5. POPULATION AND HUMAN HEALTH

5.1 Introduction

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

This chapter references the Proposed Development as detailed in Chapter 4 and the Study Area for the Population section of this EIAR which is defined in terms of the District Electoral Divisions (DEDs) where the site is located.

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

There are 14 no properties located within 1.63km of the proposed turbine locations, of which 4 no. are involved. The curtilage of the dwelling which is located closest to the proposed turbines is located approximately 899m southwest of T2 and belongs to a landowner who is financially participating in the Proposed Development.

5.1.1 Statement of Authority

This section of the EIAR has been prepared by Niamh McHugh and Keelin Bourke and reviewed by Órla Murphy of MKO. Niamh is an Environmental Scientist who has been working with MKO since June 2021. Niamh possesses a BSc (Hons) in Environmental Science from the National University of Ireland, Galway. Niamh has been involved in the compilation and production of a number of EIARs, mainly in the field of Renewables. Keelin is a Graduate Environmental Scientist with MKO having joined the company in September 2023. Keelin holds a BSc (Hons) in Environmental Science from University College Cork and an MSc (Dist) in Environmental Engineering from Trinity College Dublin. Prior to taking up her position with MKO, Keelin worked as an Environmental Health and Safey Officer in an EPA licensed Waste Transfer Station in Cork City. Keelin's current key strengths and areas of expertise are in environmental surveying, report writing and environmental mapping. Since joining MKO, Keelin has become a member of the MKO Environmental Renewables Team which work on produce high quality Environmental Impact Assessment Reports for a variety of Renewable Energy clients. The chapter has been reviewed by Órla Murphy and Sean Creedon of MKO. Órla is a Senior Environmental Scientist with over 8 years' experience in the environmental sector where she has acted as Project Manager for a number of EIAR applications for wind energy developments, compiling numerous EIAR chapters including chapters on Population and Human Health. Órla holds a BSc. in Geography and MSc. in Environmental Protection and Management.

5.2 Population

5.2.1 Receiving Environment

This socio-economic study of the receiving environment included an examination of the population and employment characteristics of the area. The relevant methodology pertaining to the population and human health assessment relates to the assessment of desk-based data sourced from the following. Information regarding population and general socio-economic data were sourced from the Central Statistics Office (CSO), the Kerry County Development Plan 2022 – 2028, Cork County Development Plan 2022 – 2028, Fáilte Ireland and any other literature pertinent to the area. The study included an examination of the population and employment characteristics of the area. This information was sourced from the Census of Ireland 2022, which is the most recent census for which a complete dataset is available, also the Census of Ireland 2016, the Census of Agriculture 2010 and from the CSO website (www.cso.ie). Census information is divided into State, Provincial, County, Major Town and District Electoral Division (DED) level.

The Proposed Development is located at the Existing Kilgarvan Wind Farm site, approximately 5.5km northeast of the village of Kilgarvan, Co. Kerry and approximately 6km west of Coolea, Co. Cork, as shown in Figure 4-1. The site comprises lands in the townlands of Inchincoosh, Lettercannon, Inchee, Coomacullen and Cloonkeen, Co. Kerry. Please refer to Figure 1-1 of Chapter 1: Introduction, for the site location.

In order to assess the population in the vicinity of the Proposed Development, the Study Area for the Population section of this EIAR was defined in terms of the District Electoral Divisions (DEDs) where the Proposed Development is located, and where relevant, nearby DEDs which may be affected by the Proposed Development. It should be noted that the Proposed Development is located adjacent to the border of Co. Cork and DEDs in both Co. Kerry and Co. Cork have been considered. The Proposed Development is located within 4 no DEDs; Kilgarvan, Glanlee, An Sliabh Riabhach, and Clydagh, as shown in Figure 5-1. All four of these DEDs will collectively be referred to hereafter as the Study Area for this chapter. The DEDs which fall in the area of the turbine delivery route have not been considered in this assessment as no permanent works are being proposed along this transport route.

The Study Area has a population of 2,084 persons as of 2022 and comprises a total land area of 237.1km^2 (Source: CSO Census of Population 2022).

The closest third-party dwelling to the Proposed Development is located approximately 1269m from the nearest turbine (T10), i.e. greater than the recommended setback distance (i.e. 4 times the tip height, 800m) as per the *Draft Revised Wind Energy Development Guidelines* (Department of Housing, Planning and Local Government, December 2019 (currently out for public consultation)).

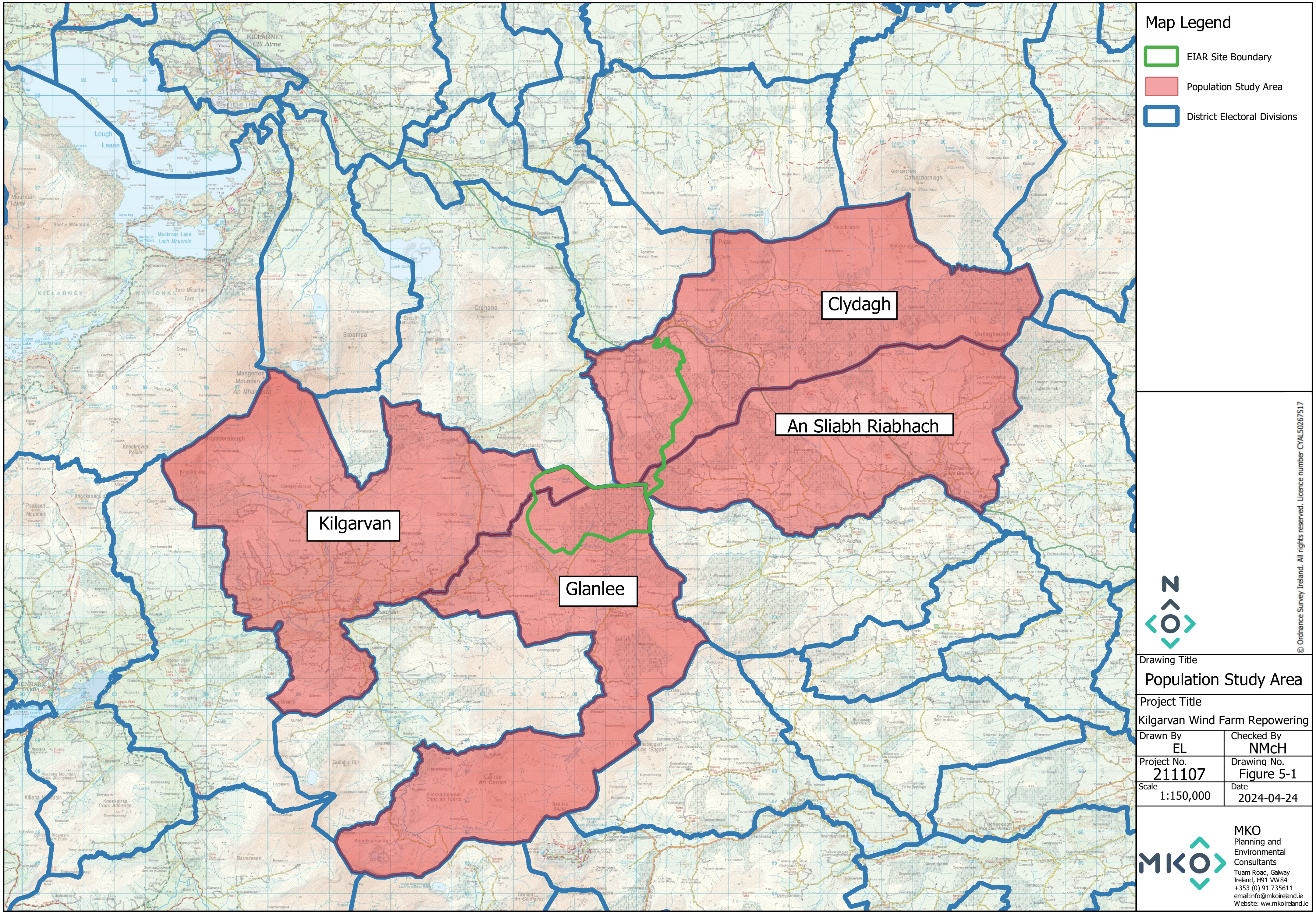
5.2.2 Population Trends

The period between the 2016 and the 2022 Census, the population of Ireland increased by 8.1%. During this time, the population of Co. Kerry grew by 5.9% to 156,454 persons, and the population of Co. Cork grew by 7.6% to 584,156 persons. Other population statistics for the State, County Kerry, County Cork and the Study Area have been obtained from the Central Statistics Office (CSO) and are presented in Table 5-1.

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

Area	Population Change		% Population Change
	2016	2022	2016-2022
State	4,761,865	5,149,139	8.1%
County Kerry	147,707	156,458	5.9%
County Cork	542,868	584,156	7.6%
Study Area	1,814	2,084	14.9%

The data presented in Table 5-1 shows that the population of the Study Area saw large growth, with a population increase of 14.9% in the period between 2016 and 2022. This trend of population increase is in line with the population growth observed at both a County and State level during the same period. When the population data is examined in closer detail, it shows that the rate of population change in the Study Area is very uneven across each of the District Electoral Divisions (DEDs). Kilgarvan DED experienced the largest population increase of 18.1%, Glanlee DED experienced a population increase of 10.9%, An Sliabh Riabhach DED experienced a population increase of 14.9%, and Clydagh experienced the lowest population increase of 2.5%. Of the DEDs that make up the Study Area for this assessment, the highest population was recorded in An Sliabh Riabhach, with 978 persons during the 2022 Census, while Clydagh DED had the lowest recorded population with 125 persons recorded during the 2022 Census.



Clydagh
An Sliabh Riabhach
Kilgarvan
Glanlee
Map Legend
EIAR Site Boundary
Population Study Area
District Electoral Divisions
© Ordnance Survey Ireland. All rights reserved. Licence number CYAL50267517
Drawing Title
Population Study Area
Project Title
Kilgarvan Wind Farm Repowering
Drawn By
EL
Checked By
NMcH
Project No.
211107
Drawing No.
Figure 5-1
Scale
1:150,000
Date
2024-04-24
MKO
Planning and Environmental Consultants
Tuam Road, Galway Ireland, H91 VW84
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email:info@mkoireland.ie
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5.2.3 Population Density

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

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

Area	Population Density (Persons per square kilometre)	
	2016	2022
State	70.0	75.7
County Kerry	30.7	32.5
County Cork	72.4	77.9
Study Area	7.65	8.8

The population density of the Study Area recorded during the 2022 Census was 8.8 persons per km^2. This figure is significantly lower than the national population density of 75.7 persons per km^2 and the county population density of 32.5 persons per km^2 in Kerry and 77.9 persons per km^2 in Cork. These findings indicate that the study area has a low population density.

Similar to the trends observed in the population, the population density recorded across the Study Area site varies between DEDs. Clydagh has the lowest population density which was recorded as being 2.07 persons per km^2. An Sliabh Riabhach had the highest recorded population density in the 2022 Census at 20.66 persons per km^2. Kilgarvan DED had a population density recorded at 11.65persons per km^2 in the 2022 Census, and Glanlee had a population density of 3.13 persons per km^2 in the 2022 Census.

5.2.4 Household Statistics

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

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

Area	2016		2022	
	No. of Households	Avg. Size (persons)	No. of Households	Avg. Size (persons)
State	1,702,289	2.75	1,841,152	2.73
County Cork	195,853	2.8	211,362	2.72
County Kerry	54,493	2.7	58,317	2.57
Study Area	696	2.63	802	2.59

In general, the figures in Table 5-3 show that the number of houses within the State and both counties Cork and Kerry increased from 2016 to 2022. The number of households in the Study Area also increased slightly, however, the average size of the household has decreased slightly between 2016 and 2022 within the Study Area. Average household size in the Study Area during 2022 Census is below that of the County and State level. Similar to trends observed above, the average household size recorded across the Study Area varied between DEDs. Glanlee DED had the highest, with 2.71 persons per household recorded in 2022, while Clydagh recorded the lowest household size at 2.47 persons per household. Kilgarvan DED recorded 2.53 persons per household, and An Sliabh Riabhach recorded 2.63 persons per household.

5.2.5 Age Structure

Table 5-4 presents the population percentages of the State, County Kerry, County Cork, 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 5-4.

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

Area	Age Category				
	0 - 14	15 – 24	25 - 44	45 - 64	65 +
State	19.7%	12.5%	27.6%	25.1%	15.1%
County Kerry	19.5%	12.6%	27.2%	25.5%	15.3%
County Cork	18.4%	11.3%	24.1%	27.3%	18.9%
Study Area	20.0%	10.2%	24.1%	28.8%	17.0%

The proportion of the Study Area population is broadly similar to those recorded at national and county level for most categories. For the Study Area, the highest population percentage occurs within the 25-44 and the 45-64 age category, this is similar to trends seen at both County and State level. Differences occur between State, County and Study area, where at a State level and in Co. Cork the population percentage in the 45-64 age category is 25.1% and 25.5% while the population percentage is higher in Co. Kerry at 27.3% and within the Study area at 28.8%.

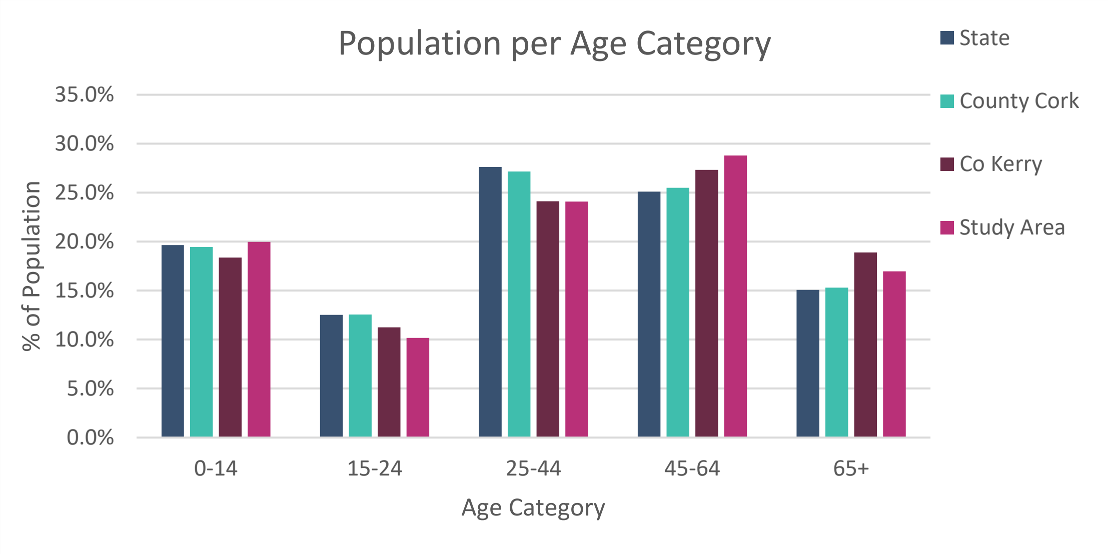

Figure 5-2 Population per Age Category in 2022 (Source: CSO)

5.2.6 Employment and Economic Activity

5.2.6.1 Economic Status of the Study Area

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

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

Status		State	County Cork	County Kerry	Study Area
% of population aged 15+ who are in the labour force		61.2%	60.3%	58.1%	62.6%
% of which are:	At work	91.7%	93.2%	91.0%	94.3%
	First time job seeker	1.4%	1.1%	1.5%	1.0%
	Unemployed	7.0%	5.7%	7.5%	4.8%
% of population aged 15+ who are not in the labour force		38.8%	39.7%	41.9%	37.4%
% of which are:	Student	28.6%	29.1%	23.3%	24.2%
	Home duties	17.0%	17.4%	16.5%	20.1%
	Retired	41.0%	39.6%	46.2%	46.2%

Status		State	County Cork	County Kerry	Study Area
	Unable to work	11.8%	12.3%	12.1%	7.9%
	Other	1.7%	1.7%	1.8%	1.6%

Overall, the principal economic status of those living in the Study Area is broadly similar to that recorded at State and County level. During the 2016 Census, the percentage of Unemployed persons in the Study Area was noticeably lower in the Study Area Population as compared to the State and County. In Census 2022, for the first time ever, two categories of unemployment detail were included, Long-term Unemployment and Short-term Unemployment, for the purpose of this assessment, both categories have been grouped into one Unemployment group. Of those who were not in the labour force during the 2022 Census, the highest percentage of the Study Area population were 'Retired' Individuals, similar to the State and County populations.

5.2.6.2 Employment by Socio-Economic Group

Socio-economic grouping divides the population into categories depending on the level of skill or educational attainment required. The 'Higher Professional' category includes scientists, engineers, solicitors, town planners and psychologists. The 'Lower Professional' category includes teachers, lab technicians, nurses, journalists, actors and driving instructors. Skilled occupations are divided into manual skilled such as bricklayers and building contractors; semi-skilled such as roofers and gardeners; and unskilled, which includes construction labourers, refuse collectors and window cleaners. Figure 5-3 shows the percentages of those employed in each socio-economic group in the State, County Cork, County Kerry, and the Study Area during 2022.

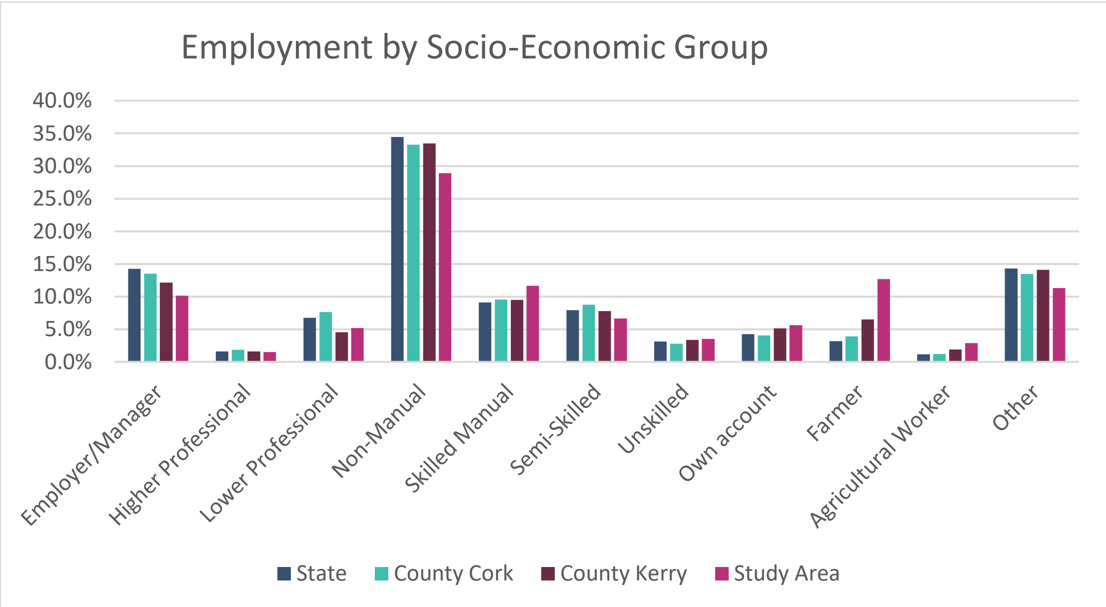

Figure 5-3 Employment by Socio-Economic Group in 2022 (Source: CSO).

The highest level of employment within the Study Area was recorded in the Non-Manual category. The levels of employment within the Employer/Manager, Higher Professional, Non-Manual, Semi-Skilled, , and Other categories were recorded at lower levels within the Study Area than at both County and State level. On the other hand, the levels of employment recorded within the Skilled Manual, Own Account Agricultural Worker and Farmer categories in the Study Area were higher in the Study Area than at State or County level, with Farmer and Agricultural work well above State and County averages.

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

5.2.6.3 Employment and Investment Potential in the Irish Wind Energy Industry

5.2.6.3.1 *Background*

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

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

More recently, a report published in 2014 by Siemens entitled '*An Enterprising Wind - An economic analysis of the job creation potential of the wind sector in Ireland'*, also in conjunction with the Irish Wind Energy Association (IWEA), concluded that, *'a major programme of investment in wind could have a sizeable positive effect on the labour market, resulting in substantial growth in employment.'* The report considers the three potential types of direct employment created, as a result of increased investment in wind energy, to be:

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

The Sustainable Energy Authority of Ireland[1] demonstrates in their '*Wind Energy Roadmap 2011-2050'*, that '*the wind energy resource represents a significant value to Ireland by 2050. This value is presented in terms of its ability to contribute to our indigenous energy needs, the benefits of enhanced employment creation and investment potential, and the ability to significantly abate carbon emissions to 2050.'*

5.2.6.3.2 *Energy Targets*

The Climate Action Plan 2024 (CAP 2024)[2] was launched in December 2023. 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*

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[1] *SEAI (2019), https://www.seai.ie/publications/Wind_Energy_Roadmap_2011-2050.pdf*
[2] *Government of Ireland - Climate Action Plan 2024 << https://www.gov.ie/pdf/?file=https://assets.gov.ie/284675/70922dc5-1480-4c2e-830e-295afd0b5356.pdf#page=null >>*

greenhouse gas emissions no later than 2050, and a reduction of 51% by 2030. The CAP 2024 sets out indicative ranges of emissions reductions for each sector of the economy. Under this revised CAP, Ireland has set targets of 6 GW of onshore wind energy by 2025, to increase to 9 GW of onshore wind energy by 2030, with at least 5 GW of offshore wind energy by the end of 2030.

5.2.6.3.3 Employment Potential

The 2014 report *"An Enterprising Wind: An economic analysis of the job creation potential of the wind sector in Ireland"* published by the Irish Wind Energy Association (IWEA) predicted that the wind energy sector in Ireland would result in 6,659 direct jobs in a scenario where 4GW capacity is achieved by 2020. This figure of 6,659 is broken down further; 5,596 of these jobs are associated directly with the construction and installation of windfarms, while the remaining 1,063 jobs are associated with the national grid. Under this scenario this contributes 1.66 direct jobs per Megawatt (MW) of wind capacity throughout the various stages of installation.

The Sustainable Energy Authority of Ireland[3] estimates, in their '*Wind Energy Roadmap 2011-2050*', note that '*Onshore and offshore wind could create 20,000 direct installation and O&M jobs by 2040'.* Furthermore, '*wind energy resource represents a significant value to Ireland by 2050. This value is presented in terms of its ability to contribute to our indigenous energy needs, the benefits of enhanced employment creation and investment potential, and the ability to significantly abate carbon emissions to 2050'*

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

A new report published by MaREI, the SFI Research Centre for Energy, Climate and Marine, hosted by University College Cork[4] (March 2021) details that in order to meet the government target of net-zero carbon emissions by 2050, at least 25,000 jobs will be created in the development of onshore and offshore wind to meet our zero carbon targets.

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

As of February 2024, there were 6,094 Megawatts (MW) of wind energy capacity installed on the island of Ireland[5]. Of this, 4,730.4 MW was installed in the Republic of Ireland. The majority of the Republic of Ireland's installed wind energy capacity is located in Counties Donegal, Galway, Cork, Clare and Kerry, contributing to employment potential on the Island of Ireland.

5.2.6.3.4 Economic Value

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

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[3] *SEAI (2019), https://www.seai.ie/publications/Wind_Energy_Roadmap_2011-2050.pdf*
[4] *https://www.marei.ie/our-climate-neutral-future-zeroby50/*
[5] *EirGrid (2024), https://www.eirgrid.ie/grid/system-and-renewable-data-reports*

differed if no wind farms had been built. The analysis indicated that the deployment of 4.1 GW of wind generation capacity in Ireland between 2000 and 2020 (2018-2020 results being projective) will result in a total net cost to consumers, over 20 years, of €0.1bn (€63 million to be exact), which equates to a cost of less than €1 per person per year since 2000. Further cost benefit analysis noted that wind energy has delivered €2.3 billion in savings in the wholesale electricity market. As such, the economic benefit of renewable energy to consumers is greater than what would have been if Ireland did not invest in wind power. This corresponds with the Deloitte report which indicates that more wind energy feeding into the national grid will result in lower and more stable energy costs for consumers.

Furthermore, in May 2020, IWEA released its 70by30 Implementation Plan Reports which further details the savings that can be made from the continuation of onshore wind. The report, entitled '*Saving Money - 70 by 30 Implementation Plan'*, notes that '*Baringa calculated previously that if onshore wind in Ireland can be delivered at €60/MWh, on average, between 2020 and 2030, then the 70 per cent renewable electricity target set out in the Climate Action Plan will actually be cost neutral for the consumer. If we can achieve prices under €60/MWh then Ireland's electricity consumers will be saving money'.*

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

5.2.7 Land-Use

The Proposed Development site is currently used for small-scale agriculture, and wind energy development, as it is currently in use as the Existing Kilgarvan Wind Farm. The predominant surrounding land use within the Population study area is also farmland. The total area of farmland within the DEDs around the Proposed Development site measures approximately 14,488 hectares, comprising approximately 61% of the Study Area land mass, according to the CSO Census of Agriculture 2010. There are 244 no. farms located within the Study Area, with an average farm size of 59.4 hectares.

5.2.8 Services

The Proposed Development is located at the Existing Kilgarvan Wind Farm, approximately 5.5km northeast of the village of Kilgarvan, Co. Kerry and approximately 6km west of Coolea, Co. Cork. There is a small service station and Church in Glenflesk village, which is located approximately 7km northwest of the Proposed Development. The main services for the study area are located within the town of Killarney which offers large-scale services and retail.

5.2.8.1 Education

The nearest primary school to the Proposed Development is the Glenflesk National School, located approximately 8 km northwest of the site at its closest point.

The nearest secondary School to the Proposed Development is Killarney Community College, located approximately 20km northwest of the Proposed Development at its closest point.

The closest Third Level Educational institution is the Institute of Technology, Tralee, which is located approximately 53km northwest of the Proposed Development.

5.2.8.2 Access and Public Transport

The site of the Proposed Development is accessed via an existing entrance from the N22 National Road which runs in an east-west direction connecting Killarney to Cork City. There is a Bus Eireann

Expressway (Route 40) bus route which runs several times daily which connects Tralee to Rosslare and passes by the entrance to the Proposed Development.

5.2.8.3 Amenities and Community Facilities

Most of the amenities and community facilities, including GAA, soccer, other sports clubs, and recreational areas are available in the nearby settlements of Coolea, Kilgarvan, Glenflesk, and Ballyvourney. The nearby town of Killarney located approximately 18km northwest of the Proposed Development possesses a number of tourist attractions such as Killarney National Park, Torc Waterfall, golf courses, hotels, Muckross Abbey, and Ross Castle. Larger scale retail and personal services are also available within Killarney town.

A number of options for walking and cycling are available within the Study Area and surrounding lands.

5.3 Tourism

5.3.1 Overseas Tourism Numbers and Revenue

Tourism is one of the major contributors to the national economy and is a significant source of full time and seasonal employment. During 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 2018 grew by 6.5% to 9.6 million ('*Tourism Facts 2019*, Fáilte Ireland, March 2021).

Ireland is divided into seven tourism regions. Table 5-6 shows the total revenue and breakdown of overseas tourist numbers to each region in Ireland during 2018 ('*Tourism Facts 2019*, Fáilte Ireland, March 2021).

Table 5-6 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**
Mid-West	€472m	1,432
West	€653m	1,943
Border	€259m	768
Total	€5,173 m	15,021

The Proposed Development is located within the South-West Region. According to '*Regional Tourism Performance in 2019'* (Fáilte Ireland, March 2021), the South-West Region which comprises the counties of Cork and Kerry, benefitted from approximately 15.5% of the overseas tourists to the country and approximately 19% of the associated tourism income generated in Ireland in 2019.

Although the data for 2019 is not available, Table 5-8 presents the most recent breakdown of overseas tourist numbers and revenue to the South-West region during 2017 ('*2017 Topline Tourism*

Performance by Region, Fáilte Ireland, August 2018). As can be observed in Table 5-8, County Cork had the highest number of overseas tourists visiting the Region during 2017 and had a tourism revenue at €631m.

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

Region	Total Revenue (€m)	Total Number of Overseas Tourists (000s)
Cork	631	1,605
Kerry	337	1,277

5.3.2 Domestic Tourism and Revenue

Fáilte Irelands latest key tourism performance data was released in October 2023, which provides Domestic Tourism and Revenue data for 2022 (*Key Tourism Facts 2022*, Failte Ireland, 2023). During 2022, total domestic expenditure was approximately €2,930 million, an increase from €2,146.6 million in 209 and €2,006 million in 2018.

Table 5-8 shows the total estimated expenditure and breakdown of domestic tourist trips numbers to each of Irelands seven tourist regions during 2022.

Table 5-8 Domestic Tourism Expenditure and Number of Trips 2022 (Source Fáilte Ireland)

Region	Estimated Expenditure (€m)	Total No. Trips (000s)
Dublin	€419	1,861
Mid-East/Midlands	€395	1,957
South-East	€381	1,899
South-West	**€665**	**2,763**
Mid-West	€261	1,322
West	€459	1,866
Border	€350	1,606
Total	€2,930	13,274

The Proposed Development is located within South-West Tourism Region. The South-West Region, benefitted from approximately 20.8% of total domestic trips and 22.7% of associated estimated expenditure in Ireland in 2022.

5.3.3 Tourist Attractions

There are no key identified tourist attractions pertaining specifically to the site of the Proposed Development itself.

Key tourist attractions within Counties Cork and Kerry include the Ring of Kerry, Killarney National Park, Cork City, and Fota Wildlife Park. Within the Cork/Kerry boundary area there are also many additional tourist attractions found around Kenmare, Coolea, Kilgarvan, and Killarney which are all within 20km of the Proposed Development. The Discover Ireland Website lists the following attractions within 20km of the Proposed Development:

- Killarney National Park is located approximately 17.1km west of the Proposed Development and possesses a number of walking and hiking trails with unrivalled views of the McGillycuddy Reeks, acres of woodland and several lakes.
    - Torc Waterfall – also located within Killarney National Park, Torc Waterfall is an extremely popular tourist attraction and can be reached within the National Park by following the Muckross House to Torc Waterfall Lake Loop.
    - Muckross House – as stated above, the Muckross House is located within Killarney National Park and can be reached by following the Muckross House to Torc Waterfall Lake Loop.
- Ring of Kerry – the starting point of this extremely popular tourist trail for walking, cycling, hiking and driving is located in Killarney, approximately 17.1km west of the Proposed Development.
- Kenmare town is a popular tourist destination and is located approximately 18km southwest of the Proposed Development. Kenmare is a picturesque coastal town nestled between the Ring of Kerry and the Ring of Beara. Kenmare has an array of walks and hikes to choose from, including the 'Old Kenmare Road' which is a 16km hike from Kenmare to the car park at Torc Waterfall.

5.4 Public Perception of Wind Energy

5.4.1 Sustainable Energy Ireland Survey 2003

5.4.1.1 Background

The results of a national survey entitled '*Attitudes Towards the Development of Wind Farms in Ireland*' were published by the Sustainable Energy Authority of Ireland (SEAI) in 2003 and updated in 2017 – see Section 5.4.1.3 below. A catchment area survey was also carried out by SEAI (formerly SEI) in order to focus specifically on people living with a wind farm in their locality or in areas where wind farms are planned.

5.4.1.2 2003 Findings

The SEAI survey published in 2003, found that the overall attitude to wind farms is very positive, with 84% of respondents rating it positively or very positively. One percent rates it negatively and 14% had no opinion either way. Approximately two thirds of respondents (67%) were found to be positively disposed to having a wind farm in their locality. Where negative attitudes were voiced towards wind farms, the visual effect of the turbines on the landscape was the strongest influence. The report also notes however that the findings obtained within wind farm catchment areas showed that effect on the landscape is not a major concern for those living near an existing wind farm.

With regards to the economic and environmental effects of wind farm development, the national survey reveals that attitudes towards wind energy are influenced by a perception that wind is an attractive source of energy:

> *"Over 8 in 10 recognise wind as a non-polluting source of energy, while a similar number believe it can make a significant contribution to Ireland's energy requirements."*

The study reveals uncertainty among respondents with regards to the issues of noise levels, local benefits and the reliability or otherwise of wind power as an energy source. It goes on to state however that the finding that people who have seen wind farms rate these economic and environmental factors more favourably is a further indication that some experience of the structures tends to translate into positive attitudes towards wind energy.

Similar to the national survey, the surveys of those living within the vicinity of a wind farm also found that the findings are generally positive towards wind farms. Perceptions of the effect of the development on the locality were generally positive, with some three-quarters of interviewees believing it had impacted positively.

In areas where a wind farm development had been granted planning permission but was not yet under construction, three quarters of the interviewees expressed themselves in favour of the wind farm being built in their area. Four per cent were against the development. The reasons cited by those who expressed themselves in favour of the wind farm included the fact that wind energy is clean (78%), it would provide local jobs (44%), it would help develop the area (32%) and that it would add to the landscape (13%). Those with direct experience of a wind farm in the locality are generally impressed with it as an additional feature in the landscape. The report states:

> *"It is particularly encouraging that those with experience of wind turbines are most favourable to their development and that wind farms are not solely seen as good in theory, but are also seen as beneficial when they are actually built."*

Few of those living in proximity either to an existing wind farm or one for which permission has been granted believe that the development damages the locality, either in terms of damage to tourism potential or to wildlife. The survey found that there is a clear preference for larger turbines in smaller numbers over smaller turbines in larger numbers.

5.4.1.3 Survey Update 2017

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

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

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

5.4.1.4 Conclusions

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

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

> *since it is voiced by those who know from direct experience about the impact of such developments on their communities."*

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

5.4.2.1 Background

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

5.4.2.2 Study Area

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

5.4.2.3 Findings

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

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

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

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

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

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

5.4.2.4 Conclusions

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

5.4.3 IWEA Interactions Opinion Poll on Wind Energy

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

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

5.4.4 WEI Interactions Opinion Poll on Wind Energy

In early 2024, Wind Energy Ireland (WEI) published the results of their most recent nationwide annual poll on attitudes to wind energy[6]. The objective of the poll was to 'measure and track public perceptions and attitudes around wind energy amongst Irish adults.'

Between 17th November and 1st December 2023, a nationally representative sample of 1,017 Irish adults together with a booster sample of 221 rural residents participated in the survey. The 2023 results reported that 4 in 5 (80%) are now in favour of wind power, a 6% increase on the 2021 results (54% of those in favour were 'strongly in favour'). 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 2023 surveys results are largely in line with those of 2022, showing a consistent level of support and a positive attitude toward wind energy in Ireland.

Amongst those in favour of wind power, the majority cited cheaper electricity, reduced carbon emissions and environmental and climate concerns as their main reasons for supporting such developments. Other reasons cited for supporting wind energy developments include: 'Support energy independence', 'Creates employment', and that it is 'Good for local communities nearby'.

When polled on opinions surrounding the offshore wind energy sector, 78% of those surveyed said that they are in favour of the use of offshore wind energy in Ireland, with 80% acknowledging the importance of offshore wind energy in providing energy security to Ireland.

When questioned about wind energy developments in their local area, 3 in 5 (60%) of those surveyed would support such proposals, compared to 58% of the nationally representative sample and 56% of the rural population surveyed in 2022.reporting the same.

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

5.5 Health Impacts of Wind Farms

5.5.1 Introduction

The 2022 Census of Ireland as carried out by the Central Statistics Office provides the general health conditions of the population of the DEDs which make up the Study Area for the Proposed Development. The vast majority of those within the Population Study Area marked their general health as being 'very good' across all DEDs. It is not anticipated that the general health of the population of the Population Study Area be altered due to the Proposed Development.

5.5.2 Health Impact Studies

While there are anecdotal reports of negative health effects on people who live very close to wind turbines, peer-reviewed research largely does not support these statements. There is currently no published credible scientific evidence to positively link wind turbines with adverse health effects. The

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[6] *WEI Latest News – National Poll. Available at: << https://windenergyireland.com/latest-news/7660-national-poll-4-in-5-people-support-irish-wind-energy-development-with-3-in-5-backing-local-wind-farms#:~:text=we%20love%20wind!-,National%20poll%3A%204%20in%205%20people%20support%20Irish%20wind%20energy,5%20backing%20local%20wind%20farms.&text=4%20in%205%20people%20in,towards%20wind%20energy%20in%20Ireland.>>*

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 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."

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

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

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

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

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 effects on human health and to validate the finding of the 'Wind Turbine Sound and Health Effects - An Expert Panel Review' (see Item 2 above) that:

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

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

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

> *"To date, there is no credible peer reviewed scientific evidence that demonstrates a direct causal link between wind turbines and adverse health impacts in people living in proximity to them. There is no evidence for any adverse health effects from wind turbine shadow flicker or electromagnetic frequency. There is no evidence in the peer reviewed published scientific literature that suggests that there are any adverse health effects from infrasound (a component of low frequency sound) at the low levels that may be emitted by wind turbines."*

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

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

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

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

CAHA notes that:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The HSE position paper determines that current scientific evidence on adverse effects of wind farms on health is weak or absent. Further research and investigative processes are required at a larger scale in order to be more informative for identifying potential health effects of exposure to wind turbine effects. They advise developers on making use of the Draft Wind Energy Development Guidelines (2006), as a means of setting noise limits and set back distances from the nearest dwellings.

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

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

For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB Lden. The GDG recognise the potential for increased risk of annoyance at levels below this value but cannot determine whether this 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. Furthermore, public perception towards wind turbines is hard to differentiate from reported effects related to noise and the two may be inextricably linked. 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'.*

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

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

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

5.5.4 Electromagnetic Interference

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

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

The ESB document 'EMF & You' (ESB, 2017)[7] provides further practical information on EMF.

Further details on the potential effects of electromagnetic interference to telecommunications and aviation are presented in Chapter 15: Material Assets.

5.5.5 Assessment of Effects on Human Health

As set out in the Department of Housing, Planning, Community and Local Government '*Key Issues Consultation Paper on the Transposition of the EIA Directive 2017*' and the guidance listed in Section 1.3.3 of Chapter 1: Introduction, the consideration of the effects on populations and on human health should focus on health issues and environmental hazards arising from the other environmental factors, for example water contamination, air pollution, noise, accidents, disasters.

Chapter 8: Land, Soils and Geology, Chapter 9: Water, Chapter 10: Air Quality, Chapter 11: Climate, Chapter 12: Noise and Vibration and Chapter 15: Material Assets (Traffic and Transport) provide an assessment of the effects of the Proposed Development on these areas of consideration. There is the potential for negative effects on human health during the wind farm construction phase related to potential emissions to air of dust, potential emissions to land and water of hydrocarbons, release of potentially silt-laden runoff into watercourses and noise emissions.

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

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

The detailed Flood Risk Assessment in Appendix 9-1 has also shown that the risk of the Proposed Development contributing to flooding is low.

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

The Proposed Development is for the development of a renewable energy project, a wind farm, capable of offsetting carbon emissions associated with the burning of fossil fuels. During the operational

[7] *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.

stage the Wind Farm will have a long term, significant, positive effect on air quality as set out in Chapter 10 which will contribute to positive effects on human health.

The provision of aviation lighting on permitted turbines is a standard and accepted part of any wind farm development. This is a safety requirement of the Irish Aviation Authority (IAA). The standard lighting required by the IAA are medium intensity lights. Such lighting is designed specifically for aviation safety and is not intended to be overbearing or dominant when viewed from the ground thus striking a reasonable balance between aviation safety and visual effect. The IAA generally only confirm lighting arrangements required for wind farm developments once a consent is in place.

It is considered that aviation lighting on the proposed turbines will have no significant effect on human health, beyond increasing aircraft safety in the context of the Proposed Development. The applicant will continue its engagement with IAA as required in relation to aviation lighting.

The assessments show that the residual effects are not significant and do not have the potential to cause negative health effects for human beings. On this basis, the potential for negative health effects associated with the Proposed Development is imperceptible.

5.5.6 Vulnerability of the Project to Natural Disasters and Major Accidents

As outlined in Section 5.5.4 above, a wind farm is not a recognised source of pollution. Should a major accident or natural disaster occur, the potential sources of pollution onsite during 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. A Major Accidents and Natural Disasters assessment is included as Chapter 16.

In the context of the Proposed Development site, there is limited potential for significant natural disasters to occur. Ireland is a geologically stable country with a mild temperate climate. The potential natural disasters that may occur are therefore limited to peat instability, flooding and fire. The risk of flooding and potential for contamination of groundwater and drinking water due to the construction of the Proposed Development is addressed in Chapter 9: Hydrology and Hydrogeology, with the risk being limited due to the proposed mitigation measures and site drainage plan, meaning there is limited risk to human health. It is considered that the risk of significant fire occurring, affecting the Wind Farm and causing the wind farm to have significant environmental effects is limited and therefore a significant effect on human health is similarly limited. As described earlier, there are no significant sources of pollution in the wind farm with the potential to cause environmental or health effects. Also, the spacing of the turbines and distance of turbines from any properties limits the potential for effects on human health. The issue of turbine safety is addressed in Section 5.5.2.

Major industrial accidents involving dangerous substances pose a significant threat to humans and the environment; such accidents can give rise to serious injury to people or serious damage to the environment, both on and off the site of the accident. The wind farm site is not regulated under the Control of Major Accident Hazards Involving Dangerous Substances Regulations i.e. SEVESO sites and so there are no potential effects from this source. A Major Accidents and Natural Disasters assessment is included as Chapter 16.

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 Scotland and the United States.

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

- Overall, the analysis found that the county-wide property market drives local house prices, not the presence or absence of wind farms.
- The econometric analysis established that construction of wind farms at the five sites examined across England and Wales has not had a detectable negative impact on house price growth within a five-kilometre radius of the sites.

A relatively new study issued in October 2016 '*Impact of wind Turbines on House Prices in Scotland'* (2016) was published by Climate Exchange. Climate Exchange is Scotland's independent centre of expertise on climate change which exists to support the Scottish Governments policy development on climate and the transition to a low carbon economy. A copy of the report is included as Appendix 5-2 of this EIAR.

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

- No evidence of a consistent negative effect on house prices: Across a very wide range of analyses, including results that replicate and improve on the approach used by Gibbons (2014[8]), we do not find a consistent negative effect of wind turbines or wind farms when averaging across the entire sample of Scottish wind turbines and their surrounding houses. Most results either show no significant effect on the change in price of properties within 2km or 3km or find the effect to be positive.
- Results vary across areas: The results vary across different regions of Scotland. Our data does not provide sufficient information to enable us to rigorously measure and test the underlying causes of these differences, which may be interconnected and complex.

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

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 (as detailed on Page XVII) 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*

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[8] *Stephen Gibbons, 2014. "Gone with the Wind: Valuing the Visual Impacts of Wind Turbines through House Prices," SERC Discussion Papers 0159, Spatial Economics Research Centre, LSE.*

> *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.

5.7 Shadow Flicker

5.7.1 Background

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

The frequency of occurrence and the strength of any potential shadow flicker effect 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 (8 oktas) for over 50% of the time. The mean cloud amount for each hour is between five and six okta. This is due to Ireland's geographical position off the northwest of Europe, close to the path of Atlantic low-pressure systems which tend to keep the country in humid, cloudy airflows for much of the time. A study at 12 stations over a 25-year period showed that the mean cloud amount was at a minimum in April and maximum in July. Cloud amounts were less at night than during the day, with the mean minimum occurring roughly between 2100 and 0100 GMT and the mean maximum occurring between 1000 and 1500 GMT at most stations. (*Source: Met Éireann, www.met.ie*)

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

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

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

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

At distances of greater than approximately 500m between a turbine and a receptor, shadow flicker generally occurs only at sunrise or sunset when the shadow cast by the turbine is longer. The Guidelines iterates that at distances greater than ten rotor diameters from a turbine, the potential for shadow flicker is very low.

Figure 5-4 illustrates the shadow cast by a turbine at various times during the day; the red shading represents the area where shadow flicker may occur. When the sun is high in the sky, the length of the shadow cast by the turbine is significantly shorter.

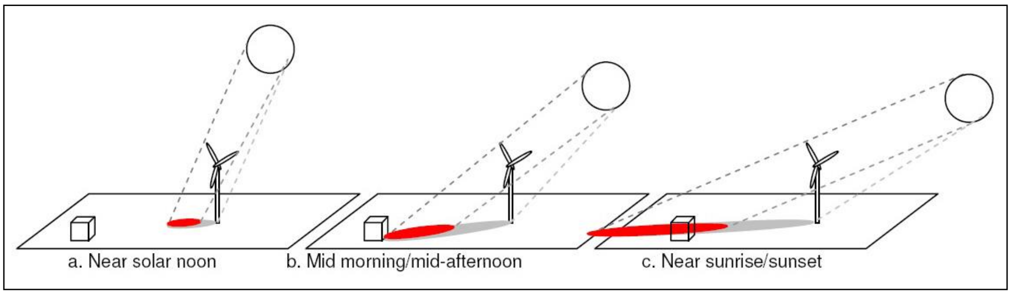


Figure 5-4 Shadow-Prone Area as Function of Time of Day (Source: Shadow Flicker Report, Helimax Energy, Dec 2008)

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

The further a property is from the turbine the less pronounced the effect 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 effect.

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

5. ***Property usage and occupancy:***

Where shadow flicker is predicted to occur at a specific location, this does not imply that it will be witnessed. Potential occupants of a property may be sleeping or occupying a room on another side of the property that is not subject to shadow flicker, or completely absent from the location during the time of shadow flicker events. As shadow flicker usually occurs only when the sun is at a low angle in the sky, i.e. very early in the morning after sunrise or late in the evening before sunset, even if there is a bedroom on the side of the property affected, the shadow flicker may not be witnessed if curtains or blinds in the bedroom are closed. It should be noted, that the below assessment considers a worst-case assessment as detailed in Section 5.7.4.3 below.

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

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

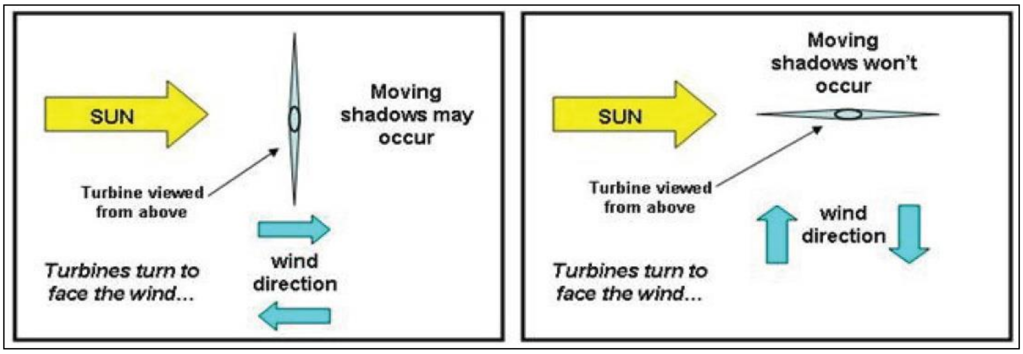


Figure 5-5 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environment Power LLC)

7. ***Rotation of turbine blades:***

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

5.7.2 Guidance

The current guidance for shadow flicker in Ireland is derived from the Guidelines and the '*Best Practice Guidelines for the Irish Wind Energy Industry*' (Irish Wind Energy Association, 2012).

The 2006 guidelines set out a threshold of less than 30 hours per year or 30 minutes per day of shadow flicker at dwellings within 500 metres of a proposed turbine location. As set out in the 2006 guidelines, the designated study area for a shadow flicker assessment is 10 times the rotor diameter. In this case, the maximum potential rotor diameter proposed for this project is 163m. As such, the shadow flicker study area in this case is 1.63km. A significant minimum separation distance of 899m from involved dwellings and 1,269m from third party dwellings has been achieved with the project design. There are 14 No. properties located within 1.63 kilometres (i.e., the shadow flicker study area of ten times the maximum rotor diameter; 10x163 = 1,630m as per the Guidelines) of the proposed turbines, of which all 14 are inhabited dwellings.

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

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

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

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

The Draft 2019 Guidelines are based on the recommendations set out in the '*Proposed Revisions to Wind Energy Development Guidelines 2006 – Targeted Review*' (December 2013) and the '*Review of the Wind Energy Development Guidelines 2006 – Preferred Draft Approach*' (June 2017). The assessment herein is based on compliance with the 2019 draft guidelines to ensure that no existing dwelling or other affected property will experience shadow flicker as a result of the wind energy development.

5.7.3 Shadow Flicker Prediction Methodology

Shadow flicker occurs only under certain, combined circumstances, as detailed above. Where shadow flicker does occur, it is generally short-lived. The 2006 DoHPLG guidelines state that careful site selection, design and planning, and good use of relevant software can help avoid the possibility of shadow flicker, all of which have been employed at the site of the Proposed Development. Proper siting of wind turbines is key in eliminating shadow flicker.

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

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

For the purposes of this shadow flicker assessment, the software package WindFarm Version 5.0.1.2 has been used to predict the level of shadow flicker associated with the Proposed Development. WindFarm is a commercially available software tool that enables developers to analyse, design and optimise proposed wind farms. It allows proposed turbine layouts to be optimised for maximum energy yield whilst taking account of environmental, planning and engineering constraints.

5.7.4 Shadow Flicker Assessment Criteria

5.7.4.1 Turbine Dimensions

Planning permission is being sought for a range of turbine dimensions. In order to assess this range adequately, 3 no assessments were run which assessed a minimum, median, and maximum turbine tip height within the range that planning consent is being applied for. Under this assumption, the turbine dimensions considered are the following:

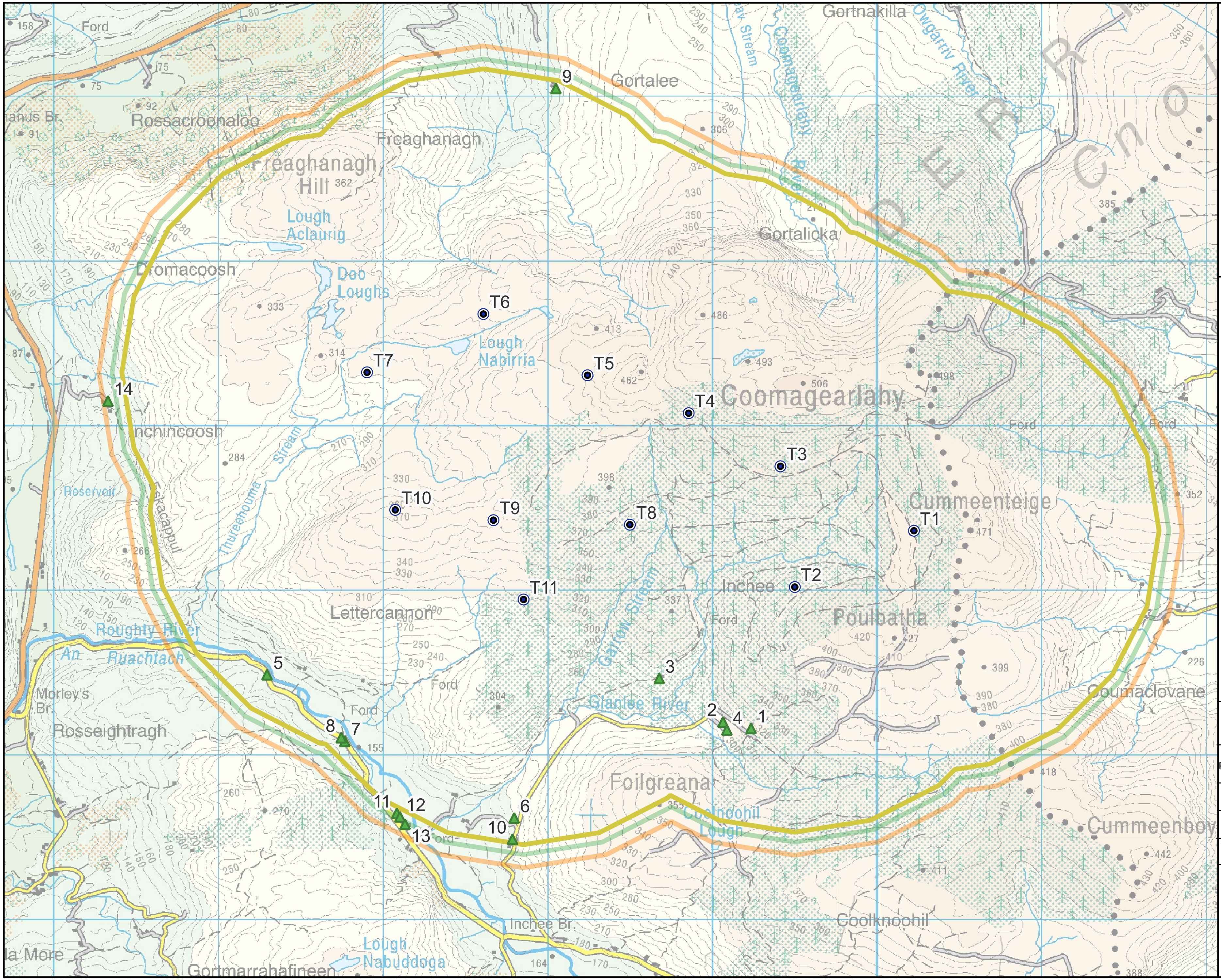
- Minimum turbine height: tip height 199.5m, rotor diameter 149m, hub height 125m
- Median turbine height: tip height 199.5m, rotor diameter 163m, hub height 118m
- Maximum turbine height: hub height 200m, rotor diameter 155m hub height 122.5:

With the benefit of the mitigation measures outlined in Section 5.9.3.4, all turbines installed onsite will comply with the Guidelines, to ensure there is no shadow flicker occurrences in excess of 30 minutes per day or 30 hours per year at any property within the 1.63km study area as a result of the Proposed Development. This will be achieved through the use of turbine control software throughout the entire operational period of the Proposed Development. Any references to the turbine dimensions in this shadow flicker assessment should be considered in the context of the above.

5.7.4.2 Study Area

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

The study area for the shadow flicker assessment is ten times rotor diameter from each turbine as set out in the Guidelines. All residential properties located within ten rotor diameters which is assumed to be 1.63 kilometres at its largest extent, have been included in the assessment. A significant minimum separation distance of 1,269m from third party dwellings has been achieved with the project design, thus exceeding the necessary setback distance. There are 14 No. properties located within 1.63 kilometres of the proposed turbines as detailed above, of which 4 no. properties are involved. The shadow flicker study area and sensitive receptor locations are shown in Figure 5-6.



Map Legend

- Dwellings within 10 x RD
- Proposed Turbine Layout
- Minimum Turbine 10 x Rotor Diameter Shadow Ficker Study Area
- Maximum Turbine 10 x Rotor Diameter Shadow Ficker Study Area
- Median Turbine 10 x Rotor Diameter Shadow Ficker Study Area

Drawing Title	Shadow Flicker Study Area
Project Title	Proposed Repowering of Kilgarvan Wind Farm
Drawn By: EL	Checked By: NMcH
Project No.: 211107	Drawing No.: Figure 5-6
Scale: 1:30,000	Date: 24/02/2023

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5.7.4.3 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 296 no. properties within 360 degrees of the Proposed Development within the study area were assessed for shadow flicker impact.

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

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

Each window measures one-metre-high by one-metre-wide, and tilt angle is assumed to be zero. The centre height of each window is assumed to be two metres above ground level and no screening due to trees or other buildings or vegetation is assumed. It was not considered necessary or practical to measure the dimensions of every window on every property in the study area. While the actual size of a window will marginally influence the incidence and duration of any potential shadow flicker impact, with larger windows resulting in slightly longer shadow flicker durations, any incidences or durations or shadow flicker can be countered by the measures outlined in Section 5.9.3.4 below.

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

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

The total annual shadow flicker calculated for each property assumes 100% sunshine during daytime hours, as referred to above. However, weather data for this region shows that the sun shines on average for 30% of the daylight hours per year. This percentage is based on Met Eireann data recorded at Cork Airport weather station over the 30-year period from 1981-2010 (www.met.ie). The actual sunshine hours at the Proposed Development site and therefore the percentage of time shadow flicker could actually occur is 32.43% of daylight hours. Where the annual shadow flicker is calculated for each property, it is corrected for the regional average of 32.43% sunshine, to give a more accurate annual average shadow flicker prediction.

Table 5-9, 5-10 and 5-11 below outlines whether a shadow flicker mitigation strategy is required for any property within the study area which may be impacted by shadow flicker.

5.7.5 Shadow Flicker Assessment Results

5.7.5.1 Daily and Annual Shadow Flicker

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

The model results assume worst-case conditions, including

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

The maximum daily shadow flicker model assumes that daylight hours consist of 100% sunshine. This is a conservative assumption which represents a worst-case scenario. Following the detail provided above on sunshine hours, a sunshine factor of 32.43% has been applied to the annual shadow flicker results as detailed above. Taking this information into consideration, the predicted shadow flicker which is estimated to occur at nearby dwellings is presented in Table 5-9, 5-10 and 5-11.

The predicted maximum daily and annual shadow flicker levels are then considered in the context of the Guidelines recommendation of committing to less than 30 minutes of shadow flicker per day, or less than 30 hours of shadow flicker per year. If there is any predicted exceedance of shadow flicker at any property, the turbines that contribute to the exceedance are also identified, with mitigation measures required for these contributing turbines.

There are 14 No. properties located within 1.63 kilometres (i.e., the shadow flicker study area of ten times the maximum rotor diameter; 10x163 = 1,630m) of the proposed turbines, of which all 14 are dwellings, and 4 no. properties are owned by participating landowners.

In order to consider the range fully, 3 no. candidate turbines were modelled which possessed measurements as set out in Chapter 1 of this EIAR, and as noted in Section 5.7.4.1 above. For the purposes of this assessment, they are labelled as the minimum turbine, the median turbine, and the maximum turbine. The number of properties assessed under each model is detailed below:

- Within the minimum turbine modelled, 10. no properties are assessed.
- Within the median turbine modelled, 14. no properties are assessed.
- Within the maximum turbine modelled, 13. no properties are assessed.

The results of the dwellings modelled as part of the shadow flicker assessment, are presented in Tables 5-9, 5-10, and 5-11. All 14 no dwellings modelled for this assessment were inhabitable.

Table 5-9 Maximum Potential Daily & Annual Shadow Flicker for Minimum Turbine Height

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
1*	509205.3	575220.7	Dwelling	899	T2	00:00:00	0:00:00	0:00:00	N/A	No	No
2*	509034.9	575259.4	Dwelling	929	T2	00:28:12	27:24:00	8:53:09	N/A	No	No
3*	508647.2	575524.3	Dwelling (Holiday Home)	951	T8	00:39:36	34:24:00	11:09:21	11	Yes	Yes
4*	509058.5	575211.8	Dwelling	961	T2	00:27:36	23:48:00	7:43:06	N/A	No	No
5	506263.2	575547	Dwelling	1269	T10	00:00:00	0:00:00	0:00:00	N/A	No	No
6	507765.5	574676.3	Dwelling	1329	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
7	506735.9	575142.3	Dwelling	1387	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
8	506714.5	575164.6	Dwelling	1390	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
9	508019.1	579109.9	Dwelling	1440	T6	00:23:24	12:42:00	4:07:07	N/A	No	No
10	507755.2	574547	Dwelling	1459	T11	00:00:00	0:00:00	0:00:00	N/A	No	No

**Participating property*

Table 5-10 Maximum Potential Daily & Annual Shadow Flicker for Median Turbine Height

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
1*	509205.3	575220.7	Dwelling	899	T2	00:27:36	30:00:00	9:43:44	N/A	No	No
2*	509034.9	575259.4	Dwelling	929	T2	00:30:36	32:06:00	10:24:36	11	Yes	Yes
3*	508647.2	575524.3	Dwelling (Holiday Home)	951	T8	00:43:48	43:06:00	13:58:38	11	Yes	Yes
4*	509058.5	575211.8	Dwelling	961	T2	00:30:00	28:24:00	9:12:36	N/A	No	No
5	506263.2	575547	Dwelling	1269	T10	00:24:36	9:12:00	2:59:01	N/A	No	No
6	507765.5	574676.3	Dwelling	1329	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
7	506735.9	575142.3	Dwelling	1387	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
8	506714.5	575164.6	Dwelling	1390	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
9	508019.1	579109.9	Dwelling	1440	T6	00:25:12	13:30:00	4:22:41	N/A	No	No
10	507755.2	574547	Dwelling	1459	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
11	507052.1	574704.3	TBC Dwelling (Mobile Home)	1511	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
12	507071	574683.6	Dwelling	1519	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
13	507102	574638.4	Dwelling	1544	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
14	505296.4	577209.8	Dwelling	1584	T7	00:00:00	0:00:00	0:00:00	N/A	No	No

**Participating property*

Table 5-11 Maximum Potential Daily & Annual Shadow Flicker for Maximum Turbine Height

House ID	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Description	Distance to Nearest Turbine (metres)	Nearest Proposed Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Proposed Turbine(s) Giving Rise to Daly Shadow Flicker Exceedance	Mitigation Strategy Required (Daily)	Mitigation Strategy Required (Annual)
1*	509205.3	575220.7	Dwelling	899	T2	00:00:00	0:00:00	0:00:00	N/A	No	No
2*	509034.9	575259.4	Dwelling	929	T2	00:29:24	29:18:00	9:30:07	N/A	No	No
3*	508647.2	575524.3	Dwelling (Holiday Home)	951	T8	00:41:24	37:54:00	12:17:27	11	Yes	Yes
4*	509058.5	575211.8	Dwelling	961	T2	00:28:48	25:42:00	8:20:04	N/A	No	No
5	506263.2	575547	Dwelling	1269	T10	00:00:00	0:00:00	0:00:00	N/A	No	No
6	507765.5	574676.3	Dwelling	1329	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
7	506735.9	575142.3	Dwelling	1387	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
8	506714.5	575164.6	Dwelling	1390	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
9	508019.1	579109.9	Dwelling	1440	T6	00:24:36	13:06:00	4:14:54	N/A	No	No
10	507755.2	574547	Dwelling	1459	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
11	507052.1	574704.3	TBC Dwelling (Mobile Home)	1511	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
12	507071	574683.6	Dwelling	1519	T11	00:00:00	0:00:00	0:00:00	N/A	No	No
13	507102	574638.4	Dwelling	1544	T11	00:00:00	0:00:00	0:00:00	N/A	No	No

**Participating property*

Minimum Turbine Height

The minimum turbine has a rotor diameter of 149m. Therefore the shadow flicker study area only requires the assessment of 10 no properties (10 x 149m = 1.49km).

Of these 10 no. properties;

- 6 no. properties are inhabitable third-party dwellings and;
- 4 no. properties are inhabitable dwellings belonging to participating landowners.

Of the 10 no. properties modelled in Table 5-9, it is predicted that 1 no. property will experience daily shadow flicker levels in excess of the Guidelines threshold of 30 minutes per day.

The 1 no. property that is experiencing daily shadow flicker exceedances belongs to a participating landowner, and so no mitigation is proposed.

Of the 10 no. properties modelled, when the regional sunshine average (i.e. the mean number if sunshine hours throughout the year) of 32.43% is taken into account, the Guidelines limit of 30 hours per year is not predicted to be exceeded at any of these properties.

Median Turbine Height

The minimum turbine has a rotor diameter of 163m. Therefore, the shadow flicker study area requires the assessment of all 14 no properties (10 x 163m = 1.63km).

Of these 14 no. properties:

- 10 no. properties are inhabitable third-party dwellings and;
- 4 no. properties are inhabitable dwellings belonging to participating landowners.

Of the 14 no. properties modelled in Table 5-10, it is predicted that 2 no. properties will experience daily shadow flicker levels in excess of the Guidelines threshold of 30 minutes per day.

All 3 no. of the properties that are experiencing daily shadow flicker exceedances belong to participating landowners, and as such, no mitigation is proposed under this scenario.

Of the 14 no. properties modelled, when the regional sunshine average (i.e. the mean number if sunshine hours throughout the year) of 32.43% is taken into account, the Guidelines limit of 30 hours per year is not predicted to be exceeded at any of these properties.

Maximum Turbine Height

The maximum turbine has a rotor diameter of 155m. therefore, the shadow flicker study area only requires the assessment of 13 no. properties (10 x 155m = 1.55km).

Of these 13 no. properties:

- 4 no. properties are inhabitable third-party dwellings and;
- 9 no. properties are inhabitable dwellings belonging to participating landowners.

Of the 13 no. properties modelled in Table 5-11, it is predicted that 1 no. property will experience daily shadow flicker levels in excess of the Guidelines threshold of 30 minutes per day.

The 1 no. property that is experiencing daily shadow flicker exceedances belongs to a participating landowner, and so no mitigation is proposed.

Of the 13 no. properties modelled, when the regional sunshine average (i.e. the mean number if sunshine hours throughout the year) of 32.43% is taken into account, the Guidelines limit of 30 hours per year is not predicted to be exceeded at any of these properties.

The predictions as outlined above assume theoretical precautionary conditions (i.e. 100% sunshine on all days where the shadow of the turbines passes over a house, wind blowing in the correct direction, no screening present, etc.) and in the absence of any mitigation measures.

Additionally, it is worth reiterating that the predicted shadow flicker listed in Table 5-9, Table 5-10 and Table 5-11 are considered conservative and in reality, the occurrence and/or duration of shadow flicker at these properties is likely to be eliminated or significantly reduced as the following items are not considered by the model:

- Receivers may be screened by topography, cloud cover and/or vegetation/built form i.e. adjacent buildings, farm buildings, garages or barns;
- Each receiver will not have windows facing in all directions onto the wind turbines.
- At distances, greater than 500-1000m '*the rotor blade of a wind turbine will not appear to be chopping the light but the turbine will be regarded as an object with the sun behind it. Therefore, it is generally not necessary to consider shadow casting at such distances'* (Danish Wind Industry Association, accessed 2010).

Section 5.9.3 below outlines the mitigation strategies which may be employed at the potentially affected properties to ensure that the Guidelines are complied with at any dwelling within the Shadow Flicker Study Area. The same mitigation strategies, outlined in Section 5.9.3, could be taken further to achieve stricter shadow flicker controls, should the shadow flicker requirements of the Draft Guidelines be adopted in advance of a planning decision being made on the Proposed Development.

5.7.5.2 Comparative Shadow Flicker Assessment

A comparative assessment was undertaken where turbines with alternative dimensions within the proposed range, as detailed in Section 4.1 of Chapter 4 of the EIAR, were modelled and compared against each other as set out in Section 5.8.4 in Tables 5-9 to 5-11 above. The three comparative modelled turbines are as follows:

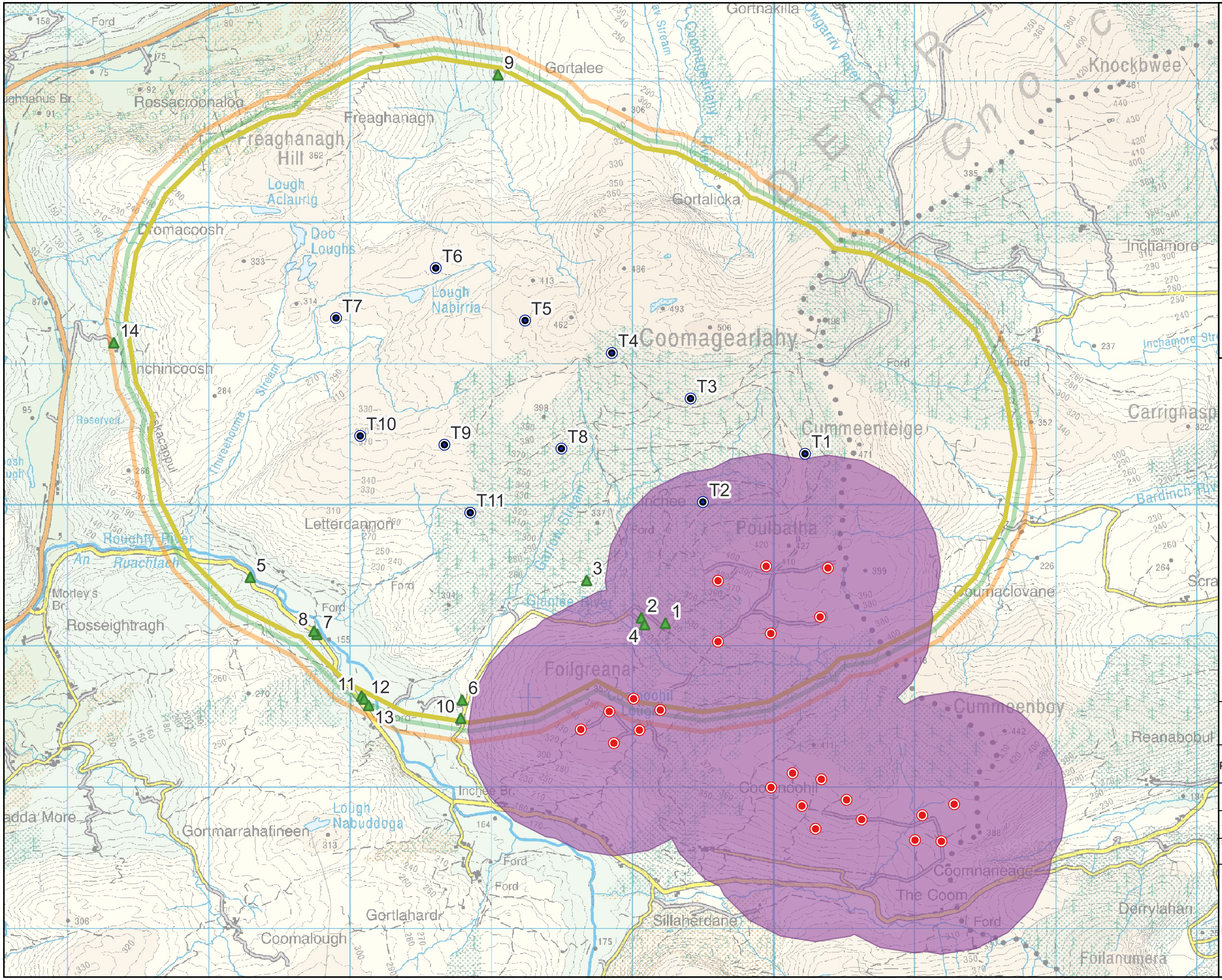
- Minimum turbine height: tip height 199.5m, rotor diameter 149m, hub height 125m
- Median turbine height: tip height 199.5m, rotor diameter 163m, hub height 118m
- Maximum turbine height: hub height 200m, rotor diameter 155m hub height 122.5:

The findings of the assessment indicate that of the properties modelled, daily shadow flicker exceedance is experienced at 1 no. properties for the minimum turbine height assessment, 2 no. properties the median turbine height assessment and at 1 no. properties for the maximum turbine height assessment. Of the properties modelled that are experiencing daily shadow flicker exceedances, these below to participating landowners, and so no mitigation is proposed. Of the properties modelled, when the regional sunshine average of 32.43% is taken into account, the Guidelines limit of 30 hours per year is not predicted to be exceeded at any of these properties. In summary, no additional shadow flicker effects occur when comparing the alternative dimensions within the proposed range.

5.7.5.3 Cumulative Shadow Flicker

The cumulative assessment of shadow flicker generated by the Proposed Development and other existing and permitted wind farms within 1.63km (i.e., the shadow flicker study area of ten times the maximum rotor diameter; 10x163 = 1,630m) was carried out based on the methodology, assumptions and criteria outlined in Section 5.7.4.

Within the Shadow Flicker Study Area there is one constructed wind farm; Midas Wind Farm (23 constructed wind turbines, rotor diameter 52m, tip height 112m, planning references 01/3571, 02/719, 03/3665) and this has been included in the cumulative shadow flicker assessment. Figure 5-7 illustrates the combined impact potential between the Proposed Development and Midas Wind Farm (for the assessment, the Proposed Development are labelled turbines no 1-11 and the Midas Wind Farm are labelled 12-34.) Mitigation strategies are outlined in Section 5.9.3.9.2.



Map Legend

- Dwellings within 10 x RD
- Proposed Turbine Layout
- Minimum Turbine 10 x Rotor Diameter Shadow Flicker Study Area
- Maximum Turbine 10 x Rotor Diameter Shadow Flicker Study Area
- Median Turbine 10 x Rotor Diameter Shadow Flicker Study Area
- Existing Midas Turbine Locations
- Midas Wind Farm 10 x Rotor Diameter Shadow Flicker Study Area (520m)

Drawing Title	Cumulative Shadow Flicker Study Area
Project Title	Proposed Repowering of Kilgarvan Wind Farm
Drawn By: EL	Checked By: NMcH
Project No.: 211107	Drawing No.: Figure 5-7
Scale: 1:35,000	Date: 24/02/2023

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5.7.5.3.1 *Cumulative Shadow Flicker for Minimum Turbine Height*

Tables 5-12, 5-13 and 5-14 below set out the potential cumulative shadow flicker that is predicted to occur due to the Proposed Development (minimum turbine) in conjunction with Midas Wind Farm.

Table 5-12 outlines any potential for cumulative shadow flicker effects on dwellings due to Midas Wind Farm and the Proposed Development with the minimum turbine.

Table 5-13 below identifies the specific days where shadow flicker is due to occur, and which individual turbines are responsible for this.

Table 5-14 below outlines the potential for annual shadow flicker effects due to Midas Wind Farm and the Proposed Development with the minimum turbine as was described in Section 5.7.5.1.

Table 5-12 Potential Cumulative Shadow Flicker Impact from the Proposed Development and the Existing Midas Wind Farm – Minimum Turbine

House no.	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Status	Nearest Proposed Turbine No. *	Distance to Nearest Turbine (metres)	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Further Assessment Required
1*	509205.3479	575220.6658	Dwelling	2	899.4695028	01:03:36	98:54:00	32:04:24	26, 29,	Yes
2*	509034.8671	575259.3912	Dwelling	2	929.3749631	01:09:36	89:36:00	29:03:26	26, 29,	Yes
4*	509058.4584	575211.7634	Dwelling	2	961.3171507	01:31:12	111:54:00	36:17:21	26, 27, 29	Yes

Table 5-13 Potential Cumulative Daily Shadow Flicker Impact from the Proposed Development and the Existing Midas Wind Farm – Minimum Turbine

Property No.	Max. Potential Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	No. of Days 30min/day Threshold is Exceeded by Proposed Development and Midas Wind Farm	No. of Days 30min/day Threshold is Exceeded by Proposed Development (Turbines 1-11)	No. of Days 30min/day Threshold is Exceeded by Midas Wind Farm (Turbines 12-34)	No. of Days where any levels of Shadow Flicker produced by the Proposed Development overlaps with that of Midas Wind Farm	Mitigation Required by Proposed Development
1*	01:03:36	26, 29,	75	0	75 (January; March to April, September to	0	No, there are no days that overlap.

Property No.	Max. Potential Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	No. of Days 30min/day Threshold is Exceeded by Proposed Development and Midas Wind Farm	No. of Days 30min/day Threshold is Exceeded by Proposed Development (Turbines 1-11)	No. of Days 30min/day Threshold is Exceeded by Midas Wind Farm (Turbines 12-34)	No. of Days where any levels of Shadow Flicker produced by the Proposed Development overlaps with that of Midas Wind Farm	Mitigation Required by Proposed Development
					October December)		
2*	01:09:36	26, 29,	29	0	29 (January; March; September to October; November to December)	30	Yes, there are 31 days where shadow flicker from the Proposed Development overlaps with shadow flicker produced from Midas wind farm
4*	01:31:12	26, 27, 29	85	0	85 (January, March to April; September to October, November to December)	0	No, there are no days that overlap.

Table 5-14 Potential Annual Cumulative Shadow Flicker from the Proposed Development and the Existing Midas Wind Farm – Minimum Turbine

House no.	Max. Potential Cumulative Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Potential Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Max. Potential Annual Shadow Flicker contributed to by Proposed Development (Turbines 1-11)	Max. Potential Annual Shadow Flicker contributed by Midas Wind Farm (Turbines 12-34)	Max. Potential Cumulative Annual Shadow Flicker Exceedance that requires mitigation (hrs:mins:sec)	Proposed Development Turbines to be controlled	Post-mitigation Maximum Annual Shadow Flicker by the Proposed Development (hrs:mins:sec)
1*	98:54:00	32:04:24	-	00:00:00	32:04:24	N/A	N/A	32:04:24
2*	89:36:00	29:03:26	T11, T23, T26, T27, T29, T34	08:04:04	20:59:22	N/A	N/A	29:03:26
4*	111:54:00	36:17:21	T11, T23, T26, T27, T29	07:00:28	29:16:53	06:17:21	T11	30:00:00

5.7.5.3.2 *Cumulative Shadow Flicker Results for Minimum Turbine Height*

Daily Cumulative

Of the 3 no. properties with the potential for a cumulative impact to arise, Table 5-12 above illustrates that all 3 properties warrant further assessment (houses 1, 2, and 4). Table 5-13 then provides further assessment in relation to these 3 no. properties and details that the Proposed Development does not give rise to any cumulative daily shadow flicker on houses 1 and 4, but that there is some cumulative daily shadow flicker impact on house 2. However, House 2 belongs to a participating landowner, and so no shadow flicker mitigation is proposed.

On this basis, no shadow flicker mitigation is proposed under the minimum turbine scenario for the cumulative shadow flicker study area.

Annual Cumulative

Table 5-14 above shows that there is a potential for annual cumulative shadow flicker at 2 no. properties, House 1 and House 4. The shadow flicker on House 1 amounts to, 32:04:24 over the course of the year. However, all of the shadow flicker occurrences originate from Midas Wind Farm. As such, no mitigation is necessary.

Table 5-14 also shows that there is potential for annual cumulative shadow flicker on House 4, amounting to (30:00:00). However, House 4 belongs to a participating landowner and as such, no shadow flicker mitigation is proposed.

On this basis, there will be no daily shadow flicker mitigation needed for any property in the cumulative shadow flicker study area.

5.7.5.3.3 *Cumulative Shadow Flicker for Median Turbine*

Tables 5-15, 5-16 and 5-17 below set out the potential cumulative shadow flicker that is predicted to occur due to the Proposed Development (median turbine as described in Section 5.7.5.1) in conjunction with Midas Wind Farm.

Table 5-15 outlines any potential for cumulative shadow flicker effects on dwellings due to Midas Wind Farm and the Proposed Development with the median turbine.

Table 5-16 below identifies the specific days where shadow flicker is due to occur, and which individual turbines are responsible for this.

Table 5-17 below outlines the potential for annual shadow flicker effects due to Midas Wind Farm and the Proposed Development with the median turbine.

Table 5-15 Potential Cumulative Shadow Flicker Impact from the Proposed Repowering of the Existing Kilgarvan Wind Farm and the Existing Midas Wind Farm – Median Turbine

House no.	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Status	Nearest Proposed Turbine No. *	Distance to Nearest Turbine (metres)	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Further Assessment Required
1*	509205.3479	575220.6658	Dwelling	2	899.4695028	01:03:36	128:48:00	41:46:11	26, 29,	No
2*	509034.8671	575259.3912	Dwelling	2	929.3749631	01:09:36	94:18:00	30:34:53	11, 26, 29	Yes
4*	508647.2236	575524.293	Dwelling	2	961.3171507	01:31:12	116:30:00	37:46:51	11, 26, 27, 29	Yes

Table 5-16 Potential Cumulative Daily Shadow Flicker from the Proposed Development and the Existing Midas Wind Farm – Median Turbine

Property No.	Max. Potential Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	No. of Days 30min/day Threshold is Exceeded by Proposed Development and Midas Wind Farm	No. of Days 30min/day Threshold is Exceeded by Proposed Development (Turbines 1-11)	No. of Days 30min/day Threshold is Exceeded by Midas Wind Farm (Turbines 12-34)	No. of Days where any levels of Shadow Flicker produced by the Proposed Development overlaps with that of Midas Wind Farm	Mitigation Required by Proposed Development
2*	01:09:36	11, 26, 29	68	39	29	31	Yes, there are 31 days where there is a cumulative shadow flicker impact on house 2 from the Proposed Development and Midas Wind Farm

Property No.	Max. Potential Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	No. of Days 30min/day Threshold is Exceeded by Proposed Development and Midas Wind Farm	No. of Days 30min/day Threshold is Exceeded by Proposed Development (Turbines 1-11)	No. of Days 30min/day Threshold is Exceeded by Midas Wind Farm (Turbines 12-34)	No. of Days where any levels of Shadow Flicker produced by the Proposed Development overlaps with that of Midas Wind Farm	Mitigation Required by Proposed Development
4*	01:31:12	11, 26, 27, 29	101	17	84 (January to February; October to November)	0	No, there are no days that overlap.

Table 5-17 Potential Cumulative Annual Shadow Flicker from the Proposed Development and the Existing Midas Wind Farm – Median Turbine

House no.	Max. Potential Cumulative Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Potential Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Max. Potential Annual Shadow Flicker contributed to by Proposed Development (Turbines 1-11)	Max. Potential Annual Shadow Flicker contributed by Midas Wind Farm (Turbines 12-34)	Max. Potential Cumulative Annual Shadow Flicker Exceedance that requires mitigation (hrs:mins:sec)	Proposed Development Turbines to be controlled	Post-mitigation Maximum Annual Shadow Flicker by the Proposed Development (hrs:mins:sec)
1*	128:48:00	41:46:11	11, 26, 27, 29, 30	09:43:44	32:02:27	09:43:44	T11	≤32:02:27
2*	94:18:00	30:34:53	11, 23, 26, 27, 29,34	10:24:36	20:10:17	00:34:53	T11	30:00:00
4*	116:30:00	37:46:51	11, 23, 26, 27, 29	09:12:36	28:34:15	07:46:51	T11	30:00:00

5.7.5.3.4 Cumulative Shadow Flicker Results for Median Turbine Height

Daily Cumulative

Of the 3 no. properties with the potential for a cumulative impact to arise, Table 5-15 above illustrates that all 3 properties warrant further assessment (houses 1, 2, and 4). Table 5-16 then provides further assessment in relation to these 3 no. properties and details that the Proposed Development does not give rise to any daily shadow flicker evidence on houses 1 and 4, but that there is some shadow flicker impact on house 2. However, House 2 belongs to a participating landowner, and so no shadow flicker mitigation has been proposed under this scenario.

On this basis, there will be no daily shadow flicker mitigation needed for any property in the cumulative shadow flicker study area.

Annual Cumulative

Table 5-17 above shows that all 3 no. properties in the cumulative study area will experience shadow flicker occurrences in excess of 30 hours per year. However, the shadow flicker exceedances due to occur at House 1 can be solely contributed to the Midas Wind Farm and, as such, no mitigation is needed.

House 2 and House 4 also experience shadow flicker in excess of 30 hours per year. However, both House 2 and House 4 belong to participating landowners and, as such, no mitigation has been proposed under this scenario.

On this basis, there will be no daily shadow flicker mitigation needed for any property in the cumulative shadow flicker study area.

5.7.5.3.5 Cumulative Shadow Flicker for Maximum Turbine

Tables 5-18, 5-19 and 5-20 below set out the potential cumulative shadow flicker that is predicted to occur due to the Proposed Development (maximum turbine) in conjunction with Midas Wind Farm.

Table 5-18 outlines any potential for cumulative shadow flicker effects on dwellings due to Midas Wind Farm and the Proposed Development with the maximum turbine.

Table 5-19 below identifies the specific days where shadow flicker is due to occur, and which individual turbines are responsible for this.

Table 5-20 below outlines the potential for annual shadow flicker effects due to Midas Wind Farm and the Proposed Development with the maximum turbine.

Table 5-18 Potential Cumulative Shadow Flicker Impact from the Proposed Repowering of the Existing Kilgarvan Wind Farm and the Existing Midas Wind Farm – Maximum Turbine

House no.	ITM Coordinates (Easting)	ITM Coordinates (Northing)	Status	Nearest Proposed Turbine No. *	Distance to Nearest Turbine (metres)	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Further Assessment Required
1*	509205.3479	575220.6658	Dwelling	T2	899.4695028	01:03:36	98:54:00	32:04:24	26,29	Yes
2*	509034.8671	575259.3912	Dwelling	T2	929.3749631	01:09:36	91:30:00	29:40:24	26,29	Yes
4*	509058.4584	575211.7634	Dwelling	T2	961.3171507	01:31:12	113:48:00	36:54:19	26,27,29	Yes

Table 5-19 Potential Cumulative Daily Shadow Flicker from the Proposed Development and the Existing Midas Wind Farm – Maximum Turbine

Property No.	Max. Potential Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	No. of Days 30min/day Threshold is Exceeded by Proposed Development and Midas Wind Farm	No. of Days 30min/day Threshold is Exceeded by Proposed Development (Turbines 1-11)	No. of Days 30min/day Threshold is Exceeded by Midas Wind Farm (Turbines 12-34)	No. of Days where any levels of Shadow Flicker produced by the Proposed Development overlaps with that of Midas Wind Farm	Mitigation Required by Proposed Development
1*	01:03:36	26,29	75	0	75 (January, March and April, September and December)	0	No, there are no days that overlap.

Property No.	Max. Potential Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	No. of Days 30min/day Threshold is Exceeded by Proposed Development and Midas Wind Farm	No. of Days 30min/day Threshold is Exceeded by Proposed Development (Turbines 1-11)	No. of Days 30min/day Threshold is Exceeded by Midas Wind Farm (Turbines 12-34)	No. of Days where any levels of Shadow Flicker produced by the Proposed Development overlaps with that of Midas Wind Farm	Mitigation Required by Proposed Development
2*	01:09:36	11,26,29	29	0	23 (January to February; October to November)	31	6th June - 6th July
4*	01:31:12	26,27,29	59	0	73 (January to March; September to December)	0	No, there are no days that overlap.

Table 5-20 Potential Cumulative Annual Shadow Flicker from the Proposed Development and the Existing Midas Wind Farm – Maximum Turbine

House no.	Max. Potential Cumulative Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Potential Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Max. Potential Annual Shadow Flicker contributed to by Proposed Development (Turbines 1-11)	Max. Potential Annual Shadow Flicker contributed by Midas Wind Farm (Turbines 12-34)	Max. Potential Cumulative Annual Shadow Flicker Exceedance that requires mitigation (hrs:mins:sec)	Proposed Development Turbines to be controlled	Post-mitigation Maximum Annual Shadow Flicker by the Proposed Development (hrs:mins:sec)
1*	98:54:00	32:04:24	T26, T27, T29, T30	00:00:00	32:04:24	07:20:08	N/A	≤30:00:00

House no.	Max. Potential Cumulative Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Potential Annual Shadow Flicker Adjusted for Average Regional Sunshine (hrs:min:sec)	Turbine(s) contributing to Cumulative Shadow Flicker impact*	Max. Potential Annual Shadow Flicker contributed to by Proposed Development (Turbines 1-11)	Max. Potential Annual Shadow Flicker contributed by Midas Wind Farm (Turbines 12-34)	Max. Potential Cumulative Annual Shadow Flicker Exceedance that requires mitigation (hrs:mins:sec)	Proposed Development Turbines to be controlled	Post-mitigation Maximum Annual Shadow Flicker by the Proposed Development (hrs:mins:sec)
2*	91:30:00	29:40:24	T11, T23, T26, T27, T29, T34	09:30:07	20:10:17	N/A	N/A	29:40:24
4*	113:48:00	36:54:19	T11, T23, T26, T27, T29	08:20:04	28:34:15	06:54:19	T11	≤30:00:00

5.7.5.3.6 *Cumulative Shadow Flicker Results for Maximum Turbine Height*

Daily Cumulative

Of the 3 no. properties with the potential for a cumulative impact to arise, Table 5-18 above illustrates that all 3 properties warrant further assessment (House 1, 2 and 4). Table 5-19 then shows that out of the 3 no. houses with the potential to be affected by cumulative shadow flicker impacts, only 1 no property (House 2) has overlap of shadow flicker from the proposed turbines and the existing Midas turbines. However, House 2 belongs to a participating landowner, and so no shadow flicker mitigation measures have been proposed under this scenario.

On this basis, there will be no daily shadow flicker mitigation needed for any property in the cumulative shadow flicker study area.

Annual Cumulative

Table 5-20 shows that there is potential for annual shadow flicker exceedances at House 1 and House 4. However, the shadow flicker exceedances due to occur at House 1 are solely due to the Midas Wind Farm and, as such, no mitigation is needed for the Proposed Development. House 4 belongs to a participating resident and, as such, no mitigation is proposed under this scenario.

On this basis, there will be no annual shadow flicker mitigation needed for any property in the cumulative shadow flicker study area.

5.8 Residential Amenity

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

As noted previously, the current land-use for Proposed Development site is small-scale agricultural practices, predominantly livestock grazing, pasture and sileage, and wind energy development. The closest occupied dwelling (House No 1) to the Proposed Development is located approximately 899m from the closest turbine (Turbine No. 2). The closest third-party property is located approximately 1,269m from the nearest proposed turbine location (T10). In addition, an assessment of roadside screening was also carried out for all national roads within 5km of the proposed turbine locations, and all regional roads within 3km of the proposed turbine locations, with both the methodology and findings of this are described in Chapter 13.

When considering the amenity of residents in the context of a proposed wind farm, there are four main potential impacts of relevance: 1) Shadow Flicker, 2) Noise, 3) Visual Amenity and 4) Telecommunications. Shadow flicker and noise are quantifiable aspects of residential amenity while visual amenity is more subjective. Detailed shadow flicker and noise modelling have been completed as part of this EIAR (Section 5.7 above refers to shadow flicker modelling, Chapter 12 addresses noise). A comprehensive landscape and visual impact assessment have also been carried out, as presented in Chapter 13 of this EIAR. Impacts on human beings during the construction, operational and decommissioning phases of the Proposed Development is assessed in relation to each of these key issues and other environmental factors such as noise, traffic and dust; see Impacts in Section 5.9 below. The impact on residential amenity is then derived from an overall judgement of the combination of impacts due to shadow flicker, changes to land-use and visual amenity, noise, traffic, dust and general disturbance.

5.9 Likely Significant Impacts and Associated Mitigation Measures

5.9.1 'Do-Nothing' Scenario

If the Proposed Development were not to proceed, the existing uses for the site of small-scale agricultural farming practices, would continue, and the operational Kilgarvan Wind Farm would continue to operate until the turbines are to be decommissioned in accordance with the conditions of their respective planning permissions.

If the Proposed Development were not to proceed, the opportunity to continue to harness the wind energy resource of County Kerry would be lost, as would the opportunity to contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions.

The opportunity to generate local employment and investment would also be lost, and the local economy would continue to rely primarily on small-scale agriculture as the main source of income. It is likely that the trends of population decline and rural deprivation that have been recorded within the Study Area would continue in the absence of investment.

5.9.2 Construction Phase

5.9.2.1 Health and Safety

Pre-Mitigation Impacts

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

During construction of the Proposed Development, all staff will be made aware of and adhere to the Health & Safety Authority's '*Guidelines on the Procurement, Design and Management Requirements of the Safety, Health and Welfare at Work (Construction) Regulations 2006*'. This will encompass the use of all necessary Personal Protective Equipment, Risk Assessment and Method Statements and adherence to the site Health and Safety Plan.

Fencing will be erected in areas of the site where uncontrolled access is not permitted. Appropriate health and safety signage will also be erected on this fencing and at locations around the site.

The existing on site Coomagearlahy 110kV substation is currently a live node on the national electricity grid, and is connected to Clonkeen 110kV substation, approximately 6.07km to the north via an overhead electrical cable. It is intended that this cable will remain in place and no alterations will be made to it. Health and safety guidelines for working within and around electrical substations and underground cables will be adhered to on site.

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 due to the nature of the construction activities proposed.

Significance of Effects

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

5.9.2.2 Employment and Investment

The removal of the existing turbines, and the design, construction and operation of the Proposed Development will provide employment for technical consultants, contractors and maintenance staff. Up to approximately 100 jobs could be created during the construction, operation and maintenance phases of the Proposed Development. The construction phase of the wind farm will last between approximately 18-24 months. Most construction workers and materials will be sourced locally, thereby helping to sustain employment in the construction trade. This will have a short-term significant positive effect on the local economy due to the construction of the Proposed Development.

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

The Proposed Development will result in an influx of skilled people into the area, bringing specialist skills for both the construction and operational phases that could result in the transfer of these skills into the local workforce, thereby having a long-term positive 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 on the local area. According to Wind Energy Ireland there are over 5,130 jobs related to onshore wind energy in Ireland in 2021, a figure which is projected to grow to 6,900 by 2030.

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

Should the Proposed Development receive planning permission, there are substantial opportunities available for the local area in the form of Community Benefit Funds. The value of this fund will be directly proportional to the installed capacity and/or energy produced at the site and will support and facilitate projects and initiatives including youth, sport and community facilities, schools, educational and training initiatives, and wider amenity heritage and environmental projects. As part of the Existing

Kilgarvan Wind Farm, there has been an annual sum of €85,000 provided to the local community via the Community Benefit Fund. This fund has been distributed to local sporting organisations and community groups and has provided funding for key services in the local community. Further details on the proposed Community Gain proposals are presented in Appendix 2-3 and Section 4-5 of Chapter 4 of this EIAR.

5.9.2.3 Population

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

5.9.2.4 Land-use

The existing land-use of wind energy, small-scale agriculture and farming practices will continue on the site in conjunction with the Proposed Development. The Proposed Development will have no effect on existing land-uses as it has been operating as a wind energy development since 2007 and has been co-existing with the other land uses. Whilst there will be a small change of land use to facilitate the Proposed Development, the effect will be minimised due to the comparatively small development footprint associated with the Proposed Development.

The section of the old N22 that is being assessed as part of the turbine delivery route will not change its land use, as it was previously in use as a National Primary Route, with minimal works being needed (temporary berm, fence and gate removal) needed to restore it to an area fit to accommodate the transfer of the turbine components from the SuperWing Carrier to the blade adapter trailer.

5.9.2.5 Tourism and Amenity

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

5.9.2.6 Noise and Vibration

Pre-Mitigation Impacts

There will be an increase in noise level in the vicinity of the site during the construction phase, as a result of heavy machinery and construction work which has the potential to cause a nuisance to sensitive receptors located closest to the site. This will be a short-term very low sensitivity and low magnitude of change on human health. The noisiest construction activities associated with wind farm development are excavation and concrete pouring of the turbine bases. Excavation of a turbine base can typically be completed in one or two days however and the main concrete pours are usually conducted in one continuous pour, which is done within a matter of hours.

Construction noise at any given noise sensitive location will be variable throughout the construction of the Proposed Development, depending on the activities underway and the distance from the main construction activities to noise sensitive locations. The potential noise impact that will occur during the construction phase of the Proposed Development are further described in Chapter 12: Noise & Vibration.

Proposed Mitigation Measures

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

- No plant used on site will be permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate outside of general construction hours will be surrounded by an acoustic enclosure or portable screen.
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Chapter 12 using methods outlined in British Standard BS 5228-1:2014+A1:2019 Code of practice for noise and vibration control on construction and open sites – Noise.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 7:00hrs and 19:00hrs Monday to Saturday. However, to ensure that optimal use is made of good weather periods or at critical periods within the programme (i.e. concrete pours, large turbine component delivery, rotor/blade lifting) it could occasionally be necessary to work out of these hours.

Where rock breaking is employed in relation to the Proposed Development, the following are examples of 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 needs to be obscured.
- Enclose breaker or rock drill in portable or fixed acoustic enclosure with suitable ventilation.

Residual Effect

Following the implementation of the above mitigation measures, there will be a short-term imperceptible 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 direct or indirect effects.

5.9.2.7 Dust

Pre-Mitigation Effects

Potential dust emission sources during the construction phase of the Proposed Development include the removal of existing turbines, construction of new access roads and upgrading of existing access roads, and excavation and construction of turbine foundations. An increase in dust emissions has the potential to cause a nuisance to sensitive receptors in the immediate vicinity of the site. The entry and exit of construction vehicles from the site may result in the transfer of mud to the public road, particularly if the weather is wet. This may potentially cause nuisance and negative health effects to residents and other road users. These effects will not be significant and will be relatively short-term in duration. The potential dust effects that may occur during the construction phase of the Proposed Development are further described in Chapter 10: Air Quality.

Proposed Mitigation Measures

Truck wheels will be washed to remove mud and dirt before leaving the site. All plant and materials vehicles shall be stored in the dedicated compound area. Areas of excavation will be kept to a minimum, and stockpiling will be minimised by coordinating excavation, spreading and compaction. Construction traffic will be restricted to defined routes and a speed limit will be implemented.

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

Residual Effect

Following the implementation of the above mitigation measures, there will be a short-term slight negative effect due to dust emissions from the construction of the Proposed Development.

Significance of Effects

Based on the assessment above there will be no significant direct or indirect effects from dust emissions on residential amenity and human health during the construction phase of the Proposed Development.

5.9.2.8 Traffic

Pre-Mitigation Effects

It is proposed that the wind turbine components be delivered to the Proposed Development site from Ringaskiddy Port via the N22 National Road and the existing site entrance at Cloonkeen. The full transport route is described in further detail in Chapter 4 of this EIAR. No upgrades are required to be made to this existing entrance or the surrounding road network. All traffic (i.e. Heavy Goods Vehicles (HGVs) and Light Goods Vehicles (LGVs)) will enter the Proposed Development site via the existing entrance off the N22.

This will have a temporary slight negative effect on traffic users on the delivery routes.

Proposed Mitigation Measures

A complete Traffic and Transport Assessment (TTA) of the Proposed Development has been carried out by Alan Lipscombe Traffic and Transport Consultants Ltd and is presented within Section 15.1 of Chapter 15 of this EIAR. Traffic management measures have been presented in this chapter which, if implemented, will minimise any potential effect on the local population during the construction phase of the Proposed Project due to traffic. The prior to the commencement of any works, the occupants of dwellings in the vicinity of the proposed works area will be contacted and the scheduling of the works will be made known. Local access to properties will also be maintained throughout any construction works. Please refer to Chapter 18: Schedule of Mitigation and Monitoring Measures for a full list of measures.

Residual Effect

Once a 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 direct or indirect effects.

5.9.2.9 Shadow Flicker

Shadow flicker, which occurs during certain conditions due to the movement of wind turbine blades, as described in Section 5.7 of this chapter, occurs only during the operational phase of a wind energy development. There are therefore no shadow flicker 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 Health and Safety

Pre-Mitigation Effect

The operational phase of the Proposed Development poses little threat to the health and safety of the public. The Guidelines state that there are no specific safety considerations in relation to the operation of wind turbines. Fencing or other restrictions are not necessary for safety considerations. People or animals can safely walk up to the base of the turbines.

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

The turbine blades are typically manufactured of wood and laminated layers of glass fibre which will prevent any likelihood of an increase in lightning strikes within the site of the Proposed Development or the local area. Lightning protection conduits will be integral to the construction of the turbines. Lightning conduction cables, encased in protection conduits, will follow the electrical cable run, from the nacelle to the base of the turbine. The conduction cables will be earthed adjacent to the turbine base. The earthing system will be installed during the construction of the turbine foundations. There will be no effect on health and safety.

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.

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 and landowners remain negligible throughout the operational life of the Proposed Development.

It is Ørsted company policy that any person entering or leaving the site must first ring the NaturalPower phoneline to log their presence on the site. All persons who intend to enter the site must also carry out a site induction and be the holder of a valid SafePass card.

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

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 Proposed Development. 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, providing access for emergency services at all times.

The components of a wind turbine are designed to last up to 35 years and are equipped with a number of safety devices to ensure safe operation during their lifetime. During the operation of the Proposed Development 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 direct or indirect effects on health and safety.

5.9.3.2 Employment and Investment

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

5.9.3.3 Tourism

Pre-Mitigation Effects

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

5.9.3.4 Shadow Flicker

Pre-Mitigation Effects

Assuming worst-case conditions, a total of 2 no properties may experience daily and/or annual shadow flicker occurrences and would therefore require mitigation to reduce this to less than 30 minutes per day, or less than 30 hours per year, as per the Guidelines However, both of these properties are participating landowners and therefore no mitigation is proposed.

Proposed Mitigation Measures

As both these properties belong to participating landowners, there is no shadow flicker mitigation proposed.

Residual Effect

Shadow flicker could potentially have a long-term slight negative effect on residential amenity. However, as the 2 properties affected are both participating properties, there is no requirement for mitigation during the operational life of the Proposed Development and no residual negative effects on third party property will be experienced.

Significance of Effects

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

5.9.3.5 Interference with Communication Systems

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

As part of the scoping and consultation exercise undertaken by MKO, the national and regional broadcasters and fixed and mobile phone operators were contacted regarding potential interference from the Proposed Development. Full details are provided in of Chapter 2: Background to the Proposed Development and Section 14.2 and 14.3 (Telecommunications and Aviation) of Chapter 15: Material Assets. Copies of the scoping responses received are presented in Appendix 2-2 of the EIAR.

Responses were received from 2rn, BAI, BT, ComReg, Eir, Enet, ESB, Imagine, iMedia, Ivertec, Meteor, RTE, TETRA, Three, Virgin Media, and Vodafone. Of the above, 2rn, Eir, Enet, ESB, Three and Vodafone had links in the area of the Proposed Development. Further detail on the actions taken to ameliorate any potential interference, can be found in Chapter 2 and Chapter 15. Following these measures, there will be no interference risk from any of the proposed turbines providing the design complies with recommended buffer zones and telecommunication solutions. Therefore, the Proposed Development will have no effect on telecommunications.

5.9.3.6 Residential Amenity

Pre-Mitigation Effects

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

The visual effect of the Proposed Development is addressed comprehensively in Chapter 13: Landscape and Visual. The Proposed Development has been designed to maximise turbine separation distances to dwellings in the area, with no turbines located within 1269m from any occupied, non-participating, residential dwelling (H5). An assessment of roadside screening was carried out for roads within 5km of the proposed turbine locations, with both the methodology and findings of this are described in Chapter 13. Roughly 20% of the total road length within 5km of turbines has no roadside screening. The remaining c. 80% of roads within 5km of the Proposed Development site have either partial intermittent screening o full screening. Given the separation distance of the residential properties from the proposed turbines, and the level of existing screening in the area, the Proposed Development will have no significant effect on existing visual amenity at dwellings.

Proposed Mitigation Measures

The closest third-party dwelling to the Proposed Development is located approximately 1269m from the nearest proposed turbine (T10), which is greater than 4 times the tip height (800m) from any occupied, non-participating, residential dwelling (H5), a recognised parameter in assisting in the protection of residential visual amenity. All mitigation as outlined under noise and vibration, dust, traffic, visual amenity and shadow flicker in this EIAR will be implemented in order to reduce insofar as possible effects on residential amenity at properties located in the vicinity of the Proposed Development.

Residual Effect

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

Significance of Effects

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

5.9.4 Decommissioning Phase

The wind turbines proposed as part of the Proposed Development are expected to have a lifespan of approximately 35 years. Following the end of their useful life, the wind turbines may be replaced with a new set of turbines, subject to planning permission being obtained, or the site may be decommissioned fully. The existing onsite 110kV Coomagearlahy substation will remain in place as it will be under the ownership of ESB / EirGrid.

The works required during the decommissioning phase are described in Section 4.10 in Chapter 4: Description of the Proposed Development. Any effect 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, and the mitigation measures outlined above will be implemented during the decommissioning phase also. A decommissioning plan will be agreed with the local authorities three months prior to decommissioning the Proposed Development. The principles that will inform the final decommissioning plan are contained in the Construction and Environmental Management Plan (CEMP) in Appendix 4-3.

5.9.5 Cumulative and In Combination Effects

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

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

Further information on projects considered as part of the cumulative assessment are given in Chapter 2: Background to the Proposed Development. The effects with the potential to have cumulative effects on human beings are discussed below and in more detail in the relevant chapters: Noise and Vibration (Chapter 11), Landscape and Visual (Chapter 12) and Traffic and Transportation (Chapter 14).

5.9.5.1 Health and Safety

The Proposed Development will have no cumulative effects in terms of health and safety. There is no scientific evidence to link wind turbines with adverse health effects.

5.9.5.2 Property Values

The Proposed Development will have no cumulative effect on property value. There is no statistical evidence that house prices near wind turbines are affected post or pre-construction periods after announcing development.

5.9.5.3 Services

Potential cumulative effect through investment into local services arising from the Proposed Development and other smaller scale developments in the area, through short and long-term employment and a community benefit fund (as detailed in Section 5.9.2.2), is expected to be a long-term positive cumulative effect.

5.9.5.4 Shadow Flicker

As outlined in Section 5.7.5.2, there is 1 no. wind farm (Midas Wind Farm) located within 10 rotors of the shadow flicker study area and therefore, there is potential for shadow flicker from the Proposed Development in combination with Midas Wind Farm. The results of the Cumulative Shadow Flicker Assessment can be seen in Section 5.7.5.2.

As outlined in Section 5.7.5.2, there are 3 no. properties which have the potential to be affected by cumulative shadow flicker from the Proposed Development and Midas Wind Farm. All these properties belong to participating landowners. As such, no mitigation measures are required to be implemented due to the agreement that is in place with these landowners.

5.9.5.5 Residential Amenity

Pre-Mitigation Effects

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

Proposed Mitigation Measures

The closest third-party dwelling to the Proposed Development is located approximately 1269m from the nearest proposed turbine (T10), i.e., greater than the recommended setback distance of 4 times the tip height (i.e., 800m), as per the *Draft Revised Wind Energy Development Guidelines* (Department of Housing, Planning and Local Government, December 2019 (currently out for public consultation)).

All mitigation measures as outlined under noise and vibration, dust, traffic, visual amenity and telecommunications in this EIAR will be implemented in order to reduce insofar as possible effects on residential amenity at properties located in the vicinity of the Proposed Development works, including along the proposed turbine and construction materials haul route. It is assumed also that all mitigation measures in relation to the other cumulative projects will also be implemented.

Residual Effect

The Proposed Development will have a short-term, slight negative effect on residential amenity during construction works. During the operational phase, noise and shadow flicker from the proposed and permitted projects will be limited to below guideline levels or as committed to by the developer, resulting in a long-term, imperceptible residual effect from on residential amenity.

Significance of Effects

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

5.10 Summary

Following consideration of the residual effects (post-mitigation) it is noted that the Proposed Development will not result in any significant effects on Human Beings in the area surrounding the Proposed Development. Following appropriate mitigation, as per the draft Guidelines there will be no daily or annual shadow flicker exceedances at any dwelling within 2 km of the Proposed Development.

Provided that the Proposed Development is constructed and operated in accordance with the design, best practice and mitigation that is described within this application, significant effects on population and human health, associated with health and safety, noise, dust, traffic and shadow flicker, are not anticipated.