4 HUMAN BEINGS

4.1 Introduction

This section of the Environmental Impact Statement (EIS) assesses the likely significant effects of the proposed development on human beings and has been completed in accordance with the guidance set out by the Environmental Protection Agency in *'Guidelines on Information to be contained in Environmental Impact Statements'* (EPA, 2000). Further information on the classification of effects used in this assessment is presented in Section 1.6.2 of this EIS.

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

4.2 Receiving Environment

4.2.1 Methodology

Information regarding human beings and general socio-economic data were sourced from the Central Statistics Office (CSO), the Offaly County Development Plan 2014 – 2020, 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 most recent available census data (the Census of Ireland 2011; ahead of publication of the 2016 Census results), 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.

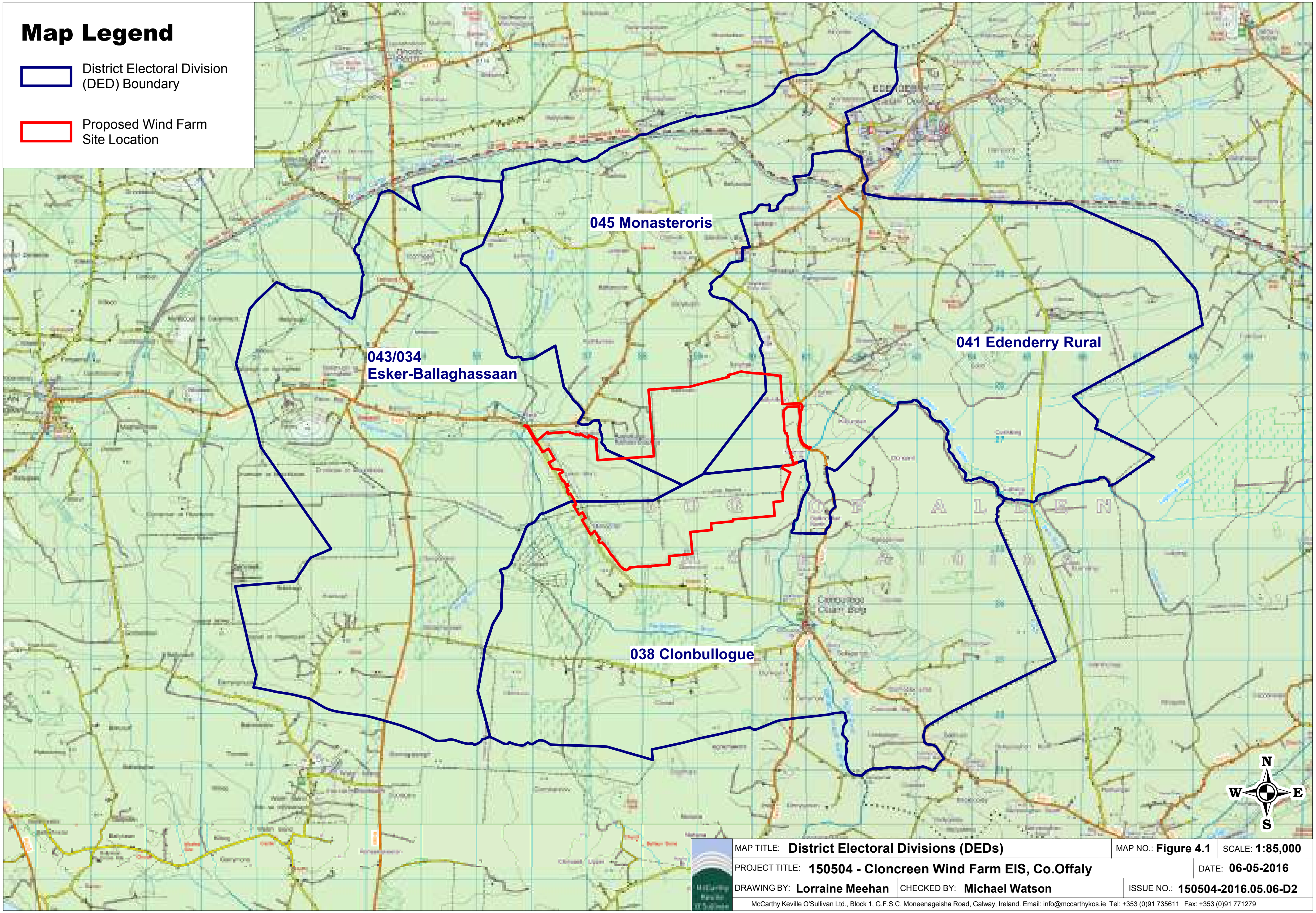
The site of the proposed development is located in the townlands of Cloncreen, Clongarret, Esker More, Rathvilla or Rathclonbracken, Ballinrath, Ballynakill, Ballykileen, Ballina, and Ballinagar, Co. Offaly. The site is located in eastern Co. Offaly, approximately 4.5 kilometres southwest of Edenderry. The villages of Clonbullogue and Rhode are located approximately 2.0 kilometres southeast and 7.0 kilometres northwest of the site, respectively.

In order to make inferences about the population and other statistics in the vicinity of the proposed development, the Study Area for the Human Beings section of this EIS was defined in terms of the District Electoral Divisions (DEDs). The site of the proposed development lies within the Monasteroris, Edenderry Rural, Clonbullogue and Esker/Ballaghassaan DEDs, as shown in Figure 4.1. The total combined DED area (Human Beings Study Area) has a population of 2,873 persons, and comprises of a total land area of 150.8 square kilometres. (Source: CSO Census of the Population 2011).

4.2.2 Population

4.2.2.1 Population Trends

In the four years between the 2006 and the 2011 Census, the population of Ireland increased by 8.2%. During this time, the population of Co. Offaly grew also by 8.2% to 76,687 persons. Other population statistics for the State, County and the Study Area



MAP TITLE: District Electoral Divisions (DEDs)
MAP NO.: Figure 4.1
SCALE: 1:85,000
PROJECT TITLE: 150504 - Cloncreen Wind Farm EIS, Co.Offaly
DATE: 06-05-2016
DRAWING BY: Lorraine Meehan
CHECKED BY: Michael Watson
ISSUE NO.: 150504-2016.05.06-D2

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279

(DEDs) have been obtained from the Central Statistics Office (CSO) and are presented in Table 4.1.

Table 4.1 Population 2006 – 2011 (Source: CSO)

Area	Population		% Population Change
	2006	2011	2006-2011
State	4,239,848	4,588,252	8.2%
Co. Offaly	70,868	76,687	8.2%
Study Area	2,504	2,873	14.7%

The data presented in Table 4.1 shows that the population of the Study Area increased by 14.7% between 2006 and 2011. This rate of population growth is higher than that recorded at State and County level from 2006 – 2011. When the population data is examined in closer detail, it shows that the rate of population change within the Study Area has been unevenly divided between the District Electoral Divisions (DEDs). The highest rate of population increase between 2006 and 2011 occurred within Monasteroris DED, which experienced a 23.1% population increase. In comparison, the population of Clonbullogue DED increased by just 5.1% during the same time period.

Of the four DEDs that make up the Study Area for this assessment (Human Beings Study Area), the highest population was recorded in Edenderry Rural DED, with 856 persons recorded during the 2011 Census, while Esker-Ballaghassaan DED had just 441 persons recorded during the 2011 Census.

4.2.2.2 Population Density

The population densities recorded within the State, Co. Offaly and the Study Area during the 2011 Census are shown in Table 4.2.

Table 4.2 Population Density in 2011 (Source: CSO)

Area	Population Density (Persons per square kilometre)
State	67.0
Co. Offaly	38.48
Study Area	19.05

The population density of the Study Area recorded during the 2011 Census was 19.05 persons per square kilometre. This figure is significantly lower than the national population density of 67 persons per square kilometre and the county population density of 38.48 persons per square kilometre.

Similar to the trends observed in population, the population density recorded across the Study Area varies between DEDs. Esker-Ballaghassaan DED has the lowest population density, at 10.48 persons per square kilometre, while Monasteroris DED has the highest population density, at 29.53 persons per square kilometre.

4.2.2.3 Household Statistics

The number of households and average household size recorded within the State, Co. Offaly and the Study Area during the 2006 and 2011 Censuses are shown in Table 4.3.

Table 4.3 Number of Households and Average Household Size 2002 – 2011 (Source: CSO)

Area	2006		2011	
	No. of Households	Avg. Size (persons)	No. of Households	Avg. Size (persons)
State	1,469,521	2.9	1,654,208	2.8
Co. Offaly	23,769	3.0	27,130	2.8
Study Area	359	3.1	405	2.9

In general, the figures in Table 4.3 show that while the number of households at State, County and Study Area level has continued to increase, the average number of people per household has decreased slightly, i.e. there are more households but less people per house. Average household size recorded within the Study Area during the 2006 and 2011 Censuses are in line with that observed at State and County level during the same time periods.

4.2.2.4 Age Structure

Table 4.4 presents the percentages of the State, Co. Offaly and Study Area population within different age groups as defined by the Central Statistics Office during the 2011 Census. This data is also displayed in Figure 4.2.

Table 4.4 Population per Age Category in 2011 (Source: CSO)

Area	Age Category				
	0 - 14	15 – 24	25 - 44	45 - 64	65 +
State	21.3%	12.6%	31.6%	22.7%	11.7%
Co. Offaly	23.4%	12.3%	29.6%	23.1%	11.6%
Study Area	24.4%	10.9%	28.6%	24.9%	11.1%

The proportion of the Study Area population within each age category is similar to those recorded at national and County level for most categories. Within the Study Area, the highest population percentage occurs within the 25-44 age category.

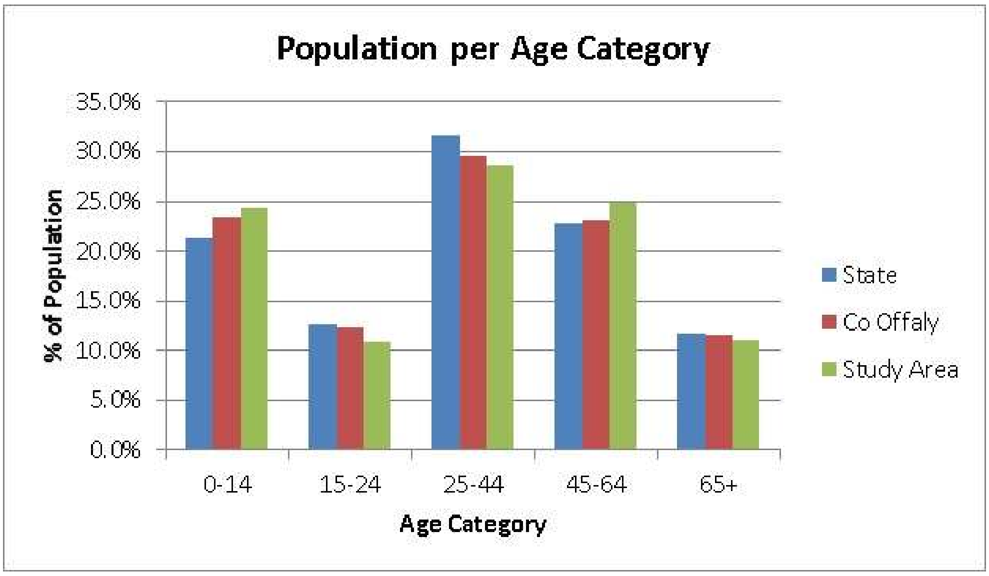


Figure 4.2 Population per Age Category in 2011 (Source: CSO)

4.2.3 Employment and Economic Activity

4.2.3.1 Economic Status of the Study Area

The labour force consists of those who are able to work, i.e. those who are aged 15+, out of full-time education and not performing duties that prevent them from working. In 2011, there were 2,232,203 persons in the labor force in Ireland. Table 4.5 shows the percentage of the total population aged 15+ who were in the labour force during the 2011 Census. This figure is further broken down into the percentages that were at work, seeking first time employment or unemployed. It also shows the percentage of the total population aged 15+ who were *not* in the labor force, i.e. those who were students, retired, unable to work or performing home duties.

Table 4.5 Economic Status of the Total Population Aged 15+ in 2011 (Source: CSO)

Status		State	Co. Offaly	Study Area
% of population aged 15+ who are in the labor force		**61.9%**	**61.0%**	**59.6%**
% of which are:	At work	81.0%	76.8%	80.1%
	First time job seeker	1.5%	1.7%	1.6%
	Unemployed	17.5%	21.5%	18.3%
% of population aged 15+ who are not in the labour force		**38.1%**	**39.0%**	**40.4%**
% of which are:	Student	29.7%	25.9%	23.5%
	Home duties	24.7%	28.9%	34.6%
	Retired	33.2%	31.8%	31.3%
	Unable to work	11.4%	12.8%	9.7%
	Other	1.0%	0.6%	0.9%

Overall, the principal economic status of those living in the Study Area is similar to that recorded at national and County level. The main difference is in the 'Home Duties' category which is higher than that at State and County level. Of those who were not in the labour force during the 2011 Census, the highest percentage of the Study Area population was in the 'Home duties' category, which is different to the figures recorded at national and County level that show 'retired' as the highest category.

4.2.3.2 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, e.g. roofers and gardeners; and unskilled, which includes construction labourers, refuse collectors and window cleaners. Figure 4.3 shows the percentages of those employed in each socio-economic group in the State, Co. Offaly and the Study Area during 2011.

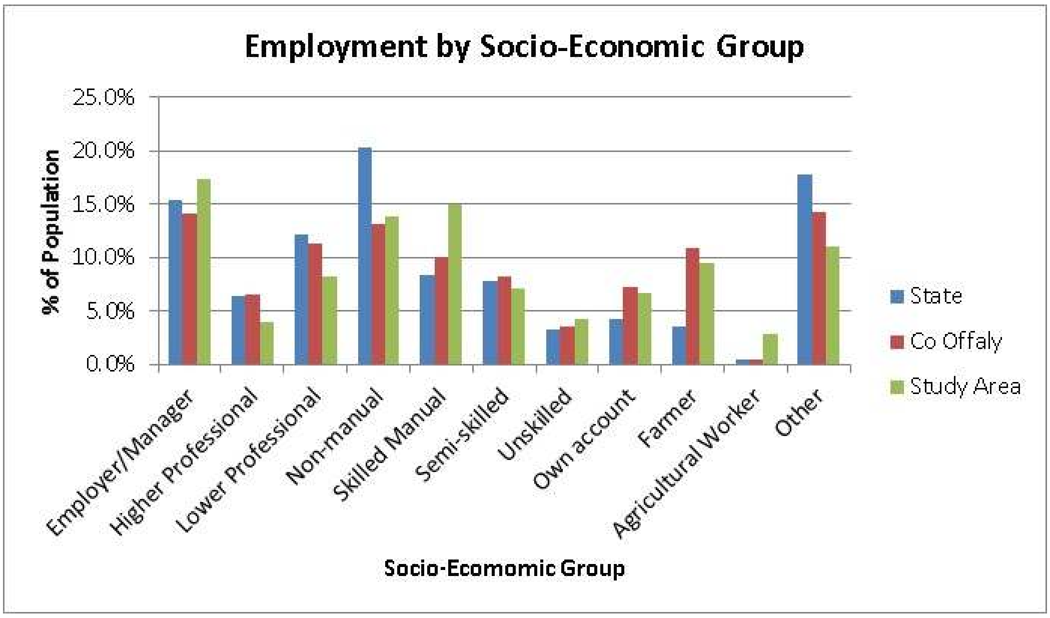


Figure 4.3 Employment by Socio-Economic Group in 2011 (Source: CSO)

The highest level of employment within the Study Area was recorded in the Employer/Manager category. Approximately 17.4% of those employed within the Study Area form part of this category, in comparison to 14.1% of the County population and 15.4% of the national population. After Employer/Manager, the next highest levels of employment within the Study Area are in the Skilled Manual and Non-manual categories. The categories in which the lowest percentage of the Study Area population was recorded are Agricultural Worker (2.9% of the Study Area population) and Higher Professional (3.9% of Study Area population).

The CSO figures for socio-economic grouping have a limitation of including the entire population, rather than just those who are in the labour force. It is likely that this is what gives rise to the high proportion of the population shown to be in the "Other" category in Figure 4.3.

4.2.3.3 The Value of Wind Energy to Ireland

4.2.3.3.1 Background

A report entitled *'The Value of Wind Energy to Ireland'* was commissioned by the Irish Wind Energy Association and published in March 2014 by Pőyry, an international consulting and engineering company. The study examines different future pathways for wind development in Ireland combining detailed market modelling by Pőyry with macroeconomic modelling by Cambridge Econometrics. It assesses the overall economic effect of planned wind development on energy prices and macroeconomic performance in Ireland.

4.2.3.3.2 Energy Targets

In 2007, the EU Department of Energy and Transport set a target of 16% for Ireland with regards to total energy consumption to come from renewable resources by 2020. Following this, the Irish Department of Environment, Heritage and Local Government increased the target for renewable energy's share of electricity consumption to 33%. This figure was further increased to 40% in late 2008, as part of the Government's strategy to make the green economy a core component of its recovery plan for Ireland. It is envisaged that wind energy will provide the largest source of renewable energy in achieving this target. Northern Ireland has adopted the same 40% renewables target for electricity and therefore significant growth in renewables across the Single Electricity Market (SEM) of the island of Ireland is expected ahead of 2020.

EU countries have also agreed on a new 2030 Framework for climate and energy, including EU-wide targets and policy objectives for the period between 2020 and 2030. These targets aim to help the EU achieve a more competitive, secure and sustainable energy system and to meet its long-term 2050 greenhouse gas reductions target. The specific targets include at least a 27% share of renewable energy consumption.

4.2.3.3.3 Employment Potential

As of September 2016, there were 3,083 Megawatts (MW) of wind energy capacity installed on the island in Ireland, the majority of this located in Counties Donegal, Cork and Kerry. Of the current installed wind power capacity, approximately 84 MW are installed in Co. Offaly, i.e. the Mountlucas wind farm.

The 2014 report by Pőyry states that meeting the 2020 renewables target will require the sustained installation of around 270 MW of new wind capacity annually. The associated annual investment of over €430 million would support 12,390 jobs during wind farm development and 920 jobs in the operation and maintenance sector by 2020. These figures translate to an estimated 5.74 direct jobs created per MW of wind capacity installed in the 'Domestic' scenario, i.e. delivering sufficient wind capacity to meet the Republic of Ireland and Northern Ireland renewables targets.

The report states that an increase in wind investment in the Republic of Ireland could create substantial benefits for associated industries, as well as increases in gross sector employment. Additional investment would lead to an increase in output and jobs in the planning and construction of new turbines, as well as permanent jobs in the operations and maintenance of these turbines.

4.2.3.4 Economic Value

Under the 'Domestic' scenario, as outlined above, the Irish wind energy industry has the potential to support €3.5 billion of direct investment, 1.2% of total Irish investment, and an additional €4.8 billion to 2030. Furthermore, Ireland currently has one of the highest energy import dependencies in Europe, importing 85% of its demand requirement. The development of indigenous wind generation reduces the reliance on fuel imports as electricity generated from fossil fuels are displaced from the merit order. Under the 'Domestic' scenario, the additional wind capacity deployed in this case would reduce reliance on imported energy sources with a 15% reduction in annual gas imports relative to a 'No Wind' development scenario in 2020 and 2030. The report states that this not only benefits security of supply but also creates a net transfer to the Irish economy, with the energy import bill falling by €282 million in 2020 and saving almost €671 million on expenditure on fuel imports per annum by 2030.

4.2.4 Land-use

The total area of farmland within the Study Area for the Human Beings assessment measures approximately 6,739 hectares or 44.7% of the Study Area, according to the CSO Census of Agriculture 2010. There are 177 farms located within the Study Area, with an average farm size of 38.1 hectares. This is slightly larger than the 36.5-hectare average farm size for Co. Offaly. Within the Study Area, farming employs 360 people, and the majority of farms are family-owned and run. Table 4.6 shows the breakdown of farmed lands within the wider DED Study Area used for this Section of the EIS. Pasture accounts for the largest proportion of farmland, followed by silage.

Table 4.6 Farm Size and Classification within the Study Area in 2010 (Source: CSO)

Characteristic	Value
Size of Study Area	15,080 hectares
Total Area Farmed within Study Area	6,739 hectares
Farmland as % of Study Area	44.7%
Breakdown of Farmed Land	Area (hectares)
Total Pasture	3,853 ha
Total Silage	1,711 ha
Grazing	192 ha
Total Hay	258 ha
Total Potatoes	1 ha
Total Cereals	568 ha
Total Crops	726 ha

4.2.5 Services

The proposed development site is located within the functional area of the Offaly County Development Plan 2014 - 2020. The nearest settlement to the proposed development site, is Clonbullogue, located on the R401 between Edenderry and Rathangan. The main services centre in the area is Edenderry, located approximately 4.5 kilometres northeast of the site.

4.2.5.1 Education

The primary schools located closest to the proposed development site are at Clonbullogue and Edenderry, located approximately 2.1 kilometres southeast and 5.1 kilometres northeast of the nearest proposed turbine locations, respectively. The secondary school located closest to the proposed development site is St. Mary's Secondary School, which lies approximately 5.4 kilometres northeast of the nearest proposed turbine location.

The third-level institution of Tallaght Institute of Technology is located approximately 46 kilometres east of the site.

4.2.5.2 Access and Public Transport

The proposed development site is accessed via the R402 and R401 Regional Roads and via local roads off the R401 and R402, which travel generally in north-south and northeast-southwest directions, east and northwest of the site respectively.

The site of the proposed development is not served by public transport. The nearest train station to the proposed development site is in Monasterevin, located approximately 14 kilometres south of the site. Also from Monasterevin, there are Bus Eireann connections to Dublin, Limerick and Cork, from which a most destinations may be reached.

4.2.5.3 Amenities and Community Facilities

Most of the amenities and community facilities, including GAA and other sports clubs, youth clubs and recreational areas, available in the area are located in Clonbullogue and the nearby settlements of Edenderry, Daingean and Rathangan. The church located closest to the proposed development site is in Clonbullogue.

There are a wide range of services available in the area. Retail and personal services are centered in Edenderry, and there are other shops and business located in

Clonbullogue, Daingean and Rathangan. Offaly County Council has a branch library at Edenderry.

The varied environment of this area of Co. Offaly provides many opportunities for walking and cycling. The Grand Canal Way walking route extends along some local roads and tracks in this part of the county. At its closest point, the route passes within 3.5 kilometres north of the subject site.

Mountlucas Wind Farm, located approximately four kilometres west of Cloncreen, features a seven-kilometre walkway/cycleway around the wind farm site, used for walking, cycling and running. It is generally accessible all year round, free of charge with onsite parking facilities. Free guided tours are also offered at Mountlucas by appointment. In 2015, there were approximately 13,500 visits to Mountlucas wind farm.

4.3 Tourism

4.3.1 Tourist Numbers and Revenue

Tourism is one of the major contributors to the national economy and is a significant source of full time and seasonal employment. During 2014 (the most recent period for which detailed figures are available), total tourism revenue generated in Ireland was approximately €6.6 billion, an increase of approximately 9.3% from the previous year. Overseas tourist visits to Ireland in 2014 grew by 6.2% to 7.1 million *('Tourism Facts 2014'*, Fáilte Ireland, September 2015).

Ireland is divided into seven tourism regions. Table 4.7 shows the total revenue and breakdown of overseas and domestic tourist numbers to each region in Ireland during 2014 (*'Tourism Facts 2014'*, Fáilte Ireland, September 2015).

Table 4.7 Overseas Tourists Revenue and Numbers 2014 (Source: Fáilte Ireland)

Region	Total Revenue (€m)	Total Number of Overseas Tourists (000s)
Dublin	€1,378.5 m	4,119
East & Midlands	€291 m	781
South-East	€205.6 m	870
South-West	€777.8 m	2,229
Shannon	€326.2 m	1,077
West	€434.4 m	1,442
North-West	€182.8 m	602
Total	€3,596.3 m	11,120

The East & Midlands region, in which the site of the proposed development is located, comprises Counties Kildare, Laois, Longford, Louth, Meath Wicklow, Westmeath and Offaly (east). This Region benefited from approximately 8.1% of the total number of overseas tourists to the country and approximately 7% of the total tourism income generated in Ireland in 2014.

Table 4.8 shows the breakdown of overseas tourist numbers to the East & Midlands Region during 2014 (the most recent regional data available) and the associated revenue generated. The regional data shows that Co. Wicklow had the highest tourism revenue and the highest number of overseas tourists within the Region during 2014. (Source: *'Regional Tourism Performance in 2014'*, Fáilte Ireland, 2016)

Table 4.8 Overseas Tourism to East & Midlands Region during 2014 (Source: Fáilte Ireland)

County	Revenue Generated by Overseas Tourists (€m)	No. of Overseas Tourists (000s)
Kildare	70	183
Laois	19	53
Longford	7	22
Louth	39	101
Meath	38	115
Wicklow	75	212
Offaly (east)	11	28
Westmeath	32	96

4.3.2 Tourist Attractions

The Grand Canal Way is a walking route running alongside the Grand Canal generally in an east-west direction from Dublin to Shannon Harbour, passing within 3.5 kilometres of the northern boundary of the proposed development site. Other tourist attractions located close to the proposed development site are the Grand Canal Adventure centre and the Irish Parachute Club, located approximately 9.5 kilometres west and 2.7 kilometres south of the nearest proposed turbine location respectively. The Grand Canal Adventure centre provides outdoor activities including kayaking, water zorbing, cycling and fishing.

4.3.3 Tourist Attitudes to Wind Farms

4.3.3.1 Fáilte Ireland Surveys

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

An updated survey was carried out by Millward Browne Landsdowne on behalf of Fáilte Ireland in 2012, in order to determine if the construction of wind farms in Ireland during the intervening period between 2007 and 2012 had resulted in any significant change in visitor attitudes. The results of the updated survey were presented in Fáilte Ireland Newsletter 2012/01: *'Visitor Attitudes on the Environment: Wind Farms'*. The 2012 surveys were undertaken with holidaymakers at various tourist offices and visitor attractions around the country, and a similar size and mix of domestic and overseas visitors was included. The 2012 survey was carried out in the Republic of Ireland only, therefore for accurate comparison the Northern Ireland data was stripped out of the 2007 survey results.

The main findings of the 2012 survey include:

- The 2012 research indicated an increase in the polarisation of opinion:
    - In 2007, the majority of visitors felt that wind farms had either no impact (49%) or a positive impact on the landscape (32%), whilst 17% felt it had a negative impact.
    - The 2012 research indicated increased positive (47%) and negative (30%) reactions, and less neutral responses (23%). The report does however point out *"It is notable that those interviewed who did not see*

a wind farm during their trip held more negative perceptions on wind farms to those that did".

- There has been an increase in the number of visitors who have seen at least one wind farm on their holiday, accompanied by a slight increase (from 45% in 2007 to 48% in 2012) in the number of visitors who felt that this had no impact on their sight-seeing experience. However, fewer now say they have a positive impact (down to 32% from 40%) and there is a slight increase in negative perceptions (from 15% in 2007 to 21% in 2012).

- As in 2007, the type of landscape in which a wind farm is sited can have a significant impact on attitudes. A greater relative negativity was expressed about potential wind farms on coastal landscapes (40%), followed by fertile farmland (37%) and mountain moorland (35%). Less than one in four were negatively disposed to the construction of wind farms on bogland (24%) or urban industrial land (21%).

- In 2012, 71% of visitors claimed that potentially greater numbers of wind farms in Ireland over the next few years would have either no impact or a positive impact on their likelihood to visit Ireland. There was a slight increase from 21% to 24% in those who said it would impact negatively on their likelihood to visit again. Again however, the report notes:

  "Interestingly those who have not seen a wind farm on this visit have more negative opinions regarding the theoretical impact of a wind farm on their sightseeing compared to those who have actually seen one. This suggests there are some negative associations with wind farms that in reality do not materialise for those who have seen them."

Overall, the survey notes that given the scenario where more wind farms are to built in Ireland in the future, the most widely held view by survey respondents is that this will not impact on their likelihood to visit the area again, with a slightly greater majority saying that this would have a positive rather than a negative effect. Compared to 2007, the proportion citing a positive impact has declined (32% in 2012 compared to 40% in 2007) in favour of those who feel it would have no impact.

Further details regarding the general public perception of wind energy, including those living in the vicinity of a wind farm, are presented in Section 4.4 below.

4.3.3.2 Scottish Tourism Survey 2016

BiGGAR Economics undertook a study, 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. This found that in the majority of cases (66%) sustainable tourism employment performed better in areas surrounding wind farms than in the wider local authority area. There was no pattern emerging that would suggest that onshore wind farm development has had a detrimental impact on the tourism sector, even at the very local level.

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

4.4 Public Perception of Wind Energy

4.4.1 Scotland and Ireland Survey

4.4.1.1 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.

4.4.1.2 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 close proximity.

4.4.1.3 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 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.

4.4.1.4 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.

4.4.2 Sustainable Energy Ireland Survey

4.4.2.1 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.

4.4.2.2 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 effects of wind farm development, the national survey reveals that attitudes towards wind energy are influenced by a perception that wind is an attractive source of energy:

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

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

Similar to the national survey, the surveys of those living within the vicinity of a wind farm also found that the findings are generally positive towards wind farms. Perceptions of the 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.

4.4.2.3 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."

4.4.3 Local Consultation

As part of the public consultation undertaken during the design of the proposed development, a range of activities were undertaken including, public information evening, all occupied dwellings within two kilometres of the site were visited by representatives of Bord na Móna, public forum clinic, community engagement forum as well as the Mount Lucas Newsletter containing updates on the Cloncreen wind farm project.

Further details on the public consultation exercise are presented in Section 2.9.4 of this EIS.

4.5 Health Effects of Wind Farms

4.5.1 Health Effect Studies

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

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

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

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

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

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

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

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

The report found, amongst other things, that:

- *"Wind Turbine Syndrome" symptoms are the same as those seen in the general population due to stresses of daily life. They include headaches, insomnia, anxiety, dizziness, etc.*
- *Low frequency and very low-frequency 'infrasound' produced by wind turbines are the same as those produced by vehicular traffic and home appliances, even by the beating of people's hearts. Such 'infrasounds' are not special and convey no risk factors;*
- *The power of suggestion, as conveyed by news media coverage of perceived 'wind-turbine sickness', might have triggered 'anticipatory fear' in those close to turbine installations."*

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

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

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

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

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

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

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

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

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

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

CAHA notes that:

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

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

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

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

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

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

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

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

6. Wind Turbines and Health, A Critical Review of the Scientific Literature Massachusetts Inistute 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, was 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 4-1 of this EIS.

4.5.2 Turbine Safety

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

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

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

4.5.3 Electromagnetic Interference

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

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

The EirGrid document '*EMF & You: Information about Electric & Magnetic Fields and the electricity transmission system in Ireland'* (EirGrid, 2014) provides further practical information on EMF and is included as Appendix 4-2 of this EIS.

Further details on the potential impacts of electromagnetic interefence to telecommunications and aviation are presented in Section 13.2 of this EIS.

4.6 Property Values

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 of these LBNL studies note that their results don't 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're rare enough 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 of the major U.S. studies conducted thus far.

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

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

Although there have been no empirical studies carried out in Ireland on the effects of wind farms on property prices, it is a reasonable assumption based on the available international literature that the provision of a wind farm at the proposed location would not impact on the property values in the area.

4.7 Shadow Flicker

4.7.1 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 is defined as Shadow Casting), and therefore shadow flicker assessments are typically undertaken for the nearby adjacent properties around a proposed wind farm site.

The frequency of occurrence and the strength of any potential shadow flicker effect can depend on several factors, each of which is described below.

1. Whether the sunlight is direct and unobstructed or diffused by clouds:
If the sun is not shining, shadow flicker cannot occur. Reduced visibility conditions such as clouds, haze, and fog greatly reduce the chance of shadow flicker occurring.

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

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

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

3. How high the sun is in the sky at a given time:
At distances of greater than approximately 500 metres between a turbine and a receptor, shadow flicker generally occurs only at sunrise or sunset when the shadow cast by the turbine is longer. At distances greater than ten rotor diameters from a turbine, the potential for shadow flicker is very low (*'Wind Energy Development Guidelines for Planning Authorities',* DoEHLG, 2006). Figure 4.4 illustrates the shadow cast by a turbine at various times during the day, where the red shading represents the area where shadow flicker may occur. When the sun is high in the sky, the length of the shadow cast by the turbine is significantly shorter.

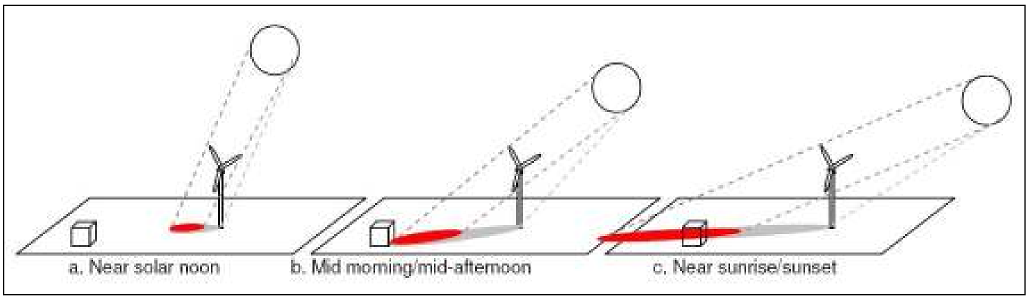


Figure 4.4 Shadow-prone Area as a Function of Time of Day (Source: Shadow Flicker Report, Helimax Energy, December 2008)

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

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

At distance, the turbine blades do not cover the sun but only partly mask it, substantially weakening the shadow. This effect 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 effect 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 have to be facing directly toward or away from the sun, so they are moving across the source of the light relative to the observer. This is demonstrated in Figure 4.5.

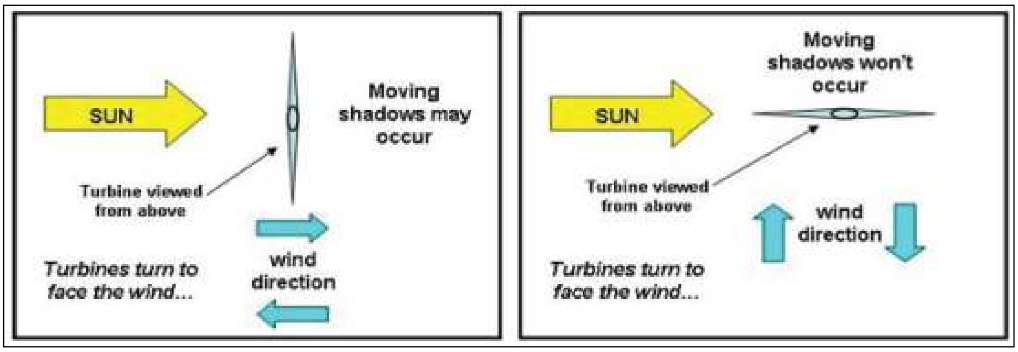


Figure 4.5 Turbine Blade Position and Shadow Flicker Effect (Source: Wind Fact Sheet: Shadow Flicker, Noise Environmental Power LLC)

7. Rotation of turbine blades:

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

4.7.2 Guidance

The relevant Irish guidance for shadow flicker is derived from the '*Wind Energy Development Guidelines for Planning Authorities*' (Department of the Environment, Heritage and Local Government, 2006). The DoEHLG 2006 wind energy guidelines recommend that shadow flicker at dwellings within 500 metres of a proposed turbine location should not exceed a total of 30 hours per year or 30 minutes per day.

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

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

There are no properties located within 500 metres of a proposed turbine location. For the purposes of this assessment however, the recommended maximum guideline thresholds of 30 hours per year or 30 minutes per day have been applied to all occupied properties located within ten rotor diameters (i.e. 1.31 kilometres) of the proposed turbine locations.

4.7.2.1 Draft Guidance

The '*Wind Energy Development Guidelines for Planning Authorities*' (2006) are currently the subject of a targeted review. The proposed changes to the assessment of impacts associated with wind energy developments are outlined in the document *'Proposed Revisions to Wind Energy Development Guidelines 2006 – Targeted Review'* in relation to noise, proximity and shadow flicker (December, 2013). A consultation process in relation to this document is currently being undertaken. In advance of the updated Wind Energy Development Guidelines being finalised and published, the noise and shadow flicker predictions presented in this EIS therefore also consider the current consultation guidance with regard to the proposed development.

The Targeted Review document suggests that a condition be attached to all planning permissions for wind farms to ensure that there will be no shadow flicker at any existing dwelling or other existing affected property within ten rotor diameters of any wind turbine. It also suggests that a further condition be included which states that if shadow flicker does occur, then the necessary measures, such as turbine shut down during the associated time periods, will be taken by the wind energy developer or operator to eliminate the shadow flicker. The proposed development will be capable of meeting this condition if required, due to the use of turbine control software; further details are provided in Section 4 below on shadow flicker mitigation.

4.7.3 Shadow Flicker Prevention and Prediction Methodology

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

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

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

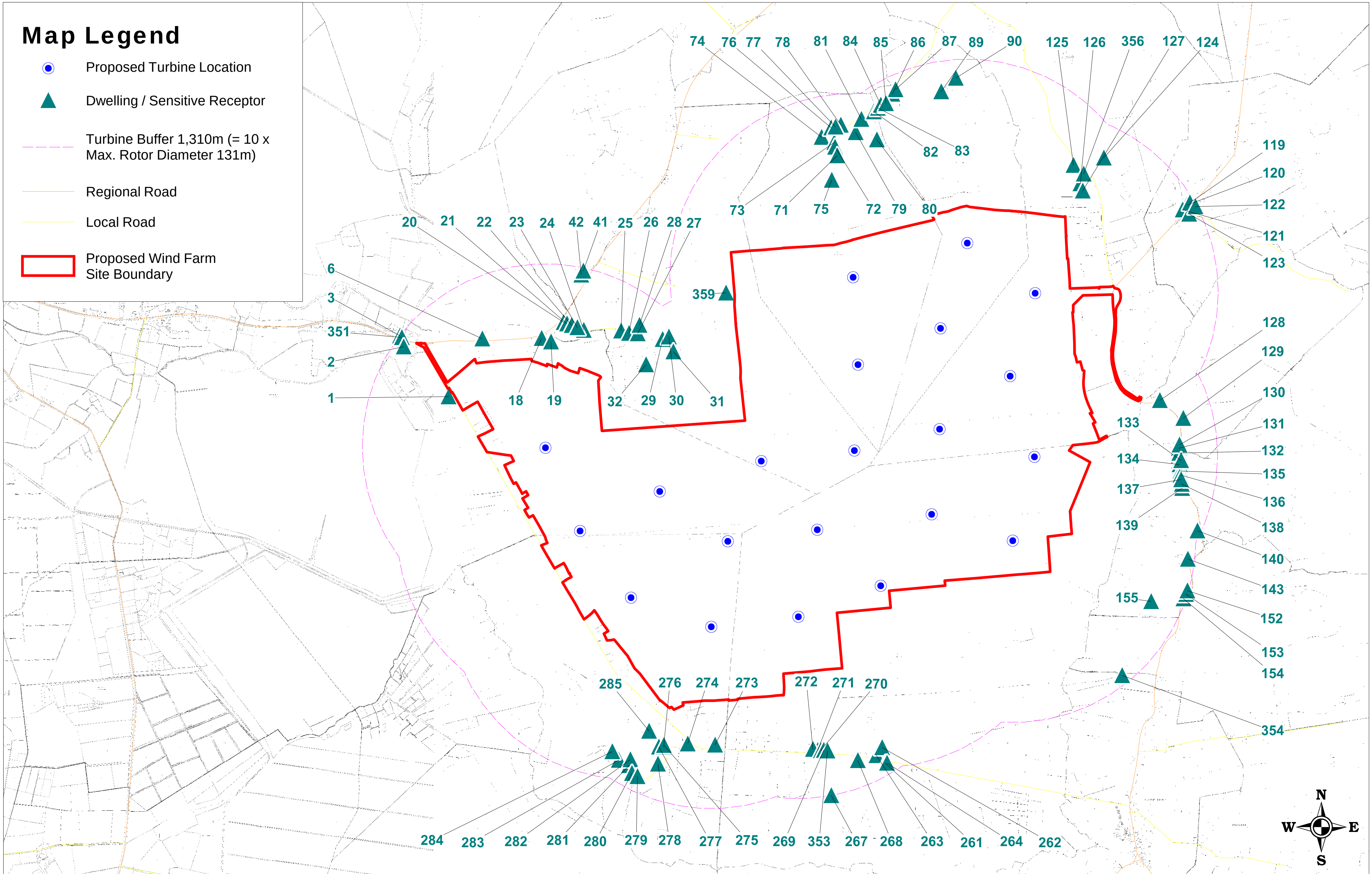
For the purposes of this shadow flicker assessment, the software package WindFarm Version 4.1.2.3 (ReSoft Ltd.) has been used to predict the level of shadow flicker associated with the proposed wind farm development. WindFarm is a commercially available software tool that enables developers to analyse, design and optimise proposed wind farms. It allows proposed turbine layouts to be optimised for maximum energy yield whilst taking account of environmental, planning and engineering constraints.

This shadow flicker assessment considers the 21 No. proposed turbines that make up the proposed Cloncreen wind farm development, and quantifies the potential shadow flicker effects that may arise from any of the turbines. The assessment then considers the potential cumulative shadow flicker effects which may be caused due to the proposed development in combination with other wind farm developments in the vicinity of the site.

4.7.4 Shadow Flicker Assessment Criteria

4.7.4.1 Study Area

A total of 95 no. properties have been identified in the vicinity of the site of the proposed development site up to a distance of ten rotor diameters from the proposed turbine locations, as shown on Figure 4.6. These houses were compiled from the list used for the original constraints mapping, and the identification numbers have remained the same for this study. The Grid Reference coordinates for each property are listed in Table 4.9. The distance to the nearest proposed turbine location from each property (P) is also listed.



MAP TITLE: House Locations		MAP NO.: Figure 4.6	SCALE: 1:35,000
PROJECT TITLE: 150504 - Cloncreen Wind Farm EIS, Co. Offaly			DATE: 27-09-2016
DRAWING BY: Lorraine Meehan	CHECKED BY: Michael Watson	ISSUE NO.: 150504-2016.09.28-D2	

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279

Table 4.9 Property Locations

Property ID	Easting	Northing	Distance to Nearest Proposed Turbine (metres)
1	256105	226847	780
2	255783	227205	1240
3	255756	227283	1310
6	256347	227262	900
18	256772	227265	780
19	256840	227241	750
20	256930	227380	900
21	256954	227369	890
22	256988	227359	890
23	257028	227343	880
24	257075	227324	880
25	257342	227319	990
26	257399	227302	1010
27	257461	227299	1040
28	257474	227360	1100
29	257640	227258	1080
30	257685	227276	1100
31	257717	227169	1000
32*	257521	227077	910
41	257071	227748	1290
42	257057	227720	1260
71	258893	228574	870
72	258876	228637	930
73	258871	228670	970
74	258780	228707	1020
75*	258853	228399	700
76	258849	228774	1070
77	258880	228781	1080
78	258918	228794	1090
79	259024	228741	1030
80	259176	228689	980
81	259065	228835	1130
82	259155	228890	1150
83	259184	228915	1150
84	259205	228937	1160
85	259242	228948	1150
86	259288	229017	1190
87	259311	229048	1210
89	259638	229034	1090
90	259742	229131	1180
119	261421	228237	1280
120	261398	228219	1250
121	261369	228187	1210
122	261461	228210	1300
123	261416	228156	1240
124	260804	228559	1080

Property ID	Easting	Northing	Distance to Nearest Proposed Turbine (metres)
125	260586	228506	940
126	260636	228374	840
127	260653	228322	800
128	261206	226820	980
129	261373	226692	1100
130	261346	226502	1040
131	261342	226477	1030
132	261345	226442	1040
133	261358	226390	1050
134	261347	226360	1040
135	261354	226314	1050
136	261355	226285	1050
137	261358	226253	1060
138	261364	226220	1070
139	261366	226190	1080
140	261475	225886	1280
143	261406	225683	1260
152	261403	225456	1300
153	261394	225431	1300
154	261374	225399	1290
155	261143	225379	1080
261	259237	224219	1230
262	259214	224332	1120
263	259173	224275	1150
264	259249	224221	1230
267	258850	223989	1310
268	259040	224239	1120
269	258796	224313	980
270	258774	224311	980
271	258753	224312	970
272	258718	224320	960
273	258016	224351	850
274	257820	224359	860
275	257648	224348	920
276	257647	224336	930
277	257613	224337	940
278	257606	224214	1060
279	257460	224125	1200
280	257419	224148	1200
281	257399	224203	1160
282	257409	224246	1120
283	257326	224242	1170
284	257279	224303	1120
285	257543	224450	880
351	255770	227272	1290
353	258822	224308	990
354	260935	224849	1250

Property ID	Easting	Northing	Distance to Nearest Proposed Turbine (metres)
356	260660	228444	920
359	258095	227591	920

** Properties 32 and 75 are classed as Farmyard Buildings*

The properties listed in Table 4.9 above include properties that are currently unoccupied and dilapidated but that could be restored to a habitable condition. The study area was also the subject of a planning history search, to identify properties that may have been granted planning permission, but not yet been constructed. In any case where planning permission for a property has been granted, the property has been included in the list of properties in Table 4.9 above.

4.7.4.2 Turbine Type

This shadow flicker assessment assesses the potential shadow flicker from the proposed 21-turbine development and assesses the proposal in relation to the permitted development. The elevations and grid reference coordinates of the proposed 21 turbines are listed in Section 3 of this EIS.

Planning permission is being sought for a turbine size up to a maximum ground to blade tip height of 170 metres. The maximum potential rotor diameter will measure 131 metres. For the purposes of this assessment, a hub height of 104.5 metres and a rotor diameter of 131 metres was used, in order to present a worst case scenario.

While the turbine dimensions of a 131-metre rotor diameter and a 104.5-metre hub height have been used for the purposes of this assessment, the actual turbine to be installed on the site will be the subject of a competitive tender process, and could include turbines of a different rotor diameter and hub height configuration than considered as part of this assessment. Regardless of the make or model of the turbine eventually selected for installation on site, the potential shadow flicker impact it will give rise to will be no different than that predicted in this assessment. With the benefit of the mitigation measures outlined below, any turbine to be installed on-site will be able to comply with the DoEHLG guideline thresholds of 30 minutes per day or 30 hours per year. Any references to the turbine dimensions in the shadow flicker assessment must be considered in the context of the above, and should not be construed as meaning it predetermines the dimensions of any wind turbine that could be used on the site.

4.7.4.3 Assumptions and Limitations

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

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

Each window measures one-metre-high by one-metre-wide, and tilt angle is assumed to be zero. The centre height of each window is assumed to be two metres above ground level and no screening due to trees or other buildings or vegetation is assumed. It was not considered necessary or practical to measure the dimensions of every window on every property in the study area. While the actual size of a window will marginally influence the incidence and duration of any potential shadow flicker effect, with larger windows resulting in slightly longer shadow flicker durations, any additional incidences or durations or shadow flicker over and above those predicted in this assessment can be countered by extending the mitigation strategies outlined further 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. turn, at all times. In reality, turbines may be switched off during maintenance or for other technical or environmental reasons.
- The turbine rotor is considered (as a sphere) to present its maximum aspect to observers in all directions. In reality, the wind direction and relative position of the turbine rotor would result in a changing aspect being presented by the turbine. The rotor will actually present as ellipses of varying sizes to observers from different directions. The time taken for the sun to pass across the sky behind a highly elliptical rotor aspect will be shorter than the modeled maximum aspect.

4.7.5 Shadow Flicker Assessment Results

4.7.5.1 Daily Shadow Flicker

The WindFarm computer software was used to model the predicted daily shadow flicker levels in significant detail, identifying the predicted daily start and end times, maximum daily duration and the individual turbines predicted to give rise to shadow flicker. The model results assume worst-case conditions, including:

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

For ease of reference, the daily shadow flicker model results are summarised in Table 4.10 below. Table 4.10 details the maximum daily predicted shadow flicker, presening the worst-case scenario for the day of the year when the greatest duration of shadow flicker may be experienced. The predicted maximum daily shadow flicker levels are then considered in the context of the DoEHLG's guideline daily threshold of 30 minutes per day, in terms of whether there is any incidence of exceedance of the 30 minute per day threshold at each of the modelled properties. If there is a predicted exceedance of the 30 minute per day threshold at any property, the number of days the threshold will be exceeded are also detailed. If there is a predicted exceedance of the 30 minute per day threshold at any property, the turbines that contribute to the exceedance are also identified.

Finally, it is considered whether a shadow flicker mitigation strategy is required for each property. Mitigation strategies are deemed necessary for any property in exceedance of the daily shadow flicker threshold of 30 minutes per day, and are detailed in Section 4.7.6 below.

Table 4.10 Potential Daily Shadow Flicker (SF)

Property No.	Maximum Daily Shadow Flicker (Pre-Mitigation) from Proposed Turbines (hrs)	Any Exceedance of DoEHLG 30min/day Threshold?	No. of Days 30min/day Threshold is Exceeded	Turbine(s) Giving Rise to Daily Shadow Flicker Threshold Exceedance	Mitigation Strategy Required?
1	0.68	Yes	37	1	Yes
2	0.46	No	0	N/A	No
3	0	No	0	N/A	No
6	0.54	Yes	31	1	Yes
18	0	No	0	N/A	No
19	0	No	0	N/A	No
20	0	No	0	N/A	No
21	0	No	0	N/A	No
22	0	No	0	N/A	No
23	0	No	0	N/A	No
24	0	No	0	N/A	No
25	0.5	No	0	N/A	No
26	0.51	Yes	25	1	Yes
27	0.98	Yes	69	1, 13	Yes
28	0.94	Yes	58	1, 13	Yes
29	0.91	Yes	48	1, 13	Yes
30	0.79	Yes	31	1, 13	Yes
31	0.71	Yes	57	1, 13	Yes
32	1.12	Yes	53	1, 13	No*
41	0	No	0	N/A	No
42	0	No	0	N/A	No
71	0.5	No	0	N/A	No
72	0.48	No	0	N/A	No
73	0.48	No	0	N/A	No
74	0.44	No	0	N/A	No
75	0.51	Yes	17	20, 21	No*
76	0.45	No	0	N/A	No
77	0.46	No	0	N/A	No
78	0.47	No	0	N/A	No
79	0.51	Yes	15	21	Yes
80	0.57	Yes	35	21	Yes
81	0.5	No	0	N/A	No
82	0.47	No	0	N/A	No
83	0.45	No	0	N/A	No
84	0.39	No	0	N/A	No
85	0.3	No	0	N/A	No

Property No.	Maximum Daily Shadow Flicker (Pre-Mitigation) from Proposed Turbines (hrs)	Any Exceedance of DoEHLG 30min/day Threshold?	No. of Days 30min/day Threshold is Exceeded	Turbine(s) Giving Rise to Daily Shadow Flicker Threshold Exceedance	Mitigation Strategy Required?
86	0	No	0	N/A	No
87	0	No	0	N/A	No
89	0	No	0	N/A	No
90	0	No	0	N/A	No
119	0.44	No	0	N/A	No
120	0.45	No	0	N/A	No
121	0.46	No	0	N/A	No
122	0.43	No	0	N/A	No
123	0.45	No	0	N/A	No
124	0.49	No	0	N/A	No
125	0.59	Yes	30	21	Yes
126	0.59	Yes	26	17, 21	Yes
127	0.59	Yes	55	17, 21	Yes
128	0.55	Yes	23	8, 16	Yes
129	0.49	No	0	N/A	No
130	0.52	Yes	9	8	Yes
131	0.52	Yes	11	8	Yes
132	0.52	Yes	11	8	Yes
133	0.51	Yes	10	8	Yes
134	0.52	Yes	12	8	Yes
135	0.52	Yes	12	7, 8	Yes
136	0.52	Yes	10	7, 8	Yes
137	0.51	Yes	10	7, 8	Yes
138	0.51	Yes	8	7, 8	Yes
139	0.51	Yes	7	7, 8	Yes
140	0.45	No	0	N/A	No
143	0.44	No	0	N/A	No
152	0.43	No	0	N/A	No
153	0.43	No	0	N/A	No
154	0.44	No	0	N/A	No
155	0.52	Yes	19	7	Yes
261	0	No	0	N/A	No
262	0	No	0	N/A	No
263	0	No	0	N/A	No
264	0	No	0	N/A	No
267	0	No	0	N/A	No
268	0	No	0	N/A	No
269	0	No	0	N/A	No
270	0	No	0	N/A	No
271	0	No	0	N/A	No
272	0	No	0	N/A	No
273	0	No	0	N/A	No
274	0	No	0	N/A	No

Property No.	Maximum Daily Shadow Flicker (Pre-Mitigation) from Proposed Turbines (hrs)	Any Exceedance of DoEHLG 30min/day Threshold?	No. of Days 30min/day Threshold is Exceeded	Turbine(s) Giving Rise to Daily Shadow Flicker Threshold Exceedance	Mitigation Strategy Required?
275	0	No	0	N/A	No
276	0	No	0	N/A	No
277	0	No	0	N/A	No
278	0	No	0	N/A	No
279	0	No	0	N/A	No
280	0	No	0	N/A	No
281	0	No	0	N/A	No
282	0	No	0	N/A	No
283	0	No	0	N/A	No
284	0	No	0	N/A	No
285	0	No	0	N/A	No
351	0.44	No	0	N/A	No
353	0	No	0	N/A	No
354	0	No	0	N/A	No
356	0.57	Yes	22	17, 21	Yes
359	0.59	Yes	36	19, 20	Yes

** Properties 32 and 75 are classed as Farmyard Buildings*

Of the 95 No. properties modelled, some level of shadow flicker is predicted to potentially occur at 56 properties, with a further 39 properties experiencing no shadow flicker as a result of the proposed development.

Of the 56 No. properties that may experience some shadow flicker in the worst-case scenario, only 29 of those properties may experience daily shadow flicker in excess of the DoEHLG guideline threshold of 30 minutes per day, P1, P6, P26-P32, P75, P79, P80, P125-P128, P130-P139, P155, P356 and P359. Two of these properties, P32 and P75 are derelict buildings now in use as farmyard buildings, therefore bringing the total number of potentially affected properties to 27. A shadow flicker mitigation strategy to control the level of daily shadow flicker experienced at the potentially affected properties is outlined in Section 4.7.6 below. This mitigation strategy outlines the method by which the exceedence at the relevant properties will be brought below 30 minutes per day.

The shadow flicker model used to predict the daily shadow flicker results assumes 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 which are also facing the property, and that the turbine blades are always turning. In reality, the actual occurrence and incidence of shadow flicker is likely to be significantly less that that predicted in Table 4.10 above.

4.7.5.2 Annual Shadow Flicker

The WindFarm software was also used to model the predicted annual shadow flicker levels in significant detail, identifying the total annual duration and the total time each individual turbine is predicted to give rise to shadow flicker over the course of a year. The annual model results also 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 which are also fully facing the property, and that the turbine blades are moving.

The DoEHLG Wind Energy Guidelines recommend that shadow flicker at dwellings within 500 metres of a proposed turbine location should not exceed a total of 30 hours per year. While there are no dwellings located within 500 metres of any proposed turbine location, this criterion has been applied to all properties located within 10 rotor diameters.

The total annual shadow flicker calculated for each property assumes 100% sunshine during daytime hours, as referred to above. However, weather data for this region shows that the sun shines on average for 29% of the daylight hours per year. This percentage is based on Met Eireann data recorded at Mullingar over the 30-year period from 1971 to 2000 (www.met.ie) as shown in Table 9.7 of Section 9 of this EIS. Table 4.11 therefore also lists the annual shadow flicker calculated for each property when the regional average of 29.2% sunshine is taken into account.

For ease of reference, the annual shadow flicker model results are summarised in Table 4.11 below. Table 4.11 details the maximum annual predicted shadow flicker. The predicted maximum annual shadow flicker levels are then reduced based on the 29.2% daylight hours per year long-term Met Eireann averages, to give a more accurate annual average shadow flicker prediction. Table 4.11 also outlines whether a shadow flicker mitigation strategy is required for each property to mitigate potential exceedances of the annual threshold figure. Mitigation strategies are detailed in Section 4.7.6 below and are deemed necessary for any property in exceedance of the daily shadow flicker threshold of 30 hours per year, after the annual sunshine reduction has been accounted for.

Table 4.11 Potential Total Annual Shadow Flicker

Property No.	Maximum Annual Shadow Flicker - Pre-Mitigation (hrs)	Adjusted (for sunshine) Annual Shadow Flicker – Pre-Mitigation (hrs)	Any Exceedance of DoEHLG 30hrs/year Threshold?	Mitigation Strategy Required?
1	30	8.76	No	No
2	16.1	4.70	No	No
3	0	0	No	No
6	26.2	7.65	No	No
18	0	0	No	No
19	0	0	No	No
20	0	0	No	No
21	0	0	No	No
22	0	0	No	No
23	0	0	No	No
24	0	0	No	No
25	22.5	6.57	No	No
26	28.7	8.38	No	No
27	62.2	18.16	No	No
28	51.9	15.15	No	No
29	56.1	16.38	No	No
30	49.1	14.33	No	No

Property No.	Maximum Annual Shadow Flicker - Pre-Mitigation (hrs)	Adjusted (for sunshine) Annual Shadow Flicker – Pre-Mitigation (hrs)	Any Exceedance of DoEHLG 30hrs/year Threshold?	Mitigation Strategy Required?
31	55	16.06	No	No
32	53.6	15.65	No	No*
41	0	0	No	No
42	0	0	No	No
71	18.3	5.34	No	No
72	18	5.25	No	No
73	18.1	5.28	No	No
74	15.4	4.49	No	No
75	31.9	9.31	No	No*
76	18.9	5.51	No	No
77	20.6	6.01	No	No
78	24	7.00	No	No
79	33.9	9.89	No	No
80	39.2	11.44	No	No
81	29.4	8.58	No	No
82	20.5	5.98	No	No
83	16.3	4.75	No	No
84	11.6	3.38	No	No
85	6.4	1.86	No	No
86	0	0	No	No
87	0	0	No	No
89	0	0	No	No
90	0	0	No	No
119	13.4	3.91	No	No
120	13.7	4.00	No	No
121	14.5	4.23	No	No
122	12.5	3.65	No	No
123	13.4	3.91	No	No
124	16.8	4.90	No	No
125	26.6	7.76	No	No
126	35.6	10.39	No	No
127	46.4	13.54	No	No
128	36.1	10.54	No	No
129	28.1	8.20	No	No
130	16.2	4.73	No	No
131	16.4	4.78	No	No
132	16.5	4.81	No	No
133	16.5	4.81	No	No
134	17.1	4.99	No	No
135	28.7	8.38	No	No
136	29	8.46	No	No
137	29	8.46	No	No
138	29.1	8.49	No	No

Property No.	Maximum Annual Shadow Flicker - Pre-Mitigation (hrs)	Adjusted (for sunshine) Annual Shadow Flicker – Pre-Mitigation (hrs)	Any Exceedance of DoEHLG 30hrs/year Threshold?	Mitigation Strategy Required?
139	29.4	8.58	No	No
140	18.9	5.51	No	No
143	12.1	3.53	No	No
152	13.4	3.91	No	No
153	13.8	4.02	No	No
154	14.7	4.29	No	No
155	27.2	7.94	No	No
261	0	0	No	No
262	0	0	No	No
263	0	0	No	No
264	0	0	No	No
267	0	0	No	No
268	0	0	No	No
269	0	0	No	No
270	0	0	No	No
271	0	0	No	No
272	0	0	No	No
273	0	0	No	No
274	0	0	No	No
275	0	0	No	No
276	0	0	No	No
277	0	0	No	No
278	0	0	No	No
279	0	0	No	No
280	0	0	No	No
281	0	0	No	No
282	0	0	No	No
283	0	0	No	No
284	0	0	No	No
285	0	0	No	No
351	16.2	4.73	No	No
353	0	0	No	No
354	0	0	No	No
356	23	6.71	No	No
359	40.3	11.76	No	No

** Properties 32 and 75 are classed as Farmyard Buildings*

Of the 95 no. properties modelled, the DoEHLG total annual guideline limit of 30 hours is predicted to be exceeded at 13 no. properties, P27-P32, P75, P79, P80, P126-P128, P359. Two of these properties, P32 and P75 are derelict buildings now in use as farmyard buildings as described above, therefore bringing the total number of potentially affected properties to 11. When the regional sunshine average of 29.2% is taken into account, i.e. the mean amount of sunshine hours throughout the year, the number of properties at which an exceedance of the 30-hour annual guideline limit is predicted is reduced to zero.

Mitigation measures in the form of a shadow flicker mitigation strategy would normally be applied to any property in exceedance of the annual shadow flicker threshold after the sunshine reduction has been accounted for, to reduce the daily level of shadow flicker at the affected properties below the guidelines level of 30 hours per year. In this instance, considering no property is in exceedance of the annual 30-hour threshold, no such shadow flicker mitigation strategy is deemed necessary. Should any situation arise after construction where a shadow flicker mitigation strategy is required, details of potential strategies are given in Section 4.7.6 below.

4.7.5.3 Cumulative Shadow Flicker

For the assessment of cumulative shadow flicker, any other existing, permitted or proposed wind farm would be considered where it had the potential to generate an in-combination shadow flicker effect with the proposed 21 Cloncreen turbines, on the 95 properties considered in this assessment.

The nearest wind turbines to the proposed development site are located within the Mountlucas wind farm, west of Cloncreen. The minimum distance between the Mountlucas operating turbines and the proposed Cloncreen turbines is 4.12 kilometres, therefore, there are no houses located within 10 rotor diameters of both wind farms, and thus no potential for cumulative shadow flicker. The minimum distance between the permitted Yellow River turbines and the proposed Cloncreen turbines is 9.2 kilometres, therefore, there is no potential for cumulative shadow flicker from this wind farm.

4.7.6 Shadow Flicker Mitigation Strategies

In cases where a property is predicted to experience shadow flicker in exceedance of the DoEHLG guideline limits of 30 minutes per day or 30 hours per year, a number of measures can be implemented to mitigate these effects and reduce the incidence and duration of potential shadow flicker below the recommended guidelines thresholds. Conditions are regularly attached to planning permission for wind farm projects requiring adherence to the DoEHLG guideline limits of 30 minutes per day or 30 hours per year and therefore such mitigation measures have been widely adopted through the wind energy industry.

Specific measures are generally not necessary to mitigate annual shadow flicker, as it has been established by long-term weather data that the sun shines on average for only 22-35% of daylight hours across Ireland over the course of a year. When the local sunshine data is applied to the worst-case model prediction figures, with proper project design, exceedances of the annual guideline limit of 30 hours per year are generally only likely at a small number of properties. Understandably, it is more likely that an exceedance of the daily guideline limit of 30 minutes would occur on a cloudless day with the sun shining, and so property-specific shadow flicker mitigation measures are better focused on reducing the daily shadow flicker durations below the guideline figure of 30 minutes per day.

There are three main mitigation strategies that can be employed to limit the incidence or duration of shadow flicker where necessary, each of which is now outlined and described below.

Screening Assessment
Where a property or property is predicted to be subject to some incidence of shadow flicker, the shadow flicker has been predicted on the basis of a "bare-earth" scenario, in the absence of any screening. In reality, the likelihood, incidence and duration of any potential shadow flicker may be significantly reduced or entirely eliminated due the presence of screening features in the immediate environs of the property. Such screening features could include small undulations in the local topography, built structures such as sheds, walls or other structures, and vegetation in the form of natural or planted trees, hedgerows or scrub. When such additional screening features are accounted for, the actual incidence and duration of any potential shadow flicker may be significantly reduced or entirely eliminated, negating the requirement for any further mitigation strategies as outlined below.

Screening Measures
In the absence of any screening features as described above, at any property where the shadow flicker generated by the proposed development exceeds the daily or annual guideline threshold and the owner(s) of the property would like the incidence of shadow flicker reduced, the operator of the wind farm will engage with the property owner to ensure the DoEHLG guideline threshold are not exceeded. The property owner will be asked to log the date, time and duration of shadow flicker events occurring on at least five different days. The provided log will be compared with the predicted occurrence of shadow flicker effects. In the unlikely event that there is a variance in the predicted and recorded incidence of shadow flicker, a visit will be carried out to verify the occurrence of shadow flicker at the residence. If an occurrence of shadow flicker is verified to be in exceedance of the guideline thresholds, a number of screening measures will be proposed to the property owner, including:

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

If agreement can be reached on a set of appropriate measures, the necessary works to install the required mitigation would be implemented in cooperation with the property owner as soon as practically possible, with the full costs to be borne by the wind farm operator.

Should it not be possible for the parties to agree on a set of appropriate screening measures, turbine control measures will then be used to meet the guidelines thresholds, as described below.

Wind Turbine Control Measures
Modern wind turbines can be fitted with shadow flicker control units to allow the turbines to be controlled to prevent the occurrence or limit the duration of shadow flicker at properties surrounding the wind farm. The shadow flicker control units can be added to any required turbines, and are not cost prohibitive.

A shadow flicker control unit allow a wind farm's turbines to be programmed and controlled using the wind farm's SCADA control system to change a particular turbine's operating mode during certain conditions or times, or even turn the turbine off if necessary. This measure can be utilised at the site of the proposed development so as to prevent an exceedance of the guideline shadow flicker values at any property.

All predicted incidents of shadow flicker in excess of the daily or annual guidelines thresholds can be pre-programmed into the wind farm's control software. The wind farm's SCADA control system can be programmed to shut down any particular turbine at any particular time on any given day to ensure the daily or annual guidelines thresholds are not exceeded. 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 photo cells, 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. This method of shadow flicker mitigation has been technically well-proven at wind farms in areas outside Ireland that experience significantly longer periods of direct sunlight.

4.8 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 proposed wind farm site is located on a site currently used for commercial peat extraction, therefore a certain level of activity and traffic movements are associated with the site, which will assist in the assimilation of the proposed development into the receiving environment. There are no properties located within 700 metres of a proposed turbine location.

When considering the amenity of residents in the context of a proposed wind farm, 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 EIS (Section 4.7 above refers to shadow flicker modelling, Section 10 of the EIS addresses noise). A comprehensive landscape and visual impact assessment has also been carried out, as presented in Section 11 of this EIS. Impacts on human beings during the construction and operational phases of the proposed development are assessed in relation to each of these key issues and other environmental factors such as noise, traffic and dust; see Impacts in Section 4.9 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.

4.9 Likely and Significant Effect and Associated Mitigation Measures

4.9.1 'Do-Nothing' Scenario

If the proposed development were not to proceed, the existing uses for the site of commercial peat harvesting would continue until the peat is exhausted and then a rehabilitation plan implemented.

If the proposed development were not to proceed, the opportunity to capture an even greater part of Co. Offaly's valuable renewable energy resource would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources, increasing energy security of supply and the reduction of greenhouse gas emissions.

4.9.2 Construction Phase

4.9.2.1 Population

Those working on the construction phase of the proposed development will travel daily to the site from the wider area. It is estimated that a maximum of 120 staff members will be employed on the site at any one time during the six-month site preparation and groundworks stage of construction, reducing to a maximum of approximately 40 staff at any one time during the turbine construction stage. The construction phase will have no effect on the population of the Study Area in terms of changes to population trends or density, household size or age structure.

4.9.2.2 Health and Safety

The site specific Emergency Response Plan (ERP) will be developed prior to the construction of the facility and will include details on the response required and the responsibilities of all personnel in the event of an emergency. The ERP in terms of health and safety will require updating and submissions from the various contractors and suppliers on appointment as the proposed project progresses.

The Environmental Manager will be responsible for any corrective actions required as a result of an incident e.g. an investigative report, formulation of alternative construction methods or environmental sampling, and will advise the Main Contractor as appropriate.

Construction of the proposed development will necessitate the presence of a construction site. Construction sites and the machinery used on them pose a potential health and safety hazard to construction workers if site rules are not properly implemented. This will have a short-term potential significant negative effect.

Mitigation

During construction of the proposed development, all staff will be made aware of (through appropriate training and signage) and adhere to the Health & Safety Authority's *'Guidelines on the Procurement, Design and Management Requirements of the Safety, Health and Welfare at Work (Construction) Regulations 2006'*. This will encompass the use of all necessary Personal Protective Equipment and adherence to the site Health and Safety Plan. Appropriate health and safety signage will also be erected at locations around the site to ensure workers adhere to guidelines and regulations.

A 110 kv electricity line from the Cushaling substation traveses the site along the southern boundary. Appropriate warning measures including 'goalposts' will be used as appropriate to prevent contact with overheads lines.

Residual Effect
Short-term potential slight negative effect

4.9.2.3 Employment and Investment

The construction cost of the project will be in the region of €110 million, approximately 30% of which will relate to onsite works. The construction phase of the proposed development will last for approximately 18 months and during this time will employ up to 120 people. Where possible, the majority of construction workers and materials will be sourced locally, thereby helping to sustain employment in the construction trade. This will have a short-term significant positive effect.

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

The proposed development will result in skilled jobs being available in the area, bringing specialist skills for both the construction and operational phases that could result in the transfer of these skills into the local workforce, thereby having a long-term positive effect on the local skills base. Up-skilling and training of local staff in the particular requirements of the wind energy industry is likely to lead to additional opportunities for those staff as additional wind farms are constructed in Ireland. Any such upskilling and training will have a long-term moderate positive indirect effect.

4.9.2.4 Land-use

The existing land-use of peat extraction will have ceased prior to construction. The site rehabilitation plan (see Section 5 of the EIS) incorporates the development of the wind farm. The required rehabilitation will commence once construction activities have been completed. This will have a temporary slight negative effect.

4.9.2.5 Noise

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

Construction noise at any given noise sensitive location will be variable throughout the construction project, depending on the activities underway and the distance from the main construction activities to the receiving properties. The potential noise effects that will occur during the construction phase of the proposed development are further described in Section 10 of this EIS. This will have a temporary slight negative effect.

Mitigation
Best practice measures for noise control will be adhered to onsite during the construction phase of the proposed development in order to mitigate the slight short-

term negative effect associated with this phase of the development. The measures will include:

- Sensitive location of equipment, taking account of local topography and natural screening.
- Working methods: construction noise will be controlled by prescribing that standard construction work will be restricted to the specified working hours. Any construction work carried out outside of these hours shall be restricted to activities that will not generate noise of a level that may cause a nuisance to local noise sensitive properties (e.g. dwelling houses). The phasing of works has also been designed with regard to avoidance of noise effects.
- Where possible, plant will be selected taking account of the characteristics of noise emissions from each item. All plant and machinery used on the site shall comply with E.U. and Irish legislation in relation to noise emissions. The timing of on- and off-site movements of plant near occupied properties will be controlled.
- Operation of plant: all construction operations shall comply with guidelines set out in British Standard documents *'BS 5338: Code of Practice for Noise Control on Construction and Demolition Sites'* and *'BS5228: Part 1: 1997: Noise & Vibration Control on Construction and Open Sites'*. The correct fitting and proper maintenance of silencers and/or enclosures, the avoidance of excessive and unnecessary revving of vehicle engines, and the parking of equipment in locations that avoid possible effects on noise-sensitive locations will be employed.
- Training and supervision of operatives in proper techniques to reduce site noise, and self-monitoring of noise levels, if appropriate.

Residual Effect
Short-term imperceptible negative effect

4.9.2.6 Dust

Potential dust emission sources during the construction phase of the proposed development include upgrading of existing access tracks and construction of new access roads, turbine foundations, internal road network, construction compounds and substations. These effects will not be significant and will be relatively short-term in duration. This will have a short-term slight negative effect.

Mitigation
It is anticipated that a significant volume of the aggregate material for the construction of roads and turbine bases will be sourced onsite; therefore, the need to transport this material to the site will be minimised. Any material sourced off site will be from local authorised quarry operators and will access the site using the haul route.

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

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

Residual Effect
Short-term imperceptible negative effect

4.9.2.7 Traffic

A full Traffic and Transport assessment has been carried out by Alan Lipscombe Traffic and Transport Consultants, the results of which are presented in Section 13.1 of this EIS.

Turbines will be delivered to the site of the proposed development from the direction of Tullamore, Co. Offaly. The site will have one entrance for the purposes of turbine delivery, which is into the western side of the site via the R402 and the L1003 local road. This entrance will also be used for the majority of general construction traffic. The junction at the R402 and the local road and the local road itself for about 430 metres will require upgrade to accommodate the abnormal loads related to turbine delivery.

There is an existing entrance into the eastern side of the site via the R401 Regional road in the townland of Ballykilleen which is proposed for a portion of the general construction traffic and for during the operational phase. Minor upgrade works will be required to the eastern entrance in order to accommodate access and egress of construction vehicles.

During the turbine construction stage when general materials are delivered to the site, the delivery of construction materials will have a slight effect but will be temporary. During the days when the various components of wind turbine plant are delivered to the site by extended articulated vehicles, the effect of the delivery vehicles on traffic during these days will be significant but will be temporary; see Section 13.1 for further details. During the days when the concrete foundations are poured the effect on the surrounding road network will be moderate but will be temporary.

Mitigation
Aggregate materials for the construction of any additional site tracks will be primarily obtained from the proposed borrow pit on the site of the proposed development. This will significantly reduce the number of delivery vehicles required to access the site.

Turbine plant will be delivered to the site at night in order to reduce impacts on local traffic.

Residual Effect
Temporary slight negative effect

4.9.2.8 Tourism and Amenity

Temporary widening of the R402 road in Ballinagar village is required to accommodate the transport of turbines to the proposed wind farm. The temporary works will require the temporary removal of the existing footpath, vegetation and boundary wall that form part of the public park area. Further excavations will be required to allow the importation of suitable fill material to build the area back up to the existing road level. The extended area will then be stoned over to allow the traverse of the vehicles carrying the large components. The relevant areas of the public park will be closed to the public during the turbine delivery period. This temporary loss of amenity will have a moderate negative effect.

As there are no tourism or amenity attractions specifically pertaining to the wind farm site there are no effects associated with the construction phase of the proposed development at this location.

Mitigation
Once turbine deliveries are completed, the public park area will be fully reinstated and planted in accordance with the requirements of Offaly County Council.

Residual Effect
Temporary slight negative effect

4.9.2.9 Shadow Flicker

Shadow flicker, which occurs during certain conditions due to the movement of wind turbine blades, as described in Section 4.7 of this chapter of the EIS, occurs only during the operational phase of a wind energy development. There are therefore no shadow flicker effects associated with the construction phase of the proposed development.

4.9.2.10 Residential Amenity

The construction phase of the proposed development will give rise to some effects in terms of noise and vibration, dust, traffic and visual amenity, as described in the relevant chapters of this EIS and also addressed above in terms of effects on Human Beings. In the absence of any mitigation, the construction works could pose a significant to moderate short-term negative effect on residential amenity at properties located in the vincity of the proposed development site.

Mitigation
All mitigation as described in relation to noise and vibration, dust, traffic and visual amenity in this EIS will be implemented in order to reduce and avoid insofar as possible effects on residential amenity at properties located in the vicinity of the proposed development works, including along the proposed turbine and construction materials haul route.

Residual Effect
There will be a short-term slight negative effect on residential amenity in the vincinity of the proposed development site during construction works.

4.9.3 Operational Phase

4.9.3.1 Population

The operational phase of the proposed development will have no effect on the population of the Study Area with regards to changes to trends, population density, household size or age structure.

4.9.3.2 Health and Safety

The operational phase of the proposed development poses no significant threat for the health and safety of the general public. The Department of the Environment, Heritage and Local Government (DoEHLG)'s *'Wind Energy Development Guidelines for Planning Authorities 2006'* state that there are no specific safety considerations in relation to the operation of wind turbines. Fencing or other restrictions are not necessary for safety considerations. People or animals can safely walk up to the base of the turbines. The wind turbines will be fitted with anti-vibration sensors, which will detect any imbalance caused by icing of the blades. The sensors will cause the turbine to wait until the blades have been de-iced prior to beginning operation. Lightning protection conduits will be integral to the construction of the turbines. The provision of underground electric cables of the capacity proposed is common practice throughout the country and installation to the required specification does not give rise to any specific health concerns. Further details on turbine safety are presented in Section 4.5.2 above.

The site-specific Emergency Response Plan (ERP) will be developed prior to the construction of the facility and will include details on the response required and the responsibilities of all personnel in the event of an emergency.

The Environmental Manager will be responsible for any corrective actions required as a result of an incident e.g. an investigative report or environmental sampling, and will advise the wind farm operator as appropriate.

There will therefore be no effects on health and safety during the operational phase of the proposed development.

4.9.3.3 Employment and Investment

On a long-term scale, the proposed development will create up to six jobs during the operational phase relating to the maintenance and control of the wind farm, having a long-term slight positive effect.

4.9.3.4 Land-use

The footprint of the proposed development site, including turbines, roads etc., will occupy only a small percentage of the total Study Area defined for the purposes of this EIA. The main land-use of commercial peat harvesting will cease prior to the construction of the wind farm and a rehabilitation plan will be implemented as described in Section 5.4 of the EIS. Other land-uses within the wider area, will be unaffected by the proposed development. The design of the proposed development incorporates parking spaces at the site entrances, in order to accommodate use of the completed onsite roads for walking and cycling. Therefore, the proposed development will have moderate positive effect in terms of land-use.

4.9.3.5 Noise

A noise assessment of the operational phase of the proposed development has also been carried out through modelling of the development using noise prediction software, the results of which are presented in Section 10 of this EIS. The predicted noise levels for the proposed development have been compared with the existing background noise levels and the guidance levels for noise emissions from wind farms as set out by the Department of the Environment, Heritage and Local Government (DoEHLG).

It is predicted that noise levels associated with the proposed development will be within best practice noise criteria curves recommended in Irish guidance *'Planning Guidelines for Wind Farm Development 2006'*. While noise levels at low wind speeds will increase, the predicted levels are will remain low, albeit a new source of noise will be introduced into the soundscape.

In the event that exceedances of noise conditions arise, the curtailment of turbine operation can be implemented for the relevant turbines at the specified wind conditions in order to ensure noise levels are within the relevant noise criterion curves/planning conditions. Such curtailment can be applied using the wind farm SCADA system without undue impact on the wind farm operations. The wind farm's SCADA control system can change a particular turbine's operating mode during certain conditions or times, or even turn the turbine off if necessary.

As has been demonstrated in Section 10 of this EIS the relevant national guidance in relation to noise associated with wind turbines can be satisfied, and the predicted effect associated with the operational turbines is long term and not significant.

In relation to the proposed substation the associated effect is long term and not significant.

4.9.3.6 Traffic

During the operational phase the effect on the surrounding local highway network will be negligible given that there will only be a maximum of six staff members on site at any one time. Operation and maintenance activities will therefore have an imperceptible effect on local traffic.

4.9.3.7 Renewable Energy Production and Reduction in Greenhouse Gas Emissions

Emissions from energy production account for 23% of Ireland's greenhouse gas emissions, which is higher than the percentage produced by any other sector. The National Climate Change Strategy 2007 – 2012 states that electricity generation from renewable sources provides the most effective way of reducing the contribution of power generation to Ireland's greenhouse gas emissions.

The proposed development will offer significant benefits in terms of renewable energy production and reductions in greenhouse gas emissions. In this regard it will have a long-term significant positive effect.

4.9.3.8 Tourism and Amenity

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".*

Mountlucas Wind Farm is open for anybody who would like to explore the area. This wind farm received an estimated 15,000 visits in 2015. The visits comprised of guided tours of the site and visitors accessing the walkway/cycle way. Bord na Móna has created a 7 km public walkway-cycleway around the wind farm. This trackway is ideal for a number of activities including, bird watching, nature exploration, cycling, walking and running The walkway-cycleway is accessible all year round (except December 21st) during daylight hours – free of charge. This type of amenity use has been proven on wind farms on cutaway peatlands and will be considered for Cloncreen, as detailed in Section 3.4 of this EIS.

It is noteworthy that the Bord and Móna Ballycon bog lies between the Cloncreen wind farm site and the existing Mountlucas site. In 2006 a program of wetland enhancement work commenced at Ballycon Bog to establish a wetland habitat following the cessation of peat extraction. This area would be considered to form part of the portfolio of rehabilitated cutaway peatlands areas of high biodiversity with the Bord na Móna landbank. The Mountlucas Wind Farm is connected by rail line to Cloncreen that passes through the Ballycon bog. This connection creates the potential for further extension of the existing Mountlucas amenity walkway to Ballycon and also connection to the proposed walkway in Cloncreen. A potential connection between Mountlucas and

Cloncreen will be considered pending permission and construction of Cloncreen wind farm.

It is not considered that the proposed development would have an adverse effect on tourism infrastructure in the vicinity and taking proposals for recreational facilities at the site into consideration, the proposed development would have a long-term slight positive effect on tourism.

4.9.3.9 Shadow Flicker

The amount of shadow flicker that will occur at properties located within the area surrounding the proposed development site has been calculated using the WindFarm Version 4.1.2.3 software package. Some level of shadow flicker is predicted to occur at 56 of the 95 properties modelled for this assessment, assuming worst-case conditions. Of these 95 properties, the WindFarm model predicts that in the absence of appropriate mitigation measures, the DoEHLG guideline values for the total amount of shadow flicker to occur per day may be exceeded at 27 of these properties.

Of the 95 no. properties modelled for this assessment, the total annual guideline limit of 30 hours is predicted to be exceeded at 11 no. properties, assuming worst-case conditions. When the regional sunshine average figure of 29.2% is taken into account, the number of properties at which the annual guideline limit of 30 hours is predicted to be exceeded is reduced to zero.

Mitigation

Where necessary, a screening assessment, screening measures and/or wind turbine control measures will be employed to limit the incidence or duration of shadow flicker at the affected property. As the shadow flicker assessment is based on a "bare-earth" scenario, a screening assessment which accounts for features such as undulations in local topography, built structures such as sheds or walls, or vegetation, may find that there is no requirement for further mitigation strategies. In the absence of screening features as described above, a number of screening measures will be proposed to the property owner, including the installation of window blinds or curtains in affected rooms, planting of screening vegetation or other site specific measures agreeable to the affected party.

Should it not be possible for the parties to agree on a set of appropriate screening measures, turbine control measures will then be used to meet the guidelines thresholds, as described below. In order to demonstrate how the SCADA control system can be applied to switch off particular turbines at the relevant times and dates, Table 4.12 lists the 27 properties at which a shadow flicker mitigation strategy may be necessary to ensure the DoEHLG 30-minute per day shadow flicker threshold is not exceeded. In this case, the relevant turbine(s) would be programmed to switch off for the time required to reduce daily shadow flicker to a maximum of the guideline limit of 30 minutes. The SCADA control system would be utilised to control shadow flicker in the absence of being able to agree suitable screening measures with the relevant property owner. The mitigation strategy outlined in Table 4.12 below is based on the worst-case scenario. The details presented in Table 4.12 list the days per year and the turbines that could be programmed to switch off at specific times, in order to reduce daily shadow flicker to a maximum of 30 minutes.

Table 4.12 Shadow Flicker Mitigation Strategy – Turbine Numbers and Dates

Property No.	No. of Days 30min/day Threshold is Exceeded	Turbine(s) Producing Shadow Flicker	Days of Year When Mitigation May Be Required (Day No's)	Post-mitigation Maximum Daily Shadow Flicker (hrs:mins:sec)
1	37	1	46-63, 283-301	00:30:00
6	31	1	1-3, 7-8, 338-340, 344-366	00:30:00
26	25	1	1, 10-11, 336, 346-366	00:30:00
27	69	1, 13	1-24, 322-366	00:30:00
28	58	1, 13	1-19, 327-366	00:30:00
29	48	1, 13	1-24, 322-345, 366	00:30:00
30	31	1, 13	5-20, 327-341	00:30:00
31	57	1, 13	1-13, 16-27, 319-326, 328-331, 334-351, 362-366	00:30:00
79	15	21	16-23, 324-330	00:30:00
80	35	21	7-24, 323-339	00:30:00
125	30	21	29-43, 303-317	00:30:00
126	26	17, 21	46-58, 288-300	00:30:00
127	55	17, 21	1-2, 4-6, 51-63, 283-295, 340-342, 345-366	00:30:00
128	23	8, 16	52-61, 106-107, 238-239, 285-293	00:30:00
130	9	8	83-86, 259-263	00:30:00
131	11	8	85-89, 256-261	00:30:00
132	11	8	87-92, 253-258	00:30:00
133	10	8	92-96, 249-253	00:30:00
134	12	8	94-99, 246-251	00:30:00
135	12	7, 8	98-103, 242-247	00:30:00
136	10	7, 8	101-105, 240-244	00:30:00
137	10	7, 8	104-108, 237-241	00:30:00
138	8	7, 8	107-110, 235-238	00:30:00
139	7	7, 8	110-113, 232-235	00:30:00
155	19	7	130-138, 206-215	00:30:00
356	22	17, 21	41-51, 295-305	00:30:00
359	36	19, 20	47-51, 99-111, 235-247, 296-300	00:30:00

Where a shadow flicker mitigation strategy is to be implemented, it is likely that the control mechanisms would only have to be applied to one turbine to bring the duration of shadow flicker down to the 30-minute post-mitigation shadow flicker target.

Overall, the details presented in Table 4.12 demonstrate that using the turbine control system, it will be possible to reduce the level of shadow flicker at any affected property to below the daily guideline limit of 30 minutes, by programming the relevant turbines to switch off at the required dates and times.

Shadow flicker occurs only when the sun is shining. Therefore, if the sun is not shining, or sunlight levels are less than what would be required to cast a shadow, during the dates or times that a particular turbine has been programmed to switch off, there would be no requirement to switch that turbine off. When the mitigation measures are accounted for, there will be no significant residual effects from shadow flicker as a result of the proposed wind farm.

4.9.3.10 Interference with Communication Systems

Wind turbines, like all electrical equipment, produce electro-magnetic radiation and this can interfere with broadcast communications. This interference can be overcome by the installation of deflectors or repeaters (Department of the Environment, Heritage and Local Government, 2006). As part of the preparation of the EIS, MKO carried out an extensive scoping exercise, which included consultation with national and regional broadcasters and fixed and mobile phone operators. The details regarding the scoping exercise and a full list of consultees are provided in Section 2.9 of this EIS. Copies of scoping replies received are presented in Appendix 2-1 of the EIS.

A 40-metre telecommunications mast is currently located at Cloncreen bog. It is proposed to remove this mast as part of the proposed development. The mast is the property of Bord na Móna plc and if consent is granted for the project, Bord na Móna will enter into discussions with the current telecommunications operators with regard to the provision of an alternative location, an alternative methodology to meet the current operators' requirements or cessation of the service provision.

Further details regarding telecommunications are provided in Section 13.2, Material Assets. If further scoping responses are received, the comments of the consultees will be considered in the construction and operation of the proposed development, subject to the grant of planning permission. When mitigation measures are employed, there will be no effects on the operation of communication systems.

4.9.3.11 Residential Amenity

Potential effects on residential amenity during the operational phase of the proposed wind farm could arise primarily due to noise, shadow flicker or changes to visual amenity. Detailed noise and shadow flicker modelling has been carried out as part of this EIS, which shows that the proposed development will be capable of meeting all required guidelines in relation to noise and shadow flicker thresholds. Cognisance of potential revisions to the current guidelines has also been had, and in the event of lower thresholds for noise or shadow flicker being implemented, the appropriate mitigation measures can be used to meet the updated requirements.

The visual effect of the proposed development is addressed comprehensively in Section 10 of this EIS. The proposed development has been designed to maximise turbine separation distances to dwellings in the area, with no turbines located within 700 metres of a dwelling. Given this distance, and the level of existing screening in the area, the proposed development will have no significant effect on existing visual amenity at dwellings.

Mitigation

No turbines are proposed within 700 metres of any occupied dwellings. All mitigation as outlined under noise and vibration, dust, traffic, visual amenity and telecommunications in this EIS will be implemented in order to reduce insofar as possible effects on residential amenity at properties located in the vicinity of the proposed development works, including along the proposed turbine and construction materials haul route.

Residual Effect

The proposed development will have an imperceptible effect on residential amenity.

4.9.4 Cumulative Impact Assessment

For the assessment of cumulative impacts, any other existing, permitted or proposed developments (wind energy or otherwise) have been considered where they had the potential to generate an in-combination or cumulative effect with the proposed Cloncreen wind farm. Further information on the developments, plans and projects considered as part of the cumulative assessment are given in Section 2.10 of this EIS. The impacts with the potential to have cumulative effects on human beings, in particular noise, shadow flicker and visual effects are addressed in the relevant chapters.

4.9.4.1 Employment and Economic Activity

The permitted Yellow River wind farm is located within 20 kilometres of the proposed development site (minimum distance of 9.2 kilometres). The Yellow River and Cloncreen projects will contribute to short term employment during their construction stages and provide the potential for long-term employment resulting from maintenance operations. This results in a long-term significant positive effect.

Other projects as described in the cumulative assessment in Section 2.10.2 of this EIS also have the potential to provide employment in the short term.

4.9.4.2 Tourism

4.9.4.2.1 Recreation and Amenity

Designated sections, to be indentifed post-construction, of the internal road network at Cloncreen will be available for use as a public walkway-cycleway. This represents a positive cumulative effect in conjunction with the existing 7-kilometre public walkway-cycleway at Mountlucas wind farm.

The Bord na Móna Ballycon bog lies between the Cloncreen wind farm site and the existing Mountlucas site. In 2006 a program of wetland enhancement work commenced at Ballycon Bog to establish a wetland habitat following the cessation of peat extraction. The Mountlucas wind farm is connected by rail line to Cloncreen that passes through the Ballycon bog. This connection creates the potential for further extension of the existing Mountlucas amenity walkway to Ballycon and also connection to the proposed walkway in Cloncreen, thereby enhancing the potential positive cumulative effect.

4.9.4.2.2 Traffic

As stand alone projects or cumulatively, the construction phase of projects will have a short-term slight to moderate negative effect on tourism as nuisance from construction traffic is unavoidable.

Mitigation

Phased development will be employed to allow for construction traffic to be managed and to minimise the volume of construction traffic using the road network at any one time. The proposed phasing is set out in Chapter 3 and Chapter 13.

Residual Effect

Short term slight negative effect

4.9.4.3 Health and Safety

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

4.9.4.4 Property Values

There is no statistical evidence that home prices near wind turbines are affected post or pre construction periods after announcing development. A long-term imperceptible cumulative effect is anticipated.

4.9.4.5 Services

Potential cumulative effect through injection of money into local services though short and long-term employment and community gain fund. This is expected to be a long-term positive cumulative effect.

4.9.4.6 Shadow Flicker

As discussed in Section 4.7.5.3 above, no cumulative shadow flicker will occur at properties in the vicinity of the proposed wind farm.

4.9.4.7 Residential Amenity

In the unlikely event of all permitted and proposed projects as described in the cumulative assessment in Section 2.7 of this EIS being constructed at the same time, there is the potential for a resulting cumulative negative effect to occur on residential amenity.

Mitigation
No turbines are proposed within 700 metres of any occupied dwellings. All mitigation as outlined under noise and vibration, dust, traffic, visual amenity and telecommunications in this EIS will be implemented in order to reduce insofar as possible effects on residential amenity at properties located in the vicinity of the proposed development works, including along the proposed turbine and construction materials haul route. It is assumed also that all mitigation measures in relation to the other cumulative projects will also be implemented.

Residual Effect
The proposed development will have an imperceptible effect on residential amenity.

4.10 Conclusion

Following consideration of the residual effects (post-mitigation) it is noted that the proposed development will not result in any significant effects on Human Beings in the area surrounding the proposed development. Although some level of shadow flicker is predicted to occur at 56 no. of the 95 no. properties modelled for this assessment assuming worst-case conditions, the 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. When the regional sunshine average figure of 29.2% is taken into account, the number of properties at which the annual guideline limit of 30 hours is predicted to be exceeded is zero. Provided that the proposed wind farm development is constructed and operated in accordance with the design, best practice and mitigation that is described within this application, significant effects on human beings are not anticipated at international, national or county scale.