5. POPULATION AND HUMAN HEALTH

5.1 Introduction

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

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

5.2 Population

5.2.1 Receiving Environment

Information regarding population and general socio-economic data were sourced from the Central Statistics Office (CSO), the County Cork Development Plan 2014, Fáilte Ireland and any other literature pertinent to the area. The study included an examination of the population and employment characteristics of the area. This information was sourced from the Census of Ireland 2016, which is the most recent census for which a complete dataset is available, also the Census of Ireland 2011, the Census of Agriculture 2010 and from the CSO website (www.cso.ie). Census information is divided into State, Provincial, County, Major Town and District Electoral Division (DED) level.

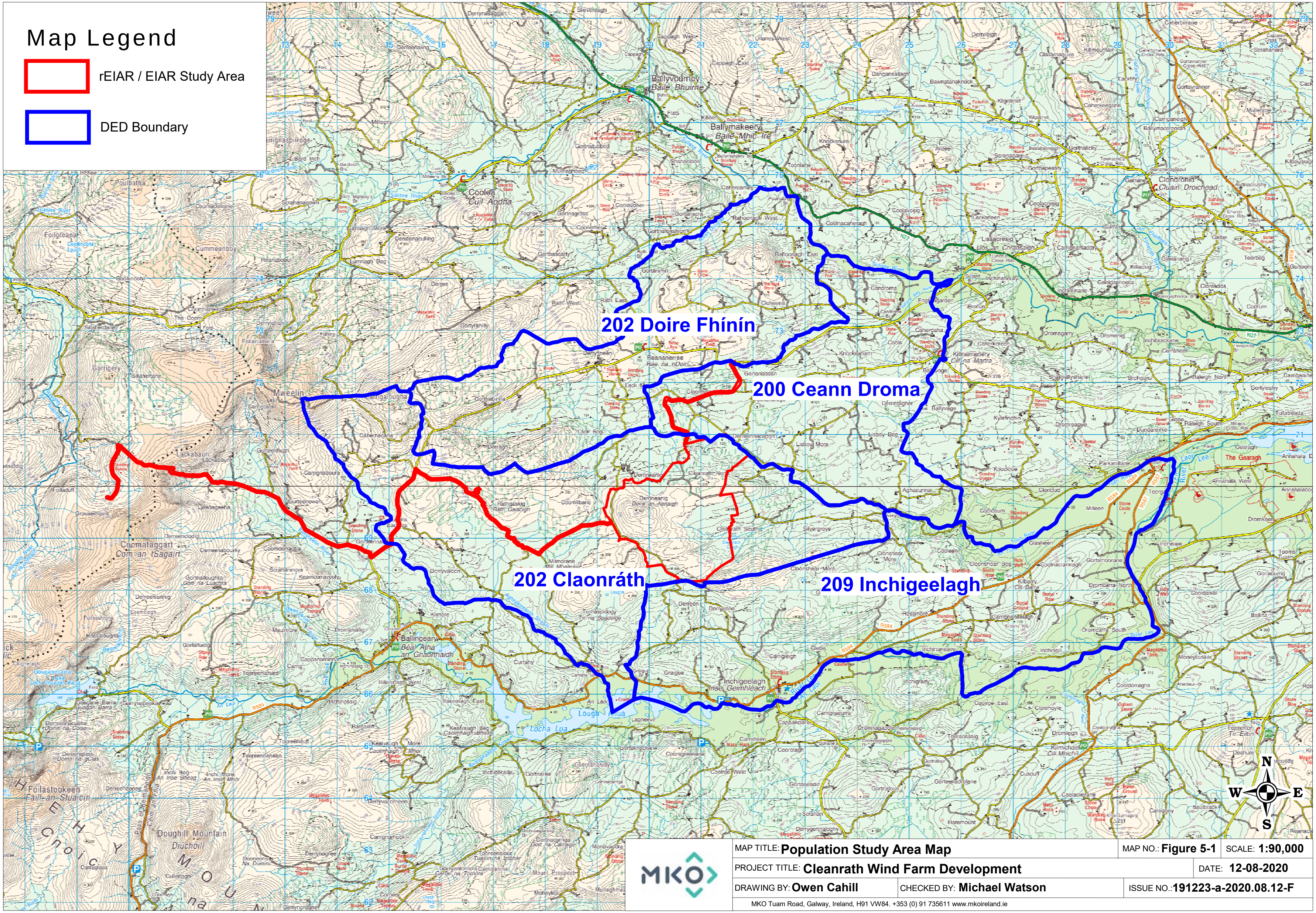
The site of the Cleanrath wind farm development is located in a number of townlands as listed in Table 1-1. The village of Inchigeelagh is located approximately 2.5 kilometres to the south of the site. The nearest town is Macroom, located approximately 12 kilometres north east of the Cleanrath Wind Farm Development.

In order to make inferences about the population and other statistics in the vicinity of the Cleanrath Wind Farm Development, the Study Area for the Population and Human Health section of this rEIAR was defined in terms of the District Electoral Divisions (DEDs) where the Cleanrath wind farm development is located.

The Cleanrath wind farm development lies principally within the Cleanrath DED however, the study area overlaps the Ceann Droma, Inchigeelagh and Doire Fhínín DEDs, as shown in Figure 5-1. The total Study Area has a combined population of 1,335 persons and comprises a total land area of 87.1 square kilometres. (Source: CSO Census of the Population 2016).

5.2.2 Population Trends

In the four years between the 2011 and the 2016 Census, the population of Ireland increased by 3.8%. During this time, the population of County Cork grew by 4.6% to 542,868 persons. Other population statistics for the State, County Cork and the Study Area have been obtained from the Central Statistics Office (CSO) and are presented in Table 5-1.



MAP TITLE: Population Study Area Map | MAP NO.: Figure 5-1 | SCALE: 1:90,000

PROJECT TITLE: Cleanrath Wind Farm Development | DATE: 12-08-2020

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

Area	Population Change		% Population Change
	2011	2016	2011 - 2016
State	4,588,252	4,761,865	3.8
County Cork	519,032	542,868	4.6
Study Area	1,322	1,335	1.0

The data presented in Table 5-1 shows that the population of the Study Area increased by 1% between 2011 and 2016. This rate of population growth is lower than that which was recorded in the Republic of Ireland and at County level between 2011 and 2016. When the population data is examined in closer detail, it shows that the rate of population increase within the Study Area has been unevenly spread through the District Electoral Divisions (DEDs). The highest rate of population increase between 2011 and 2016 occurred within Cleanrath DED, which experienced a 4.2% population increase. In comparison, the population of Doire Fhínín DED decreased by 3.2% during the same time period.

Of the DEDs that make up the Study Area for the purposes of this assessment, the highest population was recorded in Inchigeelagh DED, with 538 persons recorded during the 2016 Census. The lowest population was recorded in Cleanrath DED, with 225 persons recorded during the 2016 Census.

5.2.3 Population Density

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

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

Area	Population Density (Persons per square kilometre)	
	2011	2016
State	65.6	68.1
County Cork	69.5	72.7
Study Area	20.79	20.99

The population density of the Study Area recorded during the 2016 Census was 20.99 persons per km^2. This figure is significantly lower than the national population densities of 68.1 persons per km^2 and lower than the county population densities of 73.0 persons per km^2.

Similar to the observed population and household trends, the population density recorded across the Study Area varies between DEDs. Ceann Droma DED has the lowest population density, at 15.7 persons per km^2, while Cleanrath DED has the highest population density, at 27.4 persons per km^2.

5.2.4 Household Statistics

The number of households and average household size recorded within the State, County Cork and the Study Area during the 2011 and 2016 Censuses are shown in Table 5-3.

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

Area	2011		2016	
	No. of Households	Avg. Size (persons)	No. of Households	Avg. Size (persons)
State	1,654,208	2.8	1,702,289	2.8
County Cork	188,019	2.8	195,853	2.8
Study Area	488	2.7	489	2.8

In general, the figures in Table 5-3 show that while the number of households within the State, County and 4 DEDs has increased slightly, the average number of people per household decreased slightly. Average household size recorded within the Study Area during the 2011 and 2016 Censuses are in line with that observed at State and County level during the same time periods. Similar to the trends observed above, the average household size recorded across the Study Area varies between DEDs. Doire Fhínín DED had the highest, with 3.1 and 3.0 persons per household recorded in 2011 and 2016 respectively. Cleanrath DED and Inchigeelagh DED both recorded the lowest, with 2.7 and 2.6 persons per household recorded in 2011 respectively and 2.7 for both in 2016.

5.2.5 Age Structure

Table 5-4 presents the population percentages of the State, County Cork and Study Area within different age groups as defined by the Central Statistics Office during the 2016 Census. This data is also displayed in Figure 5-2.

Table 5-4 Population per Age Category in 2016 (Source: CSO)

Area	Age Category				
	0 - 14	15 – 24	25 - 44	45 - 64	65 +
State	1,006,552	576,452	1,406,291	1,135,003	637,567
County Cork	113,531	67,346	157,675	130,473	73,843
Study Area	295	138	350	369	183

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

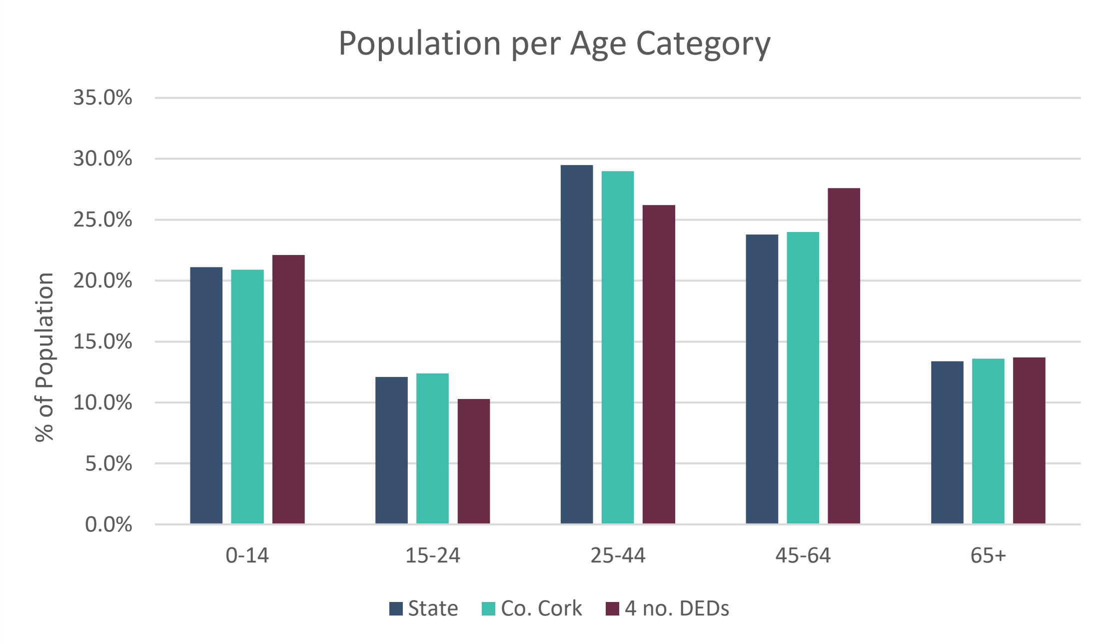


Figure 5-2 Population per Age Category in 2016 (Source: CSO)

5.2.6 Employment and Economic Activity

5.2.6.1 Economic Status of the Study Area

The labour force consists of those who are able to work, i.e. those who are aged 15/16+, out of full-time education and not performing duties that prevent them from working. In 2016, there were 2,304,037 persons in the labour force in the Republic of Ireland. Table 5-5 shows the percentage of the total population aged 15/16+ who were in the labour force during the 2016 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 15/16+ who were not in the labour force, i.e. those who were students, retired, unable to work or performing home duties.

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

	Status	Republic of Ireland	County Cork	Study Area
% of population aged 15+ who are in the labour force		**61.4%**	**60.0%**	**62.9%**
% of which are:	At work	87.1%	89.4%	91.6%
	Unemployed	11.5%	9.5%	7.8%
% of population aged 15+ who are not in the labour force		**38.6%**	**40.0%**	**37.1%**
% of which are:	Student	29.4%	30.5%	26.4%
	Home duties	21.1%	20.7%	25.9%
	Retired	37.6%	36.5%	36.3%

	Status	Republic of Ireland	County Cork	Study Area
	Unable to work	10.9%	11.4%	11.1%
	Other	1.0%	0.9%	0.3%

Overall, the principal economic status of those living in the Study Area is broadly similar to that recorded in the Republic of Ireland and County level. During the 2016 Census, between 87.1%-89.4% of those recorded as being in the labour force in the Republic of Ireland and County level were in employment. Within the Study Area, this figure was 91.6%. Of those who were not in the labour force during the 2016 Census, the highest percentage of the Study Area population were Retired individuals. The highest percentage of the Study Area population at interstate and County level were Retired.

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 and the Study Area during 2016.

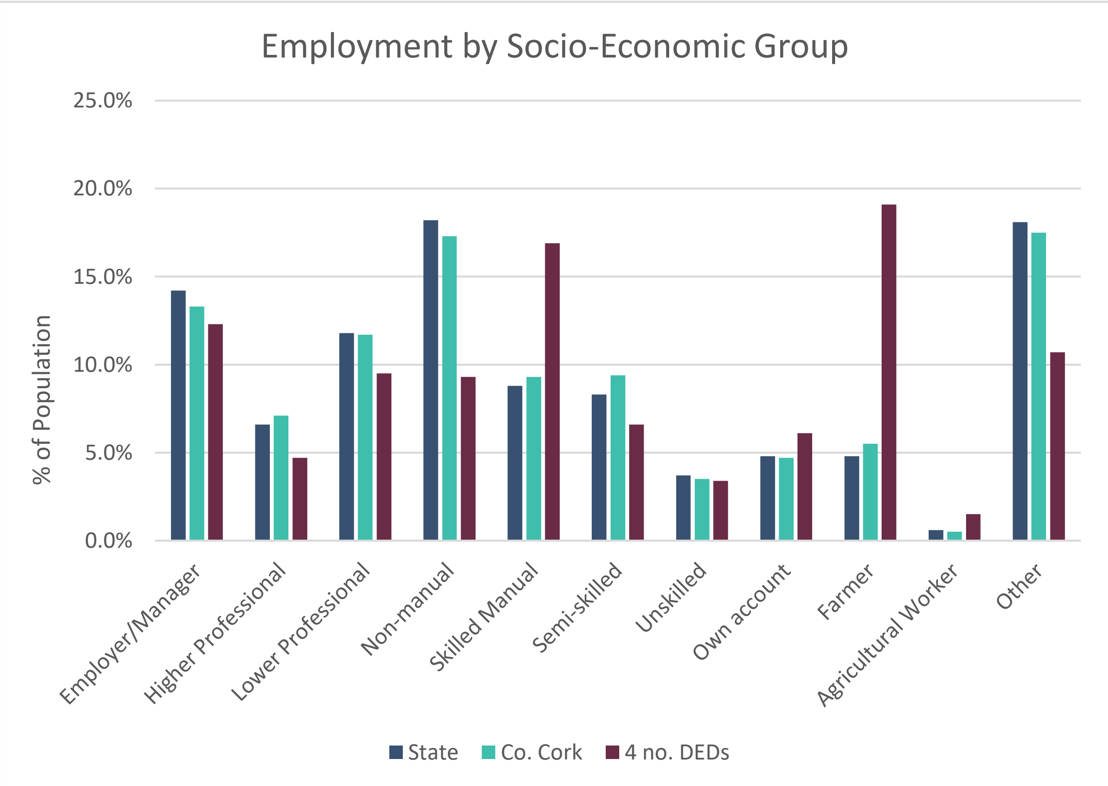


Figure 5-3 Employment by Socio-Economic Group in 2016 (Source: CSO)

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

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

5.2.6.3 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.'*

5.2.6.3.2 *Energy Targets*

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

5.2.6.3.3 *Employment Potential*

The Deloitte report (2009) estimated at the time of its publication that the Island of Ireland's installed wind energy capacity would need to reach 7,800 Megawatts (MW) by 2020, in order to meet the Government's renewable energy targets. Based on these estimates, the Deloitte report stated that the Irish wind energy sector to 2020 would be capable of supporting more than 10,760 jobs through direct and indirect involvement in the sector. This number includes construction, operation and maintenance of all wind farms and assumes a steady growth in the industry over the period to 2020. As it has been predicted that Ireland will not meet its 2020 target for renewable energy by the Sustainable Energy Authority of Ireland (SEAI) it is unlikely that this number of jobs have been created up to 2020 considering this shortfall. It also encompasses planning and financing of wind farms, and support services such as administration, payroll and marketing/communications. There are also further employment opportunities available in other areas of the wind energy sector relating to policy, Research and Development, support services and other, which total to 935 jobs across Ireland.

The Deloitte report states the majority of jobs estimated to be created would be provided within the construction industry:

> *"The wind sector offers great opportunities to a sector such as construction, which is currently facing downturn and rising unemployment[1]. It is estimated that approximately 7,258 jobs will be supported by the construction element of wind farms."*

The Deloitte study on employment and investment potential assumed that there would be a steady growth in the amount of wind power rolled out between 2009 and 2020. The report states:

> *"It is crucial that the industry expands at a sustainable rate. If Ireland's increase in installed capacity is rolled out at a steady growth rate over the next eleven years then Irish companies will have sufficient time to adapt and build up their companies in order to cope with the increasing number of MW being added every year."*

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

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

As of June 2019, there were 5,030 Megawatts (MW) of wind energy capacity installed on the island of Ireland. Of this, 3,748 MW was installed in the Republic of Ireland, with 1,282 MW installed in Northern Ireland. The majority of the Republic of Ireland's installed wind energy capacity is located in Counties Donegal, Cork and Kerry.

5.2.6.3.4 Economic Value

The Deloitte report states that the construction and development of wind energy projects across the island of Ireland would involve approximately €14.75 billion of investment from 2009 up to 2020, €5.1 billion of which would be retained in the Irish economy (€4.3 billion invested in the Republic of Ireland and €0.8 billion in Northern Ireland).

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

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

A 2019 report by Baringa, 'Wind for a Euro: Cost-benefit analysis of wind energy in Ireland 2000-2020', has analysed the financial impact for end consumers of the deployment of wind generation in Ireland over the period 2000-2020. The report calculates how the costs and benefits for consumers would have differed if no wind farms had been built. The analysis indicated that the deployment of 4.1 GW of wind generation capacity in Ireland between 2000 and 2020 (2018-2020 results being projective) will result in

[1] *It is noted that this report is dated 2009 and assessing employment figures for that period and does not account for the recent upturn in employment figures within the construction industry*

a total net cost to consumers, over 20 years, of €0.1bn (€63 million to be exact), which equates to a cost of less than €1 per person per year since 2000. Further cost benefit analysis noted that wind energy has delivered €2.3 billion in savings in the wholesale electricity market. As such, the economic benefit of renewable energy to consumers is greater than what would have been if Ireland did not invest in wind power.

The Cleanrath wind farm development will be contributing to the economic value that renewable energy brings to the country.

5.2.7 Land-Use

The predominant surrounding land use within the Population study area is that of farmland. The total area of farmland within the 4 DEDs around the wind farm site measures approximately 5,977 hectares, comprising 68% of the Study Area, according to the CSO Census of Agriculture 2010. There are 150 farms located within the 4 DEDs, with an average farm size of 39.8 hectares. This is slightly smaller than the 38.06-hectare average farm size for Co. Cork.

Within the Study Area, farming employs 150 people, and the majority of farms are family-owned and run. Table 5-6 shows the breakdown of farmed lands within the 4 DEDs. Pasture accounts for the largest proportion of farmland, followed by silage.

Table 5-6 Farm Size and Classification within the Study Area in 2010 (Source: CSO)

Characteristic	Value
Size of 4 DEDs	8761 hectares
Total Area Farmed within 4 DEDs	5,977 hectares
Farmland as % of 4 DEDs	68%
Breakdown of Farmed Land	**Area (hectares)**
Total Pasture	2,984 ha
Total Silage	1,080 ha
Rough Grazing	1,688 ha
Total Hay	196 ha
Total Potatoes	0 ha
Total Cereals	10 ha
Total Crops	19 ha

5.2.8 Services

The Cleanrath wind farm development is located within the functional area of the Blarney Macroom Local Area Plan (LAP), 2017. The nearest settlement to the Cleanrath wind farm development is Inchigeelagh, a village situated on the R584 regional route connecting Macroom with Bantry. Macroom, where larger scale retail and services are available, lies approximately 12km to the north east of the Cleanrath Wind Farm Development.

5.2.8.1 Education

The school located closest to the Cleanrath wind farm development is Inchigeelagh National School, located approximately 2.6 kilometres south west of the site. The nearest secondary school is Scoil Mhuire approximately 5 kilometres to the south west of the site in Ballingeary at its nearest point. Secondary Schools are also located in Macroom, approximately 12 kilometres to the north east of the site.

5.2.8.2 Access and Public Transport

The Cleanrath wind farm development is accessed via local roads from the N22 National Primary Road to the north and the R5824 Regional Road to the south. The N22 National Primary Route to the north and R5824 Regional road to the south. The N22 National Primary Route runs in a general north west to south east direction approximately 11 kilometres north of the site. R5824 Regional road runs in a general east west direction approximately 2.8 kilometres to the south of the site. There are no other national roads within a ten-kilometre radius of the site.

The site is served by a number of forestry tracks which are to be upgraded where appropriate to accommodate site access and construction traffic. New roads were also constructed within the site. Access to the site from the local road network is to be via the upgrade of an existing track which meets the local road at Cleanrath South.

The Cleanrath wind farm development is not served by public transport. The nearest train station to the Cleanrath wind farm development is at Millstreet, located approximately 32 kilometres north of the site. From the village of Ballingeary, located approximately 5 kilometres south west of the site, there are Bus Eireann connections to Cork City, from which a significant number of destinations may be reached. Cork Airport is located approximately 56 kilometres east of the Cleanrath Wind Farm Development.

5.2.8.3 Amenities and Community Facilities

The majority of amenities and community facilities, including GAA and other sports clubs, youth clubs and recreational areas available in the area are located in the centres of settlement throughout the wider area. Retail and personal services within the vicinity are provided in the larger settlement of Macroom.

Community Benefit proposals, which would enhance local amenities and community facilities are described in Chapter 4: Description of the Cleanrath wind farm development and is summarised in Section 5.9.2.2 below.

5.3 Public Perception of Wind Energy

5.3.1 IWEA Interactions Opinion Poll on Wind Energy

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

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

5.3.2 Sustainable Energy Ireland Survey 2003

5.3.2.1 Background

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

5.3.2.2 Findings

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

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

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

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

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

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

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

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

5.3.2.3 Survey Update 2017

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

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

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

5.3.2.4 Conclusions

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

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

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

5.3.3.1 Background

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

5.3.3.2 Study Area

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

5.3.3.3 Findings

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

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

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

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

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

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

5.3.3.4 Conclusions

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

5.4 Tourism

5.4.1 Tourism Numbers and Revenue

Tourism is one of the major contributors to the national economy and is a significant source of full time and seasonal employment. During 2018, total tourism revenue generated in Ireland was approximately €9.1 billion, an increase on the €8.8 billion revenue recorded in 2017. Overseas tourist visits to Ireland in 2018 grew by 6.5% to 9.6 million ('Tourism Facts 2018, Fáilte Ireland, September 2019).

Ireland is divided into seven tourism regions. Table 5-7 shows the total revenue and breakdown of overseas tourist numbers to each region in Ireland during 2018 ('Tourism Facts 2018, Fáilte Ireland, September 2019).

Table 5-7 Overseas Tourists Revenue and Numbers 2018 (Source: Fáilte Ireland)

Region	Total Revenue (€m)	Total Number of Overseas Tourists (000s)
Dublin	€2,095m	6,309
Mid-East/Midlands	€ 393m	1,030
South-East	€261m	1,028
South-West	€987m	2,512
Mid-West	€511 m	1,497
West	€727m	1,963
Border	€244m	752
Total	€5,218 m	15,091

The Cleanrath wind farm development is located within the South West Region. According to 'Tourism Facts 2018' (Fáilte Ireland, September 2019) the South West Region which comprises Counties Cork and Kerry, benefited from approximately 16.6% of the total number of overseas tourists to the country and approximately 18.9% of the associated tourism income generated in Ireland in 2018.

Data showing the breakdown of overseas tourist numbers in the South-West region and the associated revenue generated for 2017 was obtained from '2017 Topline performance by region (Fáilte Ireland, 2018). As can be observed in Table 5-8, County Cork had the highest tourism revenue within the Region during 2017.

Table 5-8 Overseas Tourism to South-West Region during 2016 (Source: Fáilte Ireland)

County	Revenue Generated by Overseas Tourists (€m)	No. of Overseas Tourists
Cork	€631m	1,605

5.4.2 Tourist Attractions

The varied natural landscape and scenic amenity of this area provide many opportunities for general outdoor recreation within the wider area including walking, cycling and horse-riding.

The varied environment of this area of County Cork provides many opportunities for walking and cycling. Gougane Barra Forest Park is located within 22 kilometres to the southwest of the Cleanrath wind farm development site where six different walking trails are available as well as a 318km cycle route which starts in Cork City and finishes in Gougane Barra.

Carrigaphooca Castle, a 16th century tower house, is located approximately 18km to the northwest of the Cleanrath wind farm development site and west of the town of Macroom. Independence Museum Kilmurry located at Lissarda approximately 25km east of the Cleanrath wind farm development site.

A number of amenities and tourist attractions can be found in the nearby town of Macroom, located approximately 12km northeast of the Cleanrath Wind Farm Development, including Macroom Golf Club.

Glengarriff Woods Nature Reserve and Bonane Heritage Park are located approximately 16km and 12.7km west of the Cleanrath wind farm development site respectively in County Kerry. The latter contains a complex of more than 250 archaeological sites.

Killarney National Park is located over 25km north east of the Cleanrath Wind Farm Development. The Park was deemed a UNESCO Biosphere Reserve in 1981 due to the quality and high ecological diversity, extensive habitats and range of species found that in the park.

The Study Area is within the lee River Valley tourist area which is defined as a recreational amenity and fishery area. The Cleanrath wind farm development does not impact on this tourist attraction.

Scenic roads would be considered a tourism resource for the county. The S26 is a local road that runs generally in an east-west direction to the north of the site. The local access road to the north which is part of the study area is located adjacent to this road. Other scenic roads are present in the wider landscape, include the S34 on a regional road (R584) running in an east-west direction to the north of Lough Allua to the south of the site and S26 and S27 on local roads to the west of the site which run generally in a north to south west direction.

The potential for visual impacts arising from the Cleanrath wind farm development on the wider landscape and scenic roads is assessed in Chapter 13 of this rEIAR.

5.4.3 Tourist Attitudes to Wind Farms

5.4.3.1 Scottish Tourism Survey 2016

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

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

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

5.4.3.2 Fáilte Ireland Surveys 2007 and 2012

In 2007, Fáilte Ireland in association with the Northern Ireland Tourist Board carried out a survey of domestic and overseas holidaymakers to Ireland in order to determine their attitudes to wind farms. The purpose of the survey was to assess whether the development of wind farms impacts on the enjoyment of the Irish scenery by holidaymakers. The survey involved face-to-face interviews with 1,300 tourists (25% domestic and 75% overseas). The results of the survey are presented in the Fáilte Ireland Newsletter 2008/No.3 entitled 'Visitor Attitudes on the Environment: Wind Farms'.

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

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

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

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

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

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

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

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

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

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

5.5 Health Impacts of Wind Farms

5.5.1 Health Impact Studies

While there are anecdotal reports of negative health effects on people who live very close to wind turbines, peer-reviewed research has largely not supported these statements. There is currently no published credible scientific evidence to positively link wind turbines with adverse health effects. The main publications supporting the view that there is no evidence of any direct link between wind turbines and health are summarised below.

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

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

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

The GDG points out that evidence on health effects from wind turbine noise (apart from annoyance) is either absent or rated low/very low quality and effects related to attitudes towards wind turbines are hard to differentiate from those related to noise and may be partly responsible for the associations. The

GDG also recognises that the percentage of people exposed to noise from wind turbines is far lower than other sources such as road traffic and state that any benefit from specifically reducing population exposure to wind turbine noise in all situations remains unclear.

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

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

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

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

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

3. *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 rEIAR. 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.

4. *'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."*

5. *'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.

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

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

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

7. ***'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."*

8. ***'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. Pierpoint's respondents by the mechanisms proposed."*

In light of all the health impact studies outlined in this section, 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.

5.5.2 Turbine Safety

Turbines pose no threat to the health and safety of the general public. The Department of the Environment, Heritage and Local Government (DoEHLG)'s '*Wind Energy Development Guidelines for Planning Authorities 2006*' and the '*Draft Revised Wind Energy Development Guidelines'* (Department of Housing, Planning and Local Government (DoHPLG), December 2019) (currently out for public consultation), iterate that there are no specific safety considerations in relation to the operation of wind turbines. Fencing or other restrictions are not necessary for safety considerations and should be kept to a minimum. People or animals can safely walk up to the base of the turbines.

The adopted 2006 Guidelines and the Draft 2019 Guidelines state that there is a very remote possibility of injury to people from flying fragments of ice or from a damaged blade. However, most blades are composite structures with no bolts or separate components and the danger is therefore minimised. The build-up of ice on turbines is unlikely to present problems. The wind turbines are fitted with anti-vibration sensors, which will detect any imbalance caused by icing of the blades. The sensors will cause the turbine to wait until the blades have been de-iced prior to resuming operation.

Turbine blades are manufactured of glass fibre reinforced plastic which will prevent any likelihood of an increase in lightning strikes within the site of the Cleanrath wind farm development or the local area. Lightning protection conduits are integral to the construction of 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 are earthed adjacent to the turbine base. The earthing system were installed during the construction of the turbine foundations.

5.5.3 Electromagnetic Interference

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

The ESB document 'EMF & You' (ESB, 2017) provides further practical information on EMF and is included as Appendix 5-2 of this rEIAR.

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

5.5.4 Assessment of Effects on Human Health

As set out in the Department of Housing, Planning, Community and Local Government 'Key Issues Consultation Paper on the Transposition of the EIA Directive 2017' and the guidance listed in Section 1.9.1 of Chapter 1: Introduction, the consideration of the effects on populations and on human health should focus on health issues and environmental hazards arising from the other environmental factors, for example water contamination, air pollution, noise, accidents, disasters.

Chapter 8: Land, Soils and Geology, Chapter 9: Hydrology and Hydrogeology, Chapter 10: Air and Climate, Chapter 11: Noise and Vibration and Chapter 14: Material Assets (Traffic and Transport) provide an assessment of the effects of the Cleanrath wind farm development on these areas of consideration. There is the potential for negative effects on human health during the wind farm construction phase related to potential emissions to air of dust, potential emissions to land and water of hydrocarbons, release of potentially silt-laden runoff into watercourses and noise emissions. The assessments however show that residual effects on human health have not occurred

The site design, effective implementation of mitigation measures and monitoring results outlined in Chapter 8 and Chapter 9 confirms that water supplies have not been impacted ad the potential for ongoing or future impacts on the water environment are not significant. No impacts on local water supplies have occurred or are anticipated.

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

The preliminary Flood Risk Assessment has also shown that the risk of the Cleanrath wind farm development contributing to downstream flooding is also very low. Flooding has not occurred nor has there been any change to the hydrological regime.

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

5.5.5 Vulnerability of the Project to Natural Disasters and Major Accidents

As outlined in Section 5.5.4 above a wind farm is not a recognised source of pollution. Should a major accident or natural disaster occur the potential sources of pollution onsite during all phases of the Cleanrath wind farm development are limited. Sources of pollution with the potential to cause significant environmental pollution and associated negative effects on health, such as bulk storage of hydrocarbons or chemicals, storage of wastes etc. are limited.

There is limited potential for significant natural disasters to occur at the Cleanrath wind farm development site. Ireland is a geologically stable country with a mild temperate climate. The potential natural disasters that may occur are therefore limited to flooding and fire. The risk of flooding is addressed in Chapter 9: Hydrology and Hydrogeology. It is considered that the risk of significant fire occurring, affecting the wind farm and causing the wind farm to have significant environmental effects is limited and therefore a significant effect on human health is similarly limited and the potential effect is considered imperceptible. As described earlier, there are no significant sources of pollution in the wind farm with the potential to cause environmental or health effects. Also, the spacing of the turbines and distance of turbines from any properties limits the potential for impacts on human health. The issue of turbine safety is addressed in Section 5.5.2.

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

5.6 Property Values

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

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

The main conclusion of this study is as follows:

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

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

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

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

A further study was commissioned by Renewable UK 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 5-3 of this rEIAR.

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

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

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

5.7 Shadow Flicker

5.7.1 Background

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

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

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

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

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

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

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

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

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

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

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.

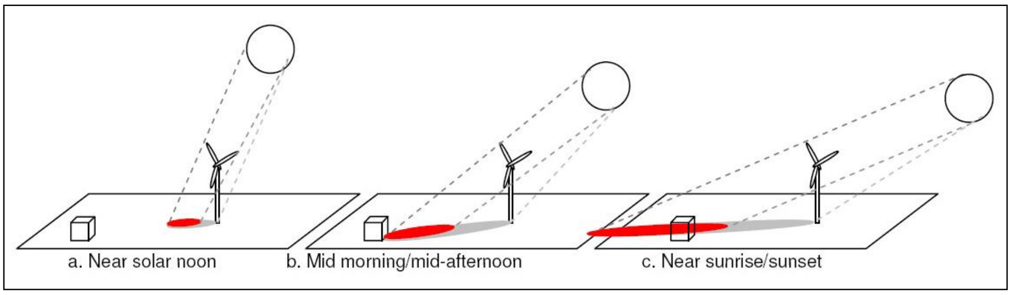


Figure 5-4 Shadow-Prone Area as Function of Time of Day (Source: Shadow Flicker Report, Helimax Energy, Dec 2008)

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

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

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

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

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

The direction of wind turbine blades changes according to wind direction, as the turbine rotor turns to face the wind. In order to cast a shadow, the turbine blades must be facing directly toward or away from the sun, so they are moving across the source of the light relative to the observer. This is demonstrated in Figure 5-5 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environment Power LLC).

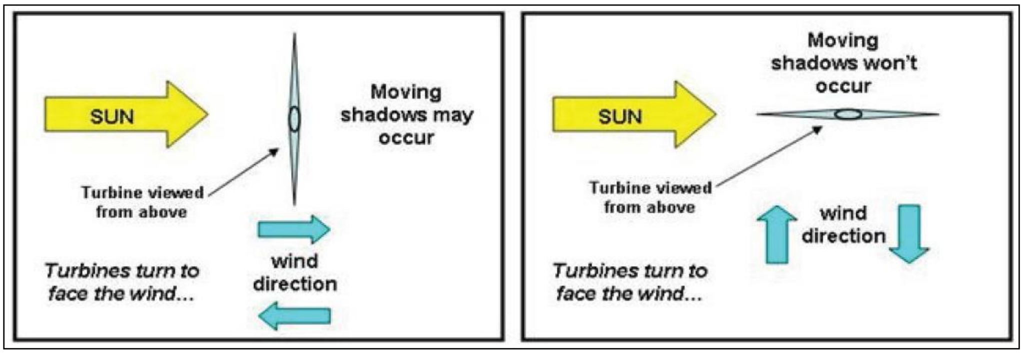


Figure 5-5 Turbine Blade Position and Shadow Flicker Impact (Source: Wind Fact Sheet: Shadow Flicker, Noise Environment Power LLC)

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

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

5.7.2 Guidance

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

The adopted 2006 DoEHLG guidelines recommend that shadow flicker at dwellings within 500 metres of a proposed turbine location should not exceed a total of 30 hours per year or 30 minutes per day and are currently under review. The DoHPLG released the 'Draft Revised Wind Energy Development Guidelines' in December 2019 which have been released for public consultation. The Draft 2019 guidelines recommend local planning authorities and/or An Bord Pleanála impose conditions to ensure that:

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

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

The assessment herein is based on compliance with the 2006 guidelines. However, it should also be noted the Cleanrath wind farm development can be brought in line with the requirements of the 2019 draft guidelines through the implementation of the mitigation measures outlined in Section 5.9.3.4.

5.7.3 Scoping

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

5.7.4 Shadow Flicker Prediction Methodology

Shadow flicker occurs only under certain, combined circumstances, as detailed above. Where shadow flicker does occur, it is generally short-lived. The DoHPLG guidelines state that careful site selection, design and planning, and good use of relevant software can help avoid the possibility of shadow flicker, all of which have been employed at the Cleanrath Wind Farm 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 or Wind Pro. The computer modelling of the occurrence and magnitude of shadow flicker is made possible by the fact that the sun rises and sets in the same position in the sky on every day each year.

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

For the purposes of this shadow flicker assessment, the software package WindPRO Version 3.3.289 has been used to predict the level of shadow flicker associated with the Cleanrath Wind Farm Development. WindPRO is a commercially available software tool that enables developers to analyse, design and optimise wind farms. It allows turbine layouts to be optimised for maximum energy yield whilst taking account of environmental, planning and engineering constraints.

5.7.5 Shadow Flicker Assessment Criteria

5.7.5.1 Turbine Dimensions

Substitute Consent is being sought for 9 turbines with a turbine size envelope comprising a tip height of up to 150 metres above ground level. This assessment has been completed using the installed turbine rotor diameter of 117m and a hub height of 91m and was modelled in order to assess the impacts from shadow flicker.

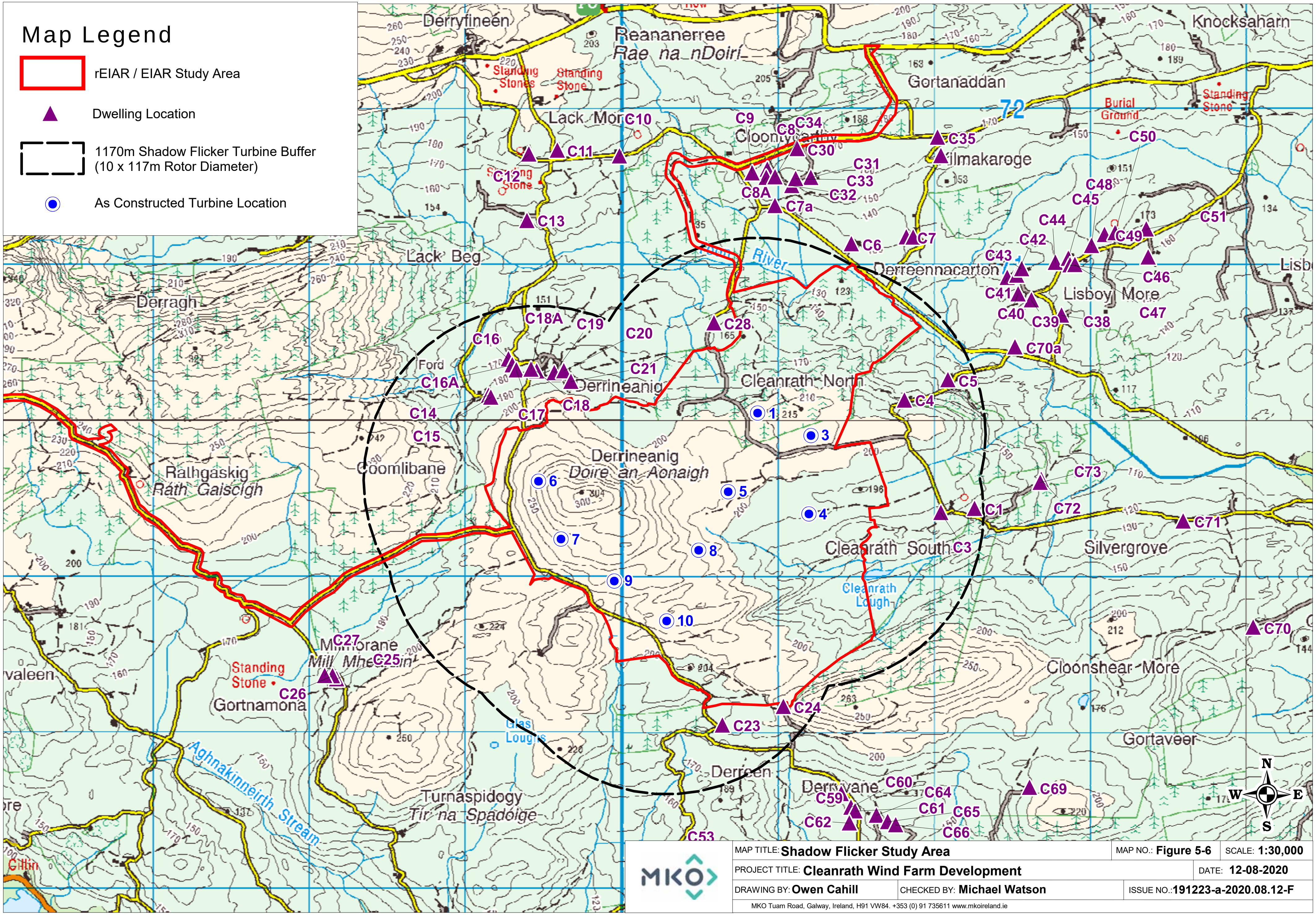
The potential shadow flicker impact Cleanrath wind farm development will give rise to will be no more than that predicted in this assessment. With the benefit of the mitigation measures outlined in section 5.9.3.4, all turbines installed onsite will comply with the current adopted 2006 DoEHLG guidelines. Any references to the turbine dimensions in this shadow flicker assessment should be considered in the context of the above.

5.7.5.2 Study Area

At the outset of the project, during the constraints mapping process detailed in Chapter 3 of this rEIAR, all sensitive receptors within 2km of the development site boundary were identified and mapped. This included all occupied and unoccupied dwellings. In addition, a planning history search to identify properties that may have been granted planning permission, but not yet been constructed, was carried out. These properties were also added to the sensitive receptors' dataset.

The study area for the shadow flicker assessment is ten times rotor diameter from each turbine as set out in the Wind Energy Development Guidelines for Planning Authorities', DoEHLG, 2006. All residential properties located within ten rotor diameters which is 1.17 kilometres have been included in the assessment. The closest residential property is located 613 metres from the nearest turbine location therefore a 4 times turbine tip height setback distance of 600m from each turbine to occupied dwellings. This a measure outlined in the 2019 Draft Revised Guidelines and has been achieved should these guidelines come into force while the Cleanrath wind farm development is in the planning system.

There is a total of 18 no. sensitive receptors located within 10 rotor diameters (1.17km) of the installed turbine locations. The shadow flicker study area and sensitive receptor locations are shown in Figure 5-6



MAP TITLE: **Shadow Flicker Study Area**

MAP NO.: **Figure 5-6**

SCALE: **1:30,000**

PROJECT TITLE: **Cleanrath Wind Farm Development**

DATE: **12-08-2020**

DRAWING BY: **Owen Cahill**

CHECKED BY: **Michael Watson**

ISSUE NO.: **191223-a-2020.08.12-F**

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5.7.5.3 Assumptions and Limitations

Due to the latitude of Ireland and the UK, shadow flicker impacts are only possible at properties 130 degrees either side of north as turbines do not cast shadows on their southern side (ODPM Annual Report and Accounts 2004: Housing, Planning, Local Government and the Regions Committee; Planning Policy Statement 22; Draft Revised Wind Energy Development Guidelines 2019). As such properties located outside of this potential shadow flicker zone will not be impacted. However, in this assessment, all 18 no. properties within 360 degrees of the Cleanrath wind farm development out to 1.17km were assessed for shadow flicker impact.

The shadow flicker analysis software was run in “Greenhouse Mode”. In this mode, the software places a notional receptor window at each property perpendicular to every turbine in order to create a worst-case scenario for shadow flicker.

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.
- Each turbine rotor is modelled perpendicular to each individual sensitivity receptor, to maximise the turbines aspect at each window and consequentially the potential instance for shadow flicker. 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 topographical information used in the model is limited to elevation changes and does not factor in the potential cover provided by vegetation and man-made structures.

The total annual shadow flicker calculated for each property assumes 100% sunshine during daytime hours, as referred to above. However, Met Éireann weather data for this region, recorded at Cork Airport, Co. Cork over the 30-year period from 1981 to 2010, shows that the mean regional daily sunshine duration over this 30 year period ranges from 1.7 to 6.2 hours, depending on the month. The greatest recorded regional daily sunshine duration, meanwhile, ranges from 7.6 to 16.0 hours, again depending on monthly variability(www.met.ie). Based on this data, it is a reasonable assertion to say that the sun shines for roughly 32.5% of daylight hours.

The actual sunshine hours at the development site and therefore the percentage of time shadow flicker could actually occur is significantly lower than the modelled 'worst-case impact'. WindPRO uses this worst-case impact information to create a 'real case model', which accurately calculates shadow flicker, taking into consideration forecasted turbine operational hours, wind directions and consequential turbine orientations, as well as monthly sunshine probabilities Localised cover from vegetation and man-made structures are not factored into this 'real case model' and therefore, in some instances, the calculated shadow flicker hours could theoretically be reduced further in real life on the ground.

Table 5-9 below lists the annual shadow flicker calculated for each property, outlining results for both the maximum 'worst-case' scenario and the expected 'real-case' scenario, as well as detailing whether a shadow flicker mitigation strategy is required for any property within 1.17km of the installed wind turbines.

5.7.6 Shadow Flicker Assessment Results

5.7.6.1 Daily and Annual Shadow Flicker

The WindPRO 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 there is a window facing each turbine,
- 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.

The predicted shadow flicker occurrence has been calculated and is presented in Table 5-9 for the full operational phase. This is the 'worst case' scenario in terms of the operational phases of this project including the current 'Sleep Mode' phase. During 'Sleep Mode' the turbines are allowed turn and face the wind and so a precautionary approach has been adopted to the assessment which assumes that the turbines are currently operating in full operational mode for the purposes of shadow flicker assessment.

As previously stated, the closest occupied dwelling is approximately 610m from any of the constructed turbine locations. This assessment has been completed using a shadow flicker study zone of 1.17km (10 turbine rotor diameters) from the installed turbine locations and all dwellings within this zone (totalling 18) were assessed for any potential shadow flicker impacts from the turbine locations.

The 18 No. buildings have been modelled as part of the shadow flicker assessment, the results of which are presented in Table 5-9.

During the operational phase, of the 18 No. residential properties modelled; it is predicted that 16 properties may experience daily shadow flicker. Based on the 2006 DoEHLG guidelines, the daily threshold for shadow flicker is exceeded at these 14 properties, however, the annual threshold for shadow flicker, once the regional sunshine average factor has been considered, is not exceeded at any property.

Additionally, it is worth nothing that the predicted shadow flicker listed in Table 5-9 is considered conservative and in reality, the occurrence and/or duration of shadow flicker at these properties is likely to be eliminated or significantly reduced as the following items are not considered by the model:

- Receivers may be screened by topography, cloud cover and/or vegetation/built form i.e. adjacent buildings, farm buildings, garages or barns;
- Each receiver will not have windows facing in all directions onto the wind farm.

The operators of the Cleanrath wind farm development have completed an assessment of the properties that were predicted to potentially exceed the daily shadow flicker threshold to determine whether either or both of the factors outlined above relate to any of the properties and therefore eliminate or reduce any shadow flicker below the acceptable threshold. The assessment found that of the 14 properties predicted to exceed the daily threshold for shadow flicker, 7 properties had a clear line of sight between the turbine and the relevant section of the dwelling with no obstruction and therefore may require the mitigation strategy to be implemented with 3 of these properties directly involved in the Cleanrath Wind Farm Development. The predicted shadow flicker at these 7 properties is presented in Table 5-10.

The prediction model will still require verification on resumption of operation due to the limitations of the computer modelling as outlined above in Section 5.7.5.3. Where an exceedance of the daily threshold is experienced, the appropriate mitigation will be implemented, so as to ensure that the relevant guidance limits are not exceeded.

Section 5.9.3.4 below outlines the mitigation strategies which may be employed at the potentially affected properties to ensure that the current adopted 2006 DoEHLG guidelines are complied with at any dwelling within the 1.17km study area. The same mitigation strategies, outlined in Section 5.9.3.4, could be taken further to achieve stricter shadow flicker controls, should the shadow flicker requirements of the Draft Revised Wind Energy Development Guidelines (2019) be adopted, as currently proposed, while this application is in the planning system.

Table 5-9 Maximum Potential Daily & Annual Shadow Flicker – Cleanrath wind farm development –Operational Phase including the periods of Short-term Operation and Sleep Mode

House No.	Irish Grid (Easting)	Irish Grid (Northing)	Distance to Nearest Turbine (metres)	Nearest Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	32.5% Average Regional Sunshine applied	Turbine(s) Giving Rise to any potential Shadow Flicker impact	Mitigation Strategy Required
C1	122262	69438	1063	T13	00:26	29:33:00	9:36:14	T13, T14	No
C3	122046	69412	846	T13	00:32	41:35:00	13:30:52	T13, T14	Yes
C4	121812	70132	637	T14	00:50	42:20:00	13:45:30	T14, T15	Yes
C5	122091	70263	945	T14	00:29	13:26	4:21:57	T14	No
C14	119146	70163	631	T7	00:44	59:33:00	19:21:14	T7, T8	Yes
C15	119160	70151	613	T7	00:45	61:33:00	20:00:13	T7, T8	Yes
C16	119273	70396	799	T7	00:36	29:19:00	9:31:40	T7	Yes
C16A	119298	70358	757	T7	00:38	33:46:00	10:58:27	T7	Yes
C17	119324	70326	720	T7	00:40	37:26:00	12:09:57	T7	Yes
C18	119454	70319	710	T7	00:41	35:04:00	11:23:48	T7	Yes
C18A	119418	70330	700	T7	00:40	33:53:00	11:00:44	T7	Yes
C19	119567	70308	695	T7	00:41	36:32:00	11:52:24	T7	Yes
C20	119628	70320	718	T7	00:40	36:23:00	11:49:29	T7	Yes

House No.	Irish Grid (Easting)	Irish Grid (Northing)	Distance to Nearest Turbine (metres)	Nearest Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	32.5% Average Regional Sunshine applied	Turbine(s) Giving Rise to any potential Shadow Flicker impact	Mitigation Strategy Required
C21	119674	70252	665	T7	00:43	49:01:00	15:55:49	T7	Yes
C21a	119674	70252	665	T7	00:43	49:01:00	15:55:49	T7	Yes
C23	120645	68050	764	T10	00:00	00:00	0:00:00	-	No
C24	121036	68169	932	T10	00:15	04:13	1:22:14	T10	No
C28	120591	70627	635	T15	01:13	84:40:00	27:31:00	T14, T15	Yes

Table 5-10 Maximum Potential Daily & Annual Shadow Flicker for the properties which have a clear line of sight to a turbine

House No.	Irish Grid (Easting)	Irish Grid (Northing)	Distance to Nearest Turbine (metres)	Nearest Turbine No.	Max. Daily Shadow Flicker: Pre-Mitigation (hrs:min:sec)	Max. Annual Shadow Flicker: Pre-Mitigation (hrs:min:sec)	32.5% Average Regional Sunshine applied	Turbine(s) Giving Rise to any potential Shadow Flicker impact	Mitigation Strategy Required
C4	121812	70132	637	T14	00:50	42:20:00	13:45:30	T14, T15	Yes
C16	119273	70396	799	T7	00:36	29:19:00	9:31:40	T7	Yes
C16A	119298	70358	757	T7	00:38	33:46:00	10:58:27	T7	Yes
C18	119454	70319	710	T7	00:41	35:04:00	11:23:48	T7	Yes
C18A	119418	70330	700	T7	00:40	33:53:00	11:00:44	T7	Yes
C19	119567	70308	695	T7	00:41	36:32:00	11:52:24	T7	Yes
C20	119628	70320	718	T7	00:40	36:23:00	11:49:29	T7	Yes

5.7.6.2 Cumulative Shadow Flicker

For the assessment of cumulative shadow flicker, any other existing, permitted or proposed wind farms are considered where they are located within 10 rotors of the shadow flicker study area. In this case, the closest wind farm is the Derragh Wind Farm located 2km west of the site. At this distance, there is no potential for shadow flicker in combination with the Cleanrath wind farm development and therefore no cumulative shadow flicker assessment is required.

5.8 Residential Amenity

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

The Cleanrath wind farm development is spread across forested, peatland and agricultural areas with agricultural practices and clear-felling on-going in some localised areas, therefore a certain level of industrial activity and traffic movements are associated with the site, which has assisted in the assimilation of the Cleanrath wind farm development into the receiving environment. The closest occupied residential property is approximately 613m from any turbines constructed as part of the Cleanrath Wind Farm Development.

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

5.9 Likely Significant Impacts and Associated Mitigation Measures

5.9.1 'Do-Nothing' Scenario

An alternative to developing the Cleanrath wind farm development would have been to leave the site as it was prior to construction, with no changes made to the land-use practices of low-intensity agriculture, turf cutting and commercial forestry. This option would have no positive impact with regards to the production of renewable energy or the offsetting of greenhouse gas emissions. On the basis of the positive environmental effects arising from the Cleanrath Wind Farm Development, the do–nothing scenario was not the chosen option. Instead, an application for planning permission was made and granted ultimately by An Bord Pleanála.

The Cleanrath wind farm development has been constructed, has been operational and is now in Sleep Mode with the site essentially in a shut-down mode with no export of electricity pending the outcome of the Substitute Consent process. In the event that Substitute Consent is obtained, the intention is to recommence and continue the full operation of the Cleanrath wind farm development until the end of

25 years from the formal commissioning of the turbines in July 2020 and implement the decommissioning plan for the Cleanrath wind farm development at the end of the operational period.

In the event that Substitute Consent is not granted and full operation of the development is not recommenced, it will remain in Sleep Mode which is, in effect, the "do nothing" option insofar as it represents the current situation as at the date of the application for Substitute Consent. There is the possibility that the decommissioning plan may need to be implemented early, should Substitute Consent not be granted and therefore this is also assessed in this rEIAR and below.

In general, the opportunity to generate local employment and investment would be lost should the project not proceed, and the local economy would continue to rely primarily on agriculture and commercial forestry 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 Cleanrath wind farm development involved the provision of a construction site. Construction sites and the machinery used on such sites pose a potential health and safety hazard to construction workers if site rules are not properly implemented.

Mitigation Measures

The Cleanrath wind farm development was constructed, 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 site induction in the construction phase of the Cleanrath Wind Farm Development, all staff were made aware of their responsibility to 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 included the use of all necessary Personal Protective Equipment, Risk Assessment and Method Statements and adherence to the site Health and Safety Plan.

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

Residual Impact

With the implementation of the above, there was a short-term potential slight negative residual impact on health and safety during the construction phase of the Cleanrath Wind Farm Development.

Significance of Effects

Based on the assessment above there was no significant direct and indirect effects on health and safety during the construction phase of the Cleanrath Wind Farm Development.

5.9.2.2 Employment and Investment

The design and construction of the wind farm provided employment for technical consultants, contractors and maintenance staff. Up to approximately 80 jobs were created during the various phases of construction of the Cleanrath Wind Farm Development. The construction phase lasted for approximately 16 months. Many construction workers and materials were sourced locally, thereby helping to sustain employment in the construction trade. This had a short-term significant positive impact.

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

The Cleanrath wind farm development resulted in an influx of skilled people into the area, bringing specialist skills for the construction phase that resulted in the transfer of these skills into the local workforce, thereby having a long-term positive impact on the local skills base. Up-skilling and training of local staff in the particular requirements of the wind energy industry is likely to lead to additional opportunities for those staff as additional wind farms are constructed in Ireland. This had a long-term moderate positive indirect impact. According to the Irish Wind Energy Association there are over 4,400 jobs related to wind energy in Ireland in 2019, a figure which is projected to grow to over 8,000 by 2020.

Rates payments for the Cleanrath wind farm development have been paid to Cork County Council which will contribute significant funds that will be redirected to the provision of public services within Co. Cork. 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.

Community Benefit Scheme

The applicant company has given careful consideration to the issue of community gain arising from the Cleanrath wind farm development if consent is granted. Community gain from significant development proposals, including wind farms, whilst a relatively recent approach, is now a common consideration for developers and, indeed, planning authorities. This approach recognises that, with any significant wind farm proposal, the locality in which the site is situated is making a significant contribution towards helping achieve national renewable energy and climate change targets, and the local community should derive some benefit from accommodating such a development in their locality.

Community gain proposals can take a number of forms, generally depending on the nature and location of the Cleanrath wind farm development and the nature and make-up of the local community. In some instances, funds are paid by the developer, either annually or as a one-off payment, to a community fund that is administered by a voluntary committee. These funds may then be used for a variety of projects, such as environmental improvements, local amenities and facilities, voluntary and sporting groups and clubs, educational projects and energy efficiency improvement works.

The community gain proposal for the Cleanrath wind farm development is to contribute to a Community Gain Fund to support local environmental improvements and recreational, social or community amenities and initiatives in the locality of the project. This will require the establishment of a Community Gain Committee.

The community benefit scheme is to be funded as follows:

- An initial contribution of €150,000 has been made available to the local community. The project has been constructed and did operate for a short period and over €100,000 in funds have already been distributed to the community.
- The annual contribution to the community is estimated at c€30,000 each year for the lifetime of the project, when it is in full operational mode.

The number and size of grant allocations will be decided by a Community Fund liaison committee with various groups and project benefiting to varying degrees depending on their funding requirement.

Overall, it is concluded that the socio-economic impacts of the Cleanrath wind farm development will be beneficial on a local, regional and national level.

5.9.2.3 Population

Those that worked on the construction phase of the Cleanrath wind farm development will have travelled daily to the site from the wider area. The construction phase had no impact on the population of the area in terms of changes to population trends or density, household size or age structure.

5.9.2.4 Land-use

The existing land-use of agriculture, turf cutting and commercial forestry is continuing on the site with scheduled felling operations continuing in conjunction with the Cleanrath Wind Farm Development. The Cleanrath wind farm development is having no impact on existing land-uses as it has been designed to co-exist with these land-uses.

5.9.2.5 Tourism and Amenity

Given that there are currently no tourism attractions specifically pertaining to the site there was no impacts associated with the construction phase of the Cleanrath Wind Farm Development. With regard to tourist attractions and amenity use around the site, described in Section 5.4.2, traffic management safety measures were implemented. Please see Chapter 14 which assesses traffic impacts for further details on mitigation measures adopted.

5.9.2.6 Noise

Pre-Mitigation Impacts

There was an increase in noise levels in the vicinity of the Cleanrath wind farm development site during the construction phase, as a result of heavy machinery and construction work which had the potential to cause a nuisance to sensitive receptors located closest the Cleanrath wind farm development site. These impacts were short-term in duration. The noisiest construction activities associated with Cleanrath wind farm development was rock breaking, excavation and pouring of the turbine bases. Excavation of a base varied depending on the presence of rock that required extraction which on average was completed over ten days and the main concrete pours were conducted in one continuous pour. Concrete pours were completed within a matter of hours to a maximum of 12 hours for an individual pour.

Construction noise at any given noise sensitive location was variable throughout the construction project, depending on the activities underway and the distance from the main construction activities to the receiving properties. The potential noise impacts that occurred during the construction phase of the Cleanrath wind farm development are further described in Chapter 11: Noise and Vibration.

Mitigation Measures

Best practice measures for noise control were adhered to onsite during the construction phase of the Cleanrath wind farm development in order to mitigate the slight short-term negative impact associated with this phase of the development. These measures included:

- No plant used on site was permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, was employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant were fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors were attenuated models fitted with properly lined and sealed acoustic covers which were kept closed whenever the machines were in use and all ancillary pneumatic tools were fitted with suitable silencers.
- Machinery that was used intermittently was shut down or throttled back to a minimum during periods when not in use.
- During the course of the construction programme, supervision of the works included ensuring compliance with the limits detailed in Chapter 11 using methods outlined in British Standard BS 5228-1:2014+A1:2019 Code of practice for noise and vibration control on construction and open sites – Noise.
- The hours of construction activity were limited to avoid unsociable hours where possible. Construction operations were generally restricted to between 7:00hrs and 19:00hrs Monday to Saturday.

Residual Impact

Following the implementation of the above mitigation measures, there was a short-term imperceptible negative residual impact due to an increase in noise levels during the construction phase of the Cleanrath Wind Farm Development.

Significance of Effects

It is concluded that there were no significant noise impacts associated with the construction phase of the Cleanrath wind farm development with further details outlined in Chapter 11 of this rEIAR.

5.9.2.7 Dust

Pre-Mitigation Impacts

Potential dust emission sources during the construction phase of the Cleanrath wind farm development included upgrading of existing access tracks and construction of new access roads and turbine foundations. An increase in dust emissions had 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 have resulted in the transfer of mud to the public road, particularly if the weather was wet and cause nuisance to residents and other road users. These impacts were not significant and were relatively short-term in duration. The potential dust impacts that occurred during the construction phase of the Cleanrath wind farm development are further described in Chapter 10: Air and Climate.

Mitigation Measures

All aggregate material for the construction of roads and turbine bases was sourced onsite and was only outsourced where necessary; thereby reducing the need to transport this material to the site. As the site had an already well established existing road network at the entry points to the site, truck wheel wash was not required during construction works. All plant and materials vehicles were stored in a dedicated compound area with larger plant located throughout the site away from the compound and area parked on levelled areas outside the watercourse buffers. Areas of excavation was kept to a minimum, and stockpiling was minimised by coordinating excavation, spreading and compaction. Construction traffic was restricted to defined routes and a speed limit implemented.

In periods of extended dry weather, dust suppression was necessary along haul roads within the site to ensure dust did not cause a nuisance. Where necessary, water was spread with 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 was not used for dust suppression, because this would transfer the pollutants to the haul roads and generate polluted runoff or more dust. Water bowser movements was carefully monitored to ensure that it did not lead to increased runoff.

Residual Impact

Following the implementation of the above mitigation measures, there was a short-term slight negative impact over a small geographic area around the works due to dust emissions from the construction of the Cleanrath Wind Farm Development.

Significance of Effects

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

5.9.2.8 Traffic

Pre-Mitigation Impacts

The construction phase of the Cleanrath wind farm development ran for approximately 16 months. Construction materials and turbines were delivered to the site of the Cleanrath wind farm development via the N22 National Route in Co. Cork. Both turbine and non-turbine construction traffic accessed the site via the above route. The turbine delivery and construction traffic route is shown in Figure 4-6 in Chapter 4 of this rEIAR.

Non-turbine construction traffic comprised of Heavy Goods Vehicle (HGV) and Light Goods Vehicle (LGV) movements involved in the delivery of construction materials to the site and the export of excess construction materials and plant from the site. A complete Traffic and Transportation Assessment (TTA) of the Cleanrath wind farm development has been carried out by Alan Lipscombe Traffic and Transport Consultants. The full results of the TTA are presented in Section 14.1 of Chapter 14: Material Assets.

This had the potential to lead to a temporary slight to moderate negative impact on existing road users

Mitigation Measures

The types of vehicles that were used to negotiate the local network represented abnormal size loads and a detailed assessment of the geometry of the route was therefore undertaken. A Traffic Management Plan was developed and implemented to ensure any impact was short term in duration and slight in significance during the construction of the Cleanrath wind farm development and is included as part of the Construction and Environmental Management Plan in Appendix 4-4. Prior to commencement of any works, the occupants of dwellings in the vicinity of the works were contacted and the scheduling of works outlined to each resident. Local access to properties was maintained throughout any construction works and local residents were supplied with the number of the works supervisor in order to ensure that disruption was kept to a minimum. In relation to the cable laying works, the works area in any one day was approximately 300m in length. This consisted of two crews at separate locations along the cable route working within an area of 150m in length and so the potential for significant disruption was limited.

Aggregate materials for the construction of any additional site tracks and hardstanding areas was won on site. This significantly reduced the number of delivery vehicles required to access the site. The Traffic Management Plan implemented during the construction phase (Appendix 4-4).

Residual Impact

Once the mitigation measures were implemented for the construction phase of the Cleanrath Wind Farm Development, there was a short-term imperceptible negative residual impact on local road users.

Significance of Effects

Based on the assessment above there was 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. Therefore, there are no shadow flicker impacts associated with the construction phase of the Cleanrath Wind Farm Development.

5.9.3 Operational Phase

The effects set out below relate to the operational phase of the Cleanrath wind farm development should Substitute Consent be granted. This includes the previous period of short-term operation and the current period of Sleep Mode and also assesses the future operation.

5.9.3.1 Health and Safety

During the operational phase there will be ongoing maintenance of the wind turbines and associated infrastructure. Access to the turbines is through a door at the base of the structure, which will be locked at all times outside maintenance visits. ESB Networks retains the rights to access the grid connection cables as part of their routine infrastructure inspections.

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.

Pre-Mitigation Impact

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

The DoEHLG Guidelines state that there is a very remote possibility of injury to people from flying fragments of ice or from a damaged blade. However, most blades are composite structures with no bolts or separate components and the danger is therefore minimised. The build-up of ice on turbines is unlikely to present problems. The wind turbines are 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 epoxy resin saturated glass fibre layers with balsa wood, PET foam and carbon fibre reinforcement, which will prevent any likelihood of an increase in lightning strikes within the site of the Cleanrath wind farm development or the local area. Lightning protection systems are integral to the construction of the turbines. "The lightning and overvoltage protection of the wind turbine is based on the lightning protection zone concept and meets the EN 61400-24 standard. The lightning protection system meets the requirements of lightning protection class I." Lightning conduction cables, encased in protection conduits, follow the electrical cable run, from the nacelle to the base of the turbine. The conduction cables are earthed adjacent to the turbine base. The earthing system is installed during the construction of the turbine foundations. There will be no impact on health and safety.

It is not anticipated that the operation of the Cleanrath wind farm development will present a danger to the public and livestock. Rigorous safety checks will be conducted on the turbines, grid and ancillary infrastructure during the operation to ensure the risks posed to staff, landowners and general public are negligible.

Mitigation Measures

Notwithstanding the above, the following mitigation measures have been implemented for the operation of the Cleanrath wind farm development to ensure that the risks posed to staff and landowners remain negligible throughout the operational life of the wind farm.

The site will be operated under the Wind Turbine Safety Rules 3rd Edition 2015.

Signs have been erected at suitable locations across the site as required for the safe of operation of the Cleanrath Wind Farm 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;
- "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 has been developed and will continue to be implemented to fully address identified Health and Safety issues associated with the operation of the site and providing for access for emergency services at all times. This is included as part of the Operation and Environmental Management Plan in Appendix 4-8 of this rEIAR

The components of a wind turbine are designed to last up to 25 years and are equipped with a number of safety devices to ensure safe operation during their lifetime. During the operation of the wind farm regular maintenance of the turbines will be carried out by the turbine manufacturer or appointed service company. A project or task specific Health and Safety Plan has been developed for these works in accordance with the site's health and safety requirements.

Residual Impact

With the implementation of the above mitigation measures, there will be a long-term, imperceptible residual impact on health and safety during the operational life of the Cleanrath Wind Farm Development.

Significance of Effects

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

5.9.3.2 Employment and Investment

The operational phase presents an opportunity for mechanical-electrical contractors and craftspeople to become involved with the maintenance and operation of the wind farm. On a long-term scale, the Cleanrath wind farm development has created approximately 3 jobs which will continue during the operational phase relating to the maintenance and control of the Cleanrath wind farm development should Substitute Consent be granted. This is a long-term slight positive effect.

5.9.3.3 Tourism

Pre-Mitigation Impacts

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

5.9.3.4 Shadow Flicker

Pre-Mitigation Impacts

Assuming worst-case conditions, a total of 14 properties may experience daily shadow flicker in excess of the DoEHLG guideline threshold of 30 minutes per day. The DoEHLG total annual guideline limit of 30 hours is not exceeded at any property once the regional sunshine average of 32.5% is considered.

Mitigation Measures

As outlined in Section 5.7.6 above, an assessment has already been completed for each property predicted to exceed the daily threshold for shadow. The number of properties predicted to exceed the threshold has been reduced as the assessment confirmed the presence of screening from vegetation or the absence of a window directly facing the turbine predicted model to potentially cause shadow flicker. Where, on the resumption of operations, daily or annual shadow flicker is found to have exceeded the threshold at any property through the verification at the property of the predicted model (as detailed below) then the mitigation as set out below will be implemented as appropriate.

Screening Measures

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

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

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

Wind Turbine Control Measures

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

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

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

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

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

At the end of the first full year of full operation, the operation logs will be monitored to ensure that the controls are working and a report will be provided to the Planning Authority.

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

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

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

This mitigation can be utilised at the site of the Cleanrath wind farm development to prevent incidences of shadow flicker values at any house. Therefore, the Cleanrath wind farm development could be brought in line with the requirements of the Draft Revised Wind Energy Development Guidelines 2019 should they come into force during the planning application process for this development. As these guidelines are still currently in draft form, there is the potential for the requirements to be amended. The wind farm control measures outlined above have the flexibility to ensure that any future operational phase for the Cleanrath wind farm development will adhere to the shadow flicker condition if consent is granted. A report will be submitted to, and agreed in writing with, the planning authority within 12 months of resumption of operations at the Cleanrath Wind Farm Development.

No complaints were received with regards shadow flicker during the short-term operational period and to date in the current Sleep Mode up to the date of submission of this Substitute Consent application although discussions have been held between the Community Liaison Officer (CLO) and a number of residents regarding noise and shadow flicker .The CLO will continue to engage with these residents to provide information on the current status of the site and the potential resumption of operations. Where an exceedance of any thresholds has been determined, the appropriate control and mitigation measures as outlined above will be actioned.

Residual Impact

Assuming worst-case conditions, a total of 14 residential properties may experience daily shadow flicker in excess of the current DoEHLG guideline threshold of 30 minutes per day. Shadow flicker could potentially have a long-term imperceptible negative residual impact. However, as the applicant has committed to and is currently implementing a curtailment strategy for all turbines that cause an exceedance in the existing daily and annual shadow flicker limits at residential properties up to a distance of 10 rotor diameters from the Cleanrath Wind Farm Development, there will be no significant impact from shadow flicker on human beings.

Significance of Effects

Based on the assessment and the mitigation measures above 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 Cleanrath Wind Farm Development. Full details are provided in of Chapter 2: Background to the Cleanrath wind farm development and Section 14.2 (Telecommunications and Aviation) of Chapter 14: Material Assets. Copies of the scoping responses received are presented in Appendix 2-3 of this rEIAR.

The turbines have been constructed and there have been no impacts on communications systems.

Responses were received from Eir, RTE Transmission Network Ltd. and Three Ireland and confirmed that they have no telecoms links within the area of the Cleanrath Wind Farm Development. Further detail on the actions taken to ameliorate any potential interference, including micro-siting of turbines can be found in Chapter 2 and Chapter 14. As the Cleanrath wind farm development design and turbine layout do not overlap with any of the telecoms links or clearance zones requested by operators, the Cleanrath wind farm development will have no impact on telecommunications.

5.9.3.6 Residential Amenity

Pre-Mitigation Impacts

Potential impacts on residential amenity during the operational phase of the Cleanrath wind farm development could arise primarily due to noise and vibration, dust traffic, shadow flicker or changes to visual amenity. Detailed noise and shadow flicker modelling have been carried out as part of this rEIAR, which shows that the Cleanrath wind farm development will be capable of meeting all required guidelines in relation to noise thresholds (Chapter 11) and the shadow flicker thresholds set out in the Wind Energy Guidelines (DoEHLG 2006).

The visual impact of the Cleanrath wind farm development is addressed comprehensively in Chapter 13: Landscape and Visual. The Cleanrath wind farm development has been designed to maximise turbine separation distances to dwellings in the area, with no turbines located within 600 metres (4 x turbine tip height) of an occupied dwelling. Given the separation distance of the residential properties from the installed turbines, and the level of existing screening in the area, the Cleanrath wind farm development will have no significant impact on existing visual amenity at dwellings.

Mitigation Measures

There are no turbines located within 600 metres of any property. All mitigation as outlined under noise and vibration, dust, traffic, visual amenity and shadow flicker in this rEIAR will be implemented in order to reduce insofar as possible impacts on residential amenity at properties located in the vicinity of the Cleanrath wind farm development works, including along the turbine and construction materials haul route.

Residual Impact

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

Significance of Effects

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

5.9.4 Decommissioning Phase (Early)

The wind turbines which form part of the Cleanrath wind farm development are expected to have a lifespan of approximately 25 years and remain on site for that period of time pending the outcome of the Substitute Consent process. However, should the development not be consented, there is the possibility that an early decommissioning phase will be implemented and so this option has been assessed.

The works required during either an early decommissioning phase or decommissioning after the end of the useful lifetime of the wind farm do not differ and are described in Chapter 4: Description of the Cleanrath Wind Farm Development. The potential effects do however differ. The early decommissioning of the project would result in a renewable energy facility not being provided at this location and the Cleanrath wind farm development being decommissioned and therefore diminish the capability of achieving the current national target of generating 70% of the State's electricity from renewable sources by 2030.

In order to make up the potential short fall in renewable energy generation, the early decommissioning of the Cleanrath wind farm development would ultimately lead to the potential for an alternative site being identified and developed with further potential for environmental impacts by both decommissioning the Cleanrath wind farm development and developing an alternative site.

Should a new site not be available, early decommissioning would lead to the reduction in renewable energy being supplied to the national grid which is contrary to planning policy. Should Early Decommissioning occur, this would be a potentially long term slight negative effect. The Cleanrath wind farm development and building of its infrastructure has been shown to have had no significant environmental effects nor adverse impacts on Natura 2000 sites.

Upon decommissioning of the Cleanrath Wind Farm Development, the wind turbines would be disassembled in reverse order to how they were erected. All above ground turbine components would be separated and removed off-site for reuse or recycling. Turbine foundations would remain in place underground and would be covered with earth and reseeded as appropriate. Leaving the turbine foundations in-situ is considered a more environmentally prudent option, as to remove that volume of reinforced concrete from the ground could result in significant environment nuisances such as noise, dust and/or vibration.

The site access roadways will be used for access during the decommissioning as well as providing access to the lands of the Cleanrath Wind Farm Development. The removal of these has the potential to have significant environmental effects therefore it would be prudent from an environmental perspective that they are left in situ for future use after the early decommissioning of the Cleanrath Wind Farm Development. Underground cables, that are redundant, will be removed and the ducting left in place.

A Decommissioning Plan has been prepared (Appendix 4-9) which includes a Traffic Management Plan for an early decommissioning of the Cleanrath wind farm development the detail of which will be agreed with the local authority prior to any decommissioning

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

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

5.9.5 Decommissioning Phase (Post Operational Phase)

Prior to the end of the operational period the Decommissioning Plan (Appendix 4-9) will be updated in line with decommissioning methodologies that may exist at the time and will agreed with the competent authority at that time. That decommissioning plan will be as set out in Chapter 4 and summarised above and will include the disassembly of the turbines for removal offsite for reuse or recycling. Turbine foundations would remain in place underground and would be covered with earth and reseeded as appropriate. The site access roadways are highly likely to be required by the ongoing farming operations, and therefore it would be left in situ for future use. The 33kV electrical cabling connecting the Cleanrath wind farm development to the substation in the townland of Rathgaskig will be removed from the underground cable ducting at the end of the useful life of the Cleanrath Wind Farm Development. The 38kV grid connection cabling that continues from the Derragh Substation to the Coomataggart Substation may remain in place as it will be an ESB networks asset and will serve the exiting 38kV substation .

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

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

5.9.6 Cumulative Effects

For the assessment of cumulative impacts, 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.

The potential cumulative impact of the Cleanrath wind farm development (which includes the grid connection) and other relevant developments has been carried out with the purpose of identifying what influence the Cleanrath wind farm development will have on the surrounding environment when considered cumulatively and in combination with relevant approved, and existing projects in the vicinity of the site.

Further information on projects considered as part of the cumulative assessment are given in Chapter 2: Background to the Cleanrath Wind Farm Development. The impacts with the potential to have cumulative effects on human beings are discussed below and in more detail in the relevant chapters: noise (Chapter 11), visual impacts (Chapter 13) and traffic (Chapter 14).

5.9.6.1 Employment and Economic Activity

Wind farms within 20 kilometres of the Cleanrath wind farm development which may be proposed, permitted or operational contribute to short term employment during the construction stages and provide the potential for long-term employment resulting from maintenance operations. This results in a long-term significant positive impact.

Other projects as described in the cumulative assessment in Chapter 2 of this rEIAR also have the potential to provide employment in the short term.

5.9.6.2 Health and Safety

The Cleanrath wind farm development will have no impacts in terms of health and safety. There is no credible scientific evidence to link wind turbines with adverse health impacts. Therefore, cumulative impacts in relation to health & safety do not arise.

5.9.6.3 Property Values

The Cleanrath wind farm development will have no impact on property value. There is no statistical evidence that house prices near wind turbines are affected post or pre-construction periods after announcing development. Therefore, cumulative impacts in relation to property values do not arise.

5.9.6.4 Services

Potential cumulative impact through injection of money into local services arising from this project and other wind farm developments through short and long-term employment and a community benefit fund, is expected to be a long-term positive cumulative impact.

5.9.6.5 Shadow Flicker

As outlined in Section 5.7.6.2, there are no wind farm developments within the zone of influence of the Cleanrath turbines and therefore, there is no potential for shadow flicker from the Cleanrath wind farm development in combination with other wind farm developments.

5.9.6.6 Residential Amenity

Pre-Mitigation Impacts

Some of the permitted projects as described in the cumulative assessment in Chapter 2 were constructed at the same time as the Cleanrath wind farm development including the nearby Derragh Wind Farm. This resulted in short term, significant, cumulative, negative impact to occur on residential amenity, in relation to noise and vibration, dust, traffic, telecommunications and visual amenity.

Mitigation Measures

There are no turbines as part of the Cleanrath wind farm development that will be located within 613 metres of any occupied dwellings. All mitigation as outlined under noise and vibration, dust, traffic, visual amenity and telecommunications in this rEIAR was implemented in order to reduce insofar as possible impacts on residential amenity at properties located in the vicinity of the Cleanrath wind farm development works, including works along the turbine and construction materials haul route. It is assumed also that all mitigation measures in relation to the other cumulative projects were or will also be implemented.

Residual Impact

The Cleanrath wind farm development had a short-term, slight negative effect on residential amenity during construction works. During the operational phase cumulative noise from the Cleanrath wind farm development and the nearby Derragh Wind Farm will be below guideline levels, resulting in a long-term, imperceptible residual impact on residential amenity. Further details of the cumulative noise assessment is provided in Chapter 11.

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 impacts (post-mitigation) it is noted that the Cleanrath wind farm development has not and will not result in any significant effects on Population or Human Health in the area surrounding the Cleanrath wind farm development with regards shadow flicker. Even when assuming worst-case conditions (i.e. 100% sunshine on days where the shadow of the turbines passes over a house, wind blowing in the correct direction, no screening present, etc.) the annual guideline limit of 30 hours will not be exceeded at any property. Should any problems arise with shadow flicker at any inhabited dwelling, employment of suitable mitigation measures will ensure that there is no exceedance of the DoEHLG Wind Energy Guideline daily values at any of the properties.

The Cleanrath wind farm development has been constructed and operated in accordance with the design, best practice and mitigation that is described within this application and so significant effects on the receiving environment, tourism, population and human health associated with health and safety, noise, dust, traffic and shadow flicker, have not occurred and are not anticipated to occur in the continued 'Sleep Mode' or future full operational phase.