestrians.

Picnic benches, viewing areas and information signs will also be installed along sections of site roads to promote walking activities. These dedicated areas will provide a safer visitor experience and open the site up to locals, tourists, trail runners etc. Full details of the proposed recreation and amenity infrastructure is included in Section 4.2.10 of this EIAR.

The proposed design and construction of a new recreational walking trail and new viewing areas included as part of the Proposed Development will enable the continued experience, enjoyment and appreciation of landscapes and scenic amenity of equivalent quality in the area. The Landscape and Visual effects are assessed in Chapter 14 of this EIAR.

5.9.3.3 Human Health and Public Perception of Wind Energy

5.9.3.3.1 *Health and Safety*

Pre-Mitigation Effect

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

As forementioned in Section 5.5.3 above, the extremely low frequency (ELF) electric and magnetic fields (EMF) associated with the operation of the proposed cables within the Grid Connection fully comply with the international guidelines for ELF-EMF set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), as well as the EU guidelines for human exposure to EMF. Accordingly, there will be no operational effect on properties (residential or other uses) as the ICNIRP guidelines will not be exceeded at any distances even directly above the cables.

The consensus from health and regulatory authorities is that extremely low frequency EMFs, typically associated with powerlines of this nature, do not present a health risk.

Proposed Mitigation Measures

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

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

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

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

- Buried cable route markers at 50m (maximum) intervals and change of cable route direction;

- Directions to relevant turbines at junctions;
- "No access to Unauthorised Personnel" at appropriate locations;
- Speed limits signs at site entrance and junctions;
- "Warning these Premises are alarmed" at appropriate locations;
- "Danger HV" at appropriate locations;
- "Warning – Keep clear of structures during electrical storms, high winds or ice conditions" at site entrance;
- "No unauthorised vehicles beyond this point" at specific site entrances; and
- Other operational signage required as per site-specific hazards.

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

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

Residual Effect

With the implementation of the above mitigation measures, there will be a Long-term, Imperceptible residual effect on health and safety during the operational life of the Proposed Development.

Significance of Effects

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

5.9.3.4 Property Values

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

5.9.3.5 Residential Amenity

Potential effects on residential amenity during the operational phase of the Proposed Development could arise primarily due to noise, shadow flicker, changes to visual amenity or interference with telecommunications. Detailed noise and shadow flicker modelling has been carried out as part of this EIAR, which shows that the Proposed Development will be capable of meeting all current guidelines in relation to noise thresholds and the shadow flicker thresholds.

Proposed Mitigation Measures

As detailed above, the closest proposed turbine is 751m from the nearest occupied dwelling. All mitigation as outlined under noise, shadow flicker, visual amenity and telecommunications in this EIAR will be implemented in order to reduce insofar as possible effects on residential amenity at properties located in the vicinity of the Proposed Development works.

Residual Effect

With the implementation of the mitigation measures outlined in relation to noise, shadow flicker, visual amenity and telecommunications, the Proposed Development will have No Significant effect on residential amenity.

Significance of Effects

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

5.9.3.5.2 *Noise*

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 series of computer-based prediction models have been prepared to quantify the noise level associated with the operation of the Proposed Development. The predicted noise levels for the Proposed Development have been compared with the existing background noise levels and the best practice guidance levels for noise emissions from wind farms. The existing and permitted wind farms within the vicinity of the Proposed Development have been considered as part of the cumulative noise effect assessment.

Details of the noise assessment carried out by AWN Consulting are presented in Chapter 12 of the EIAR. The noise assessment determined that the predicted operational noise effect at the nearest noise sensitive receptors to the site is of a moderate, negative, long-term nature pre-mitigation. It is noted that this effect considers the periods of greatest potential effect prior to mitigation, i.e., the worst-case scenario.

As stated in the noise assessment in Chapter 12, the predicted noise levels associated with the Proposed Development will be within best practice noise criteria curves recommended in Irish guidance '*Wind Energy Development Guidelines for Planning Authorities'* therefore, there will be no significant effect from the Proposed Development. The predicted residual operational turbine noise effects at the closest noise sensitive locations to the Wind Farm Site are considered to be Long-term, Moderate, Negative.

5.9.3.5.3 *Shadow Flicker*

A detailed impact assessment of shadow flicker on residential amenity is provided in Section 5.9.3.6 below.

5.9.3.5.4 *Visual Amenity*

Chapter 14 includes a comprehensive Landscape and Visual Impact Assessment (LVIA) informed by Zone of Theoretical Visibility (ZTV) mapping, photomontage visualisations, multiple site visits and a route screening analysis. The Landscape and Visual assessment concluded that the Proposed Development is an appropriately designed and suitably scaled project, and landscape and visual effects are deemed to be acceptable.

5.9.3.5.5 *Telecommunications*

As part of the scoping and consultation exercise undertaken by MKO, the national and regional broadcasters and fixed and mobile phone operators were contacted with regard to potential interference from the proposed Wind Farm. Full details on scoping and consultation are provided in Section 2.6 of the EIAR (in Chapter 2: Background to the Proposed Development) and Section 15.2 of the EIAR (in Chapter 15: Material Assets – Telecommunications and Aviation). Copies of scoping replies received are presented in Appendix 2-1 of the EIAR. Additionally, a Telecommunications Impact Study (Appendix 15-5) was undertaken by AI Bridges for the Wind Farm Site. The results of the desktop survey analysis indicates that the proposed turbines would not impact the Telecom Operator networks. Therefore, the Proposed Development will have No Significant effect on telecommunications.

5.9.3.6 Shadow Flicker

Pre-Mitigation Effects

Assuming theoretical precautionary conditions[17], a total of 31 no. dwellings may experience daily shadow flicker in excess of the current DoEHLG guideline (2006) threshold of 30 minutes per day due to the operation of the Proposed Development. The DoEHLG total annual guideline limit of 30 hours is predicted to be exceeded at 4 no. of the dwellings assessed, when the regional sunshine average of 30.56% is taken into account. It is considered that this would have a Long-term, Significant Negative effect on the impacted sensitive receptors.

Proposed Mitigation Measures

The applicant has committed to a zero shadow flicker policy, subject to the time needed to allow the safe shut down of the turbine. Where daily shadow flicker has 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 Wind Farm, the shadow flicker prediction data will be used to select dates on which a shadow flicker event could be observed at one or multiple affected properties and the following process will be adhered to.

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

Screening Measures

In the event of an occurrence of shadow flicker at residential receptor locations, mitigation options will be discussed with the affected homeowner, including:

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

If agreement can be reached with the homeowner, then it will 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 locally using the measures detailed above, wind turbine control measures will be implemented.

[17] *Including direct sunshine for the full duration of daylight hours throughout the year, that the turbine blades are always turning, that the turbine blades are always facing the receptors, the property has windows facing the turbines, the property is always occupied and that there is no screening (vegetation or other obstacles).*

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.

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

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

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

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

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

In order to demonstrate how the SCADA control system can be applied to switch off particular turbines at the relevant times and dates, Table 5-11 below lists the 31 no. properties at which a shadow flicker mitigation strategy may be necessary to ensure the Guidelines' 30-minute per day shadow flicker threshold is not exceeded. In this case, the relevant turbine(s) will be programmed to switch off for the time required to reduce daily shadow flicker to below the guideline limit of 30 minutes. The SCADA control system will be utilised to control shadow flicker in the absence of being able to agree alternative mitigation measures with the relevant property owner. The mitigation strategy outlined in Table 5-11 below is based on the theoretical precautionary scenario. The details presented in Table 5-11 list the days per year and the turbines that could be programmed to switch off at specific times, in order to reduce daily shadow flicker to a maximum of 28 minutes, which is below the guideline limit of 30 minutes.

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

Overall, the details presented in Table 5-11 demonstrate that using the turbine control system, it will be possible to reduce the level of shadow flicker at any affected property to below the daily guideline limit of 30 minutes, by programming the relevant turbines to switch off at the required dates and times.

Table 5-11 below illustrates the relevant turbines that may need to be controlled, based on the 'worst-case impact' of shadow flicker impacts modelled. The same mitigation will be applied regardless of the turbine model implemented within the range to ensure no shadow flicker effects.

Table 5-11 Shadow Flicker Mitigation Strategy for Annual Shadow Flicker Exceedance (Scenario 1)

Property No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Days)	Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:mins:sec)
H308	0:46:48	6:24:27	T02, T03	26	1st January – 3rd January, 9th December – 31st December	≤00:28:00	≤30:00:00
H310	1:18:00	28:12:54	T02, T03	86	1st January – 2nd February, 9th November – 31st December	≤00:28:00	≤30:00:00
H311	1:12:36	25:07:22	T02, T03	66	1st January – 23rd January, 19th November – 31st December	≤00:28:00	≤30:00:00
H312	1:03:00	12:22:41	T02, T03	34	21st January – 6th February, 5th November – 21st November	≤00:28:00	≤30:00:00
H358	0:39:36	14:09:12	T01, T02, T03	49	12th February – 14th February, 20th March – 9th April, 3rd September – 24th September, 28th October – 30th October	≤00:28:00	≤30:00:00
H359	0:50:24	17:56:21	T01, T02, T03	57	9th February – 11th February, 25th	≤00:28:00	≤30:00:00

Property No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Days)	Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:mins:sec)
					March – 27th March, 29th March – 19th April, 24th August – 14th September, 16th September – 19th September, 31st October – 2nd November		
H429	0:31:12	8:23:04	T08	26	1st January, 9th January, 10th January, 2nd December, 3rd December, 11th December – 31st December	≤00:28:00	≤30:00:00
H430	0:31:12	7:40:32	T08	20	7th January, 5th December, 13th December – 30th December	≤00:28:00	≤30:00:00
H431	0:30:36	7:10:17	T08	17	5th January, 6th December – 7th December, 15th December – 28th December	≤00:28:00	≤30:00:00

Property No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Days)	Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:mins:sec)
H433	0:43:48	5:48:09	T08, T09	7	19th December – 25th December	≤00:28:00	≤30:00:00
H434	1:12:36	16:37:53	T08, T09	52	1st January – 16th January, 26th November – 31st December	≤00:28:00	≤30:00:00
H435	0:31:48	6:49:01	T08	24	3rd January – 5th January, 7th December – 9th December, 13th December – 30th December	≤00:28:00	≤30:00:00
H436	0:36:36	9:43:55	T08	46	1st January – 13th January, 27th November – 31st December	≤00:28:00	≤30:00:00
H438	0:33:36	7:57:02	T09	31	6th June – 6th July	≤00:28:00	≤30:00:00
H439	0:34:12	10:24:37	T09	47	29th May – 14th July	≤00:28:00	≤30:00:00
H440	0:32:24	7:24:24	T09	25	9th June – 3rd July	≤00:28:00	≤30:00:00
H441	0:31:12	6:53:14	T09	17	13th June – 29th June	≤00:28:00	≤30:00:00
H487	0:31:12	8:50:12	T07	20	12th May – 21st May, 22nd July – 31st July	≤00:28:00	≤30:00:00

Property No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Days)	Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:mins:sec)
H488	0:31:48	6:58:44	T07	20	30th April – 9th May, 3rd August – 12th August	≤00:28:00	≤30:00:00
H489	0:30:36	5:58:14	T07	8	29th April – 2nd May, 10th August – 13st August	≤00:28:00	≤30:00:00
H490	0:33:00	17:12:32	T06, T07	30	12th May – 17th May, 10th June – 30th June, 26th July – 31st July	≤00:28:00	≤30:00:00
H491	1:06:00	36:33:24	T04, T06, T07	114	26th March – 9th April, 11th May – 2nd August, 3rd September – 17th September	≤00:28:00	≤30:00:00
H492	1:15:00	58:21:40	T04, T05, T06, T07, T08, T09	188	17th February – 7th March, 15th April – 21st May, 24th May – 19th July, 22nd July – 28th August, 6th October – 24th October	≤00:28:00	≤30:00:00
H493	1:04:12	31:03:13	T05, T06, T08, T09	74	6th January, 10th January – 6th February, 13th	≤00:28:00	≤30:00:00

Property No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Days)	Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:mins:sec)
					February – 20th February, 21st October – 28th October, 5th November – 2nd December, 6th December		
H494	1:20:24	33:03:51	T05, T06, T08, T09	76	1st January – 28th September, 14th November – 31st December	≤00:28:00	≤30:00:00
H495	1:24:36	29:14:41	T05, T06, T08, T09	57	1st January – 19th January, 24th November – 31st December	≤00:28:00	≤30:00:00
H582	0:37:48	14:57:36	T07	52	12th May – 6th June, 7th July – 1st August	≤00:28:00	≤30:00:00
H583	0:36:00	10:45:20	T06, T07	30	3rd May – 17th May, 27th July – 10th August	≤00:28:00	≤30:00:00
H584	0:34:48	13:39:19	T06, T07	18	24th April – 2nd May, 11th August – 19th August	≤00:28:00	≤30:00:00
H585	0:39:00	15:44:43	T06, T07	53	19th April- 2nd May, 10th June –	≤00:28:00	≤30:00:00

Property No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) Producing Shadow Flicker Exceedance	No. of Days 30min/day Threshold is Exceeded	Days of Year When Mitigation May be Required (Days)	Maximum Daily Shadow Flicker (hrs:mins:sec)	Post-mitigation Maximum Annual Shadow Flicker (hrs:mins:sec)
					3rd July, 11th August – 25th August		
H916	0:31:12	7:20:44	T07	17	6th May – 13th May, 29th July – 6th August	≤00:28:00	≤30:00:00

This measure will be utilised at the site of the Wind Farm Site to prevent incidences of shadow flicker values at any house. Therefore, the Proposed Development will achieve zero shadow flicker, and thus will also be brought in line with the requirements of the Draft Revised Wind Energy Development Guidelines 2019 should they be adopted during the planning application process for this development.

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

Residual Effect

Following the implementation of the above suite of mitigations measures, no shadow flicker will occur at any residential dwelling as a result of the Proposed Development. This will result in a Long-term, Imperceptible Negative residual effect from shadow flicker on human health.

Significance of Effects

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

5.9.4 Decommissioning Phase

The wind turbines proposed as part of the Proposed Development are expected to have a lifespan of 35 years. Following the end of their lifespan, the wind turbines may be replaced with a new set of turbines, subject to planning permission being obtained, or the Wind Farm Site will be decommissioned fully as described in Chapter 4 and the accompanying decommissioning plan in Appendix 4-6.

The works required during the decommissioning phase are described in Section 4.6 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.

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

5.9.5 Cumulative Effects

For the assessment of cumulative effects, any other existing, permitted or proposed developments, plans and projects(wind energy or otherwise) have been considered where they have the potential to generate an in-combination or cumulative effect with the construction, operational and decommissioning phases of the Proposed Development. Further information on projects considered as part of the cumulative assessment are given in Section 2.7 of this EIAR. The effects with the potential to have cumulative effects on population and human health, in particular noise, air and climate, shadow flicker, traffic, telecommunications and visual effects are addressed in their relevant chapters of this EIAR.

5.9.5.1 Population

5.9.5.1.1 *Population Trends*

The Proposed Development or any other existing, permitted or proposed developments, plans and projects in the vicinity of the Wind Farm Site and Grid Connection will have no effect on the population of the area with regards to changes to trends, population density, household size or age structure as those working on the construction and decommissioning phases of the developments will travel daily to the site from the wider area, and because the age category with the highest population percentage in the Population Study Area would be considered to be less sensitive to change during the operational phase, when compared to other age categories.

5.9.5.1.2 *Employment and Investment*

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

The existing commercial forestry activities at the Wind Farm Site and part of the Grid Connection provides between 3-6 months of employment, either for harvesting or replanting per year. These activities can continue while the Proposed Development is under construction, operating and decommissioning, resulting in a Long-term Moderate Positive cumulative effect.

5.9.5.1.3 *Land-use*

Existing land-uses (commercial forestry, agriculture, residential etc.) will continue in conjunction with the Proposed Development and all other existing and permitted wind farms (as presented in Appendix 2-2 of this EIAR). Therefore, there will be No Significant cumulative effect on land-use during the construction, operational and decommissioning phases of the Proposed Development.

5.9.5.1.4 *Services*

There will be no cumulative effect on current education, public transport or community facility services due to the Proposed Development.

5.9.5.2 Tourism

The 12 O'Clock Hills and East Clare Way walking trails are located predominantly within the proposed Wind Farm Site. The Grid Connection underground electrical cabling route will be located within the public road network however, once operational the road corridors in which the underground electrical cabling route is located will be fully reinstated with no potential to give rise to any operational phase effects.

It is not considered that the Proposed Development together with other projects in the area will cumulatively affect any tourism infrastructure in the wider area. As mentioned previously, wind farms are an existing feature in the surrounding landscape, which will assist in the assimilation of the Proposed Development into this environment. As also noted in Section 5.4 above, the conclusions from available research indicate there is a generally positive disposition among tourists towards wind development in Ireland. It is on this basis that it can be concluded that there will be a long-term imperceptible cumulative effect from the Proposed Development and other projects in the area.

5.9.5.3 Human Health and Public Perception of Wind Energy

5.9.5.3.1 *Health and Safety*

The Proposed Development will have a short-term potential slight negative residual effect on health and safety during the construction phase of the Proposed Development, and a long-term, imperceptible residual effect on health and safety during the operational life of the Proposed Development. All other existing, permitted or proposed projects and plans (wind energy or otherwise), as set out in Section 2.7 in Chapter 2 of this EIAR, will be expected to follow all relevant Health and Safety Legislation during the construction, operation and decommissioning phases of the Proposed Development. It is on this basis that it can be concluded that there will be a Long-term Imperceptible cumulative effect from the Proposed Development and other developments in the area.

5.9.5.4 Property Values

As noted in Section 5.6 above, the conclusions from available international literature indicate that property values are not impacted by the positioning of wind farms near houses. It is on this basis that it can be concluded that there will be a Long-term Imperceptible cumulative effect from the Proposed Development and other wind farm developments in the area.

5.9.5.5 Residential Amenity

From a review of all existing and proposed projects in Section 2.7 of this EIAR, it has been determined that there will be no significant cumulative effects on any sensitive receptors with regards to noise, dust, traffic, shadow flicker, visual amenity or telecommunications.

5.9.5.5.1 *Noise*

As concluded in Chapter 12 of this EIAR, the predicted noise levels associated with the Proposed Development, which takes into account the set of cumulative wind farms, will be within best practice noise criteria curves recommended in Irish guidance '*Wind Energy Development Guidelines for Planning Authorities*'.

It is therefore considered that a significant effect is not associated with the Proposed Development in combination with other wind farm developments.

5.9.5.5.2 *Dust*

During the construction phase of the Proposed Development and considering the potential cumulative effect with other existing and proposed developments, plans and projects listed in Appendix 2.2 and within 1km of the Wind Farm Site and Grid Connection, there will be potential dust emissions associated with all construction activities. Should these projects be constructed at the same time as the Proposed Development, there will be a Short-term Slight Negative cumulative Effect on air quality due to dust emissions.

The nature of the Proposed Development is such that, once operational, it will have a long-term, Moderate, Positive Effect on the air quality. Dust emissions during the operational phases of the Proposed Development and other developments, plans or projects, listed in Appendix 2-2 of Chapter 2, will be minimal, relating to the use of operation and maintenance vehicles onsite, and therefore there will be a Long-term, Imperceptible, Negative cumulative Effect on air quality.

5.9.5.5.3 Traffic

From a review of all existing and proposed projects in Section 2.7 of this EIAR, it has been determined that the potential for cumulative effects will only occur with other wind farms that have yet to be constructed as the traffic generation for existing operational wind farms is very low.

Of the 3 wind farm developments listed, 2 (Fahy Beg Wind Farm and Knockballynameath Wind Farm) are at locations where there would be little overlap between their construction delivery routes and the delivery routes for the Proposed Development. In addition, one of these wind Farms (Knockballynameath Wind Farm) is for has a single turbine so traffic generation levels will be low. The potential for cumulative impacts with these wind farms is therefore low, or slight.

For the remaining wind farms included in the assessment, Oatfield Wind Farm (11 turbines) is located adjacent to the Proposed Development site and will share the same delivery routes. It is a similar size of development (11 turbines) as the Proposed Development (9 turbines) and the potential for cumulative impacts during the construction phases of both developments is therefore high. Based on the assessment in Section 15.1.10.5 of Chapter 15 it is considered that the potential for cumulative impacts between the Proposed Development and the proposed Oatfield Wind farm is relatively high, with the severity of the effects being slight to moderate with the effects being temporary.

5.9.5.5.4 Shadow Flicker

A detailed impact assessment of cumulative shadow flicker on residential amenity is provided in Section 5.9.5.6 below.

5.9.5.5.5 Visual Amenity

The cumulative visual effect of the Proposed Development and any other existing, permitted or proposed developments in the vicinity of the Wind Farm Site and Grid Connection is addressed comprehensively in Chapter 14 of this EIAR. There are 8 No. additional existing, permitted and/or proposed wind farms located within 20km of the proposed Wind Farm Site. As demonstrated by the mapping and photomontage visualisations there is an accumulation of wind energy development proposed in this area of East Clare, particularly in the Slieve Bernagh Uplands, which is an area of the landscape (LCA-8) where wind energy is strategically directed in local planning policy. The cumulative photomontages in the Volume 2 Booklet illustrate the nature and extent of potential cumulative visual effects which are likely to occur on specific visual receptors and the differing geographic perspectives surrounding the site. The LVIA has determined that the undulating and well-defined landform features and valleys in this area have the potential to reduce the extent of cumulative visual effects experienced by visual receptors in this area that this landscape has the capacity to absorb the Proposed Development and will not have significant cumulative or in-combination effects with the other potential wind energy developments.

5.9.5.5.6 Telecommunications

A Telecommunications Impact Study (Appendix 15-5) was undertaken by AI Bridges for the Wind Farm Site. The results of the desktop survey analysis indicates that the There would be no cumulative impacts on telecommunications networks due to the proposed wind turbines at Knockshanvo.

5.9.5.6 Shadow Flicker

As outlined in Section 5.8 above, cumulative shadow flicker model results show that 13 no. sensitive receptors are predicted to experience cumulative shadow flicker effects due to the proposed Oatfield Wind Farm in conjunction with the Proposed Development. These 13 no. sensitive receptors include 2 no. additional properties which exceed the DoEHLG WEGs threshold of 30 minutes per day, and 2 no.

additional properties which exceed the threshold of 30 hours per year due to the cumulative effects of the two proposed wind farms.

Following the implementation of the suite of mitigations measures outlined in Section 5.9.3 above, no shadow flicker will occur at any sensitive receptor as a result of the Proposed Development either individually or in combination with the other plans and projects identified in Appendix 2-2. This will result in a Long-term, Imperceptible Negative residual effect from shadow flicker on human health and residential amenity. Therefore, based on the assessment above and the mitigation measures proposed there will be No Significant cumulative effects related to shadow flicker due to the Proposed Development.

5.10 Summary

Following consideration of the residual effects (post-mitigation) it is concluded that the Proposed Development will not result in any significant effects on Population and Human Health in the Population Study Area surrounding the Proposed Development. Following appropriate mitigation, '*Wind Energy Development Guidelines for Planning Authorities 2006*' (referred to as the Guidelines) shadow flicker limits will not be exceeded at any property.

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

The residual effects are of the same significance for all permutations within the range. The same mitigation will be applied regardless of the turbine installed within the range.