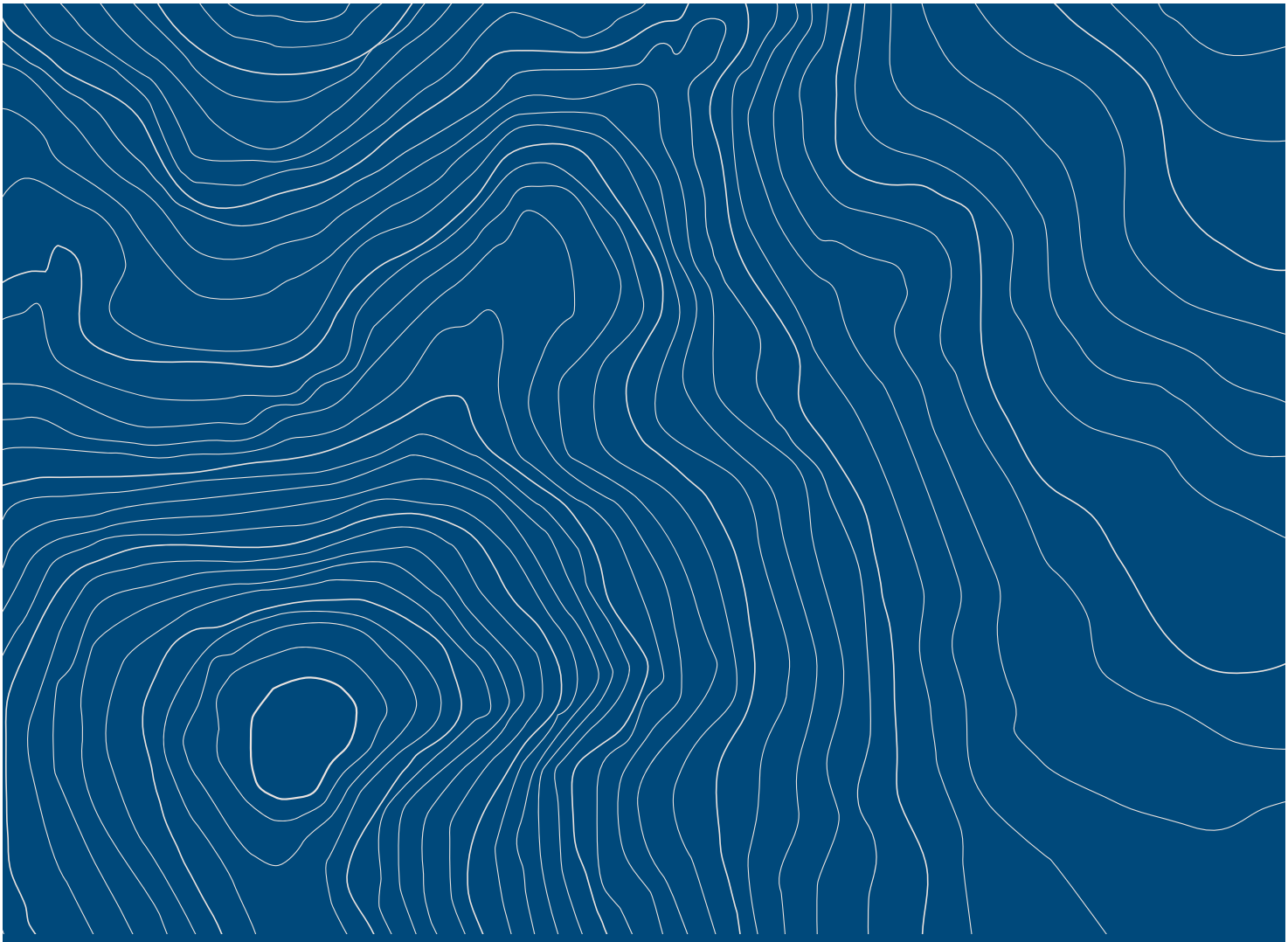

DublinArray
Generation for generations

EIAR Volume 4: Offshore Infrastructure Technical Appendices Appendix 4.3.15-2: Visual Assessment of Turbine Lighting

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Dublin Array Offshore Wind Farm

Environmental Impact Assessment Report

Volume 4, Appendix 4.3.15-2: Visual Assessment of Turbine Lighting

Contents

Acronyms

Term	Definition
AA	Appropriate Assessment
CD / mCD	Chart Datum/ meters relative to Chart Datum
CEA	Cumulative Effects Assessment
DAHG	Department for Culture, Heritage and the Gaeltacht
DCCAE	Department of Communications, Climate Action and Environment
Dublin Array	Dublin Array Offshore Wind Farm
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EIS	Environmental Impact Statement
EPA	Environment Protection Agency
GCP	Grid Connection Point at existing Carrickmines 220kV substation
GIS	Geographical Information System
GW	Gigawatt
HDD	Horizontal Directional Drilling
INFOMAR	Integrated Mapping for the Sustainable Development of Ireland's Marine Resource
km	Kilometres
LAT/ mLAT	Lowest Astronomical Tide/ meters relative to Lowest Astronomical Tide
MAC	Marine Area Consent
MAPA	Maritime Area Planning Act 2021
MARA	Marine Area Regulatory Authority
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MPDM	Marine Planning and Development Bill
MSL	Mean Sea Level
MW	Megawatt
NIS	Natura Impact Statement
NPWS	National Parks Wildlife Service
O&M	Operations and maintenance
OECR	Onshore export cable route
OECC	Onshore export cable corridor

Term	Definition
OFECC	Offshore export cable corridor
OFECR	Offshore export cable route
ORE	Offshore Renewable Energy
OREDP	Offshore Renewable Energy Development Plan
OSS	Onshore substation
OSP	Offshore Substation Platform
R&D	Research and development
ROI	Republic of Ireland
RSL	Relative Sea Level
RWE	RWE Renewables Ireland Ltd (a wholly owned subsidiary of RWE AG)
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SPA	Special Protection Area
UK	United Kingdom
WTG	Wind turbine generator
ZTV	Zone of Theoretical Visibility

1 Introduction

1.1.1 This Technical Appendix has been prepared to accompany Volume 3, Chapter 15: Seascape, Landscape and Visual Impact Assessment (hereafter referred to the SLVIA Chapter). The focus of this Appendix is on the visual assessment of the visible lighting requirements (aviation and marine navigation) of the proposed offshore infrastructure of Dublin Array Wind Farm (hereafter referred to as Dublin Array).

1.1.2 This appendix is supported by the following plan figures and night-time photomontage visualisations from three viewpoints:

- 3.15.21 – Baseline lighting
- 3.15.22 – Hub lighting ZTV
- 3.15.23 – Marine Navigation Lighting ZTV
- 3.15.28 - Viewpoint 4: Greystones Harbour
- 3.15.35 - Viewpoint 11: Vico Road seating area
- 3.15.42 - Viewpoint 18: Howth Head

1.1.3 A description of the proposed lighting is found within Volume 2, Chapter 6: Project Description, Volume 3, Chapter 12: Aviation and Radar, and Volume 3, Chapter 10: Shipping and Navigation.

2 Regulations and Guidance

2.1 International Civil Aviation Organisation (ICAO)

2.1.1 ICAO (a United Nations (UN) body) sets international Standards; Recommendations and 'Notes' for aviation lighting in its publication 'Annex 14 to the Convention on International Civil Aviation' - Volume I Aerodrome Design and Operations (ICAO, Eighth Edition, July 2018).

2.1.2 In the section on 'Lighting' of wind turbines (ICAO Annex 14 page 6-10), the following criteria is recommended:

'i) for wind turbines of less than 150 m in overall height (hub height plus vertical blade height), medium-intensity lighting on the nacelle should be provided;

ii) for wind turbines from 150 m to 315 m in overall height, in addition to the medium-intensity light installed on the nacelle, a second light serving as an alternate should be provided in case of failure of the operating light. The lights should be installed to assure that the output of either light is not blocked by the other; and

iii) in addition, for wind turbines from 150 m to 315 m in overall height, an intermediate level at half the nacelle height of at least three low-intensity Type E lights, as specified in 6.2.1.3, should be provided. If an aeronautical study shows that low-intensity Type E lights are not suitable, low-intensity Type A or B lights may be used.'

2.1.3 ICAO Table 6.1 (ICAO Annex 14 page 6-4) identifies the international definitions of daylight; twilight and night based on measured background illuminance as follows.

- Daylight: Above 500 cd/m^2
- Twilight: 50-500 cd/m^2
- Night: Below 50 cd/m^2

2.1.4 For 2,000 cd lights, ICAO indicates a requirement for no lighting to be switched on until 'Night' has been reached, as measured at 50 cd/m^2 or darker. ICAO Table 6.3 (page 6-5) identifies minimum requirements and recommendations for 2,000 cd aviation lights on wind turbine generators (WTGs) at 150 m and above. In summary these are:

2.1.5 Minimum requirements:

- 0 to +3° from horizontal: 2,000 cd minimum average intensity (or 1,500 cd minimum intensity)
- -1° from horizontal: 750 cd minimum intensity

2.1.6 The navigational requirements for marking man-made structures in the marine environment are set out in the IALA Recommendation 'R0139 (O-139) The Marking of Man-Made Structures' (2021) and IALA Guideline 'G1162 The Marking of Man-made Structures' (2022). In respect of groups of offshore WTGs, the guidelines require significant peripheral structures (SPS) to be marked using a flashing yellow light with a nominal range of 5 nautical miles and with a special mark characteristic.

2.2 Irish Aviation Authority

2.2.1 The Irish Aviation Authority (IAA) Aeronautical Services Advisory Memorandum (ASAM) Number 018 Issue 2 'guidance material on offshore wind farms' (2015) states the following in relation to 'Lighting Requirements to Protect Marine Navigation Safety':

'Yellow lights will be fixed to all machines and shall be located appropriately at a point(s) on the structure above the Highest Astronomical Tide but below the lowest point of the arc of the structure's rotor blades. Such lights will be visible through 360° in azimuth and will have vertical divergence of 5° above and below the horizontal, 5 nautical miles visibility and a minimum of 99% availability.

Structures chosen as suitable for representing the periphery of wind farms are termed Significant Peripheral Structures. Such structures will be spaced along the periphery of wind farms at intervals of no more than 3 nautical miles, where practicable. Such structures will be lighted with flashing lights of distinctive navigational characteristic fitted above the Highest Astronomical Tide but below the lowest point of the arc of the structure's rotor blades. Such lights will be visible through 360° in azimuth and have a vertical divergence of 5° above and below the horizontal, 10 nautical miles visibility and a minimum of 99% availability.'

2.2.2 The Irish Aviation Authority (IAA) 'guidance material on offshore wind farms' (2015) states the following in relation to 'Lighting Requirements to Protect Air Navigation Safety':

'The lighting required to protect air navigation will be the lighting specified to protect marine navigation safety, supplemented as follows.

All Significant Peripheral Structures, of height ≥ 90m, to the highest point of the structure including the top of blade spin where appropriate, above Mean Sea Level; will be fitted with high intensity warning lighting meeting the following requirements:

- *the lighting must be mounted on the highest point practicable of the fixed structure;*
- *be in accordance with the International Civil Aviation Organisation (ICAO) Annex 14 standards, on a H24 basis, for High Intensity Type A lighting:*
  - *colour white with a flash rate of 40~60 fpm;*
  - *have an effective intensity, with background luminance above 500cd/m², of 200,000 cd ± 25%;*

- *have an effective intensity, with background luminance 50~500cd/m², of 20,000 cd ± 25%;*
- *have an effective intensity, with background luminance below 50cd/m², of at least 2,000 cd;*
- *light fittings will be fully cut off so that practically no light will be emitted below the horizontal, or as otherwise agreed with the IAA;*
- *all lights across the farm should flash in synchronisation and reductions in light intensity should occur simultaneously, if practicable;*
- *be visible through 360° in azimuth*

- *any light which fails shall be repaired or replaced as soon as is reasonably practicable. An alerting system for light failure will be put in place, such as remote monitoring or other suitable method agreeable to the IAA.'*

2.3 Guidelines for Landscape and Visual Impact Assessment (GLVIA3)

2.3.1 GLVIA3 (page 103) provides the following guidance on the assessment of lighting effects: *'For some types of development the visual effects of lighting may be an issue. In these cases it may be important to carry out night-time 'darkness' surveys of the existing conditions in order to assess the potential effects of lighting and these effects need to be taken into account in generating the 3D model of the scheme. Quantitative assessment of illumination levels, and incorporation into models relevant to visual effects assessment, will require input from lighting engineers, but the visual effects assessment will also need to include qualitative assessments of the effects of the predicted light levels on night-time visibility.'*

2.3.2 GLVIA3 (page 60) also provides the following guidance with regards to mitigation of obtrusive light: *'lighting for safety or security purposes may be unavoidable and may give rise to significant adverse effects; in such cases, consideration should be given to different ways of minimising light pollution and reference should be made to appropriate guidance, such as that provided by the Institution of Lighting Professionals (ILP, 2011)'.*

2.4 Institute of Lighting Professional Guidance

2.4.1 Guidance produced by the Institute of Lighting Professionals (ILP) (2011) (GN01:2011) is useful in setting out some key lighting terminology that relates to potential visual effects.

'Obtrusive Light, whether it keeps you awake through a bedroom window or impedes your view of the night sky, is a form of pollution, which may also be a nuisance in law and which can be substantially reduced without detriment to the lighting task. Skyglow - the brightening of the night sky; Glare - the uncomfortable brightness of a light source when viewed against a

darker background; and Light Intrusion - the spilling of light beyond the boundary of the property or area being lit, are all forms of obtrusive light which may cause nuisance to others.'

2.4.2 The following key guidance within the ILP GN01:2011 is noted as follows:

- *'The most sensitive/critical zones for minimising sky glow are those between 90° and 100° (note that this equates to 0-10° above the horizontal).*
- *Keep glare to a minimum by ensuring that the main beam angle of all lights directed towards any potential observer is not more than 70°.*
- *In rural areas the use of full horizontal cut off luminaires installed at 0° uplift will, in addition to reducing sky glow, also help to minimise visual intrusion within the open landscape.*
- *Upward Light Ratio (ULR) of the Installation is the maximum permitted percentage of luminaire flux that goes directly into the sky. A ULR of 0 (zero) Candela (cd) is suggested for Dark Sky Parks.'*

2.4.3 The Campaign for Rural England (CPRE) is a UK based group that campaigns against light pollution along with other potentially harmful effects to rural life. They have published England's Light Pollution and Dark Skies (2016) and provide guidance on their website to explain light pollution. In the absence of an equivalent organisation in the RoI providing such information, a useful reference is made here to the following three types of light pollution relevant to this assessment:

- *'skyglow – the pink or orange glow we see for miles around towns and cities, spreading deep into the countryside, caused by a scattering of artificial light by airborne dust and water droplets.*
- *glare – the uncomfortable brightness of a light source.*
- *light intrusion – light spilling beyond the boundary of the property on which a light is located, sometimes shining through windows and curtains'.*

2.5 NatureScot Guidance

2.5.1 NatureScot guidance is specifically relevant to the assessment of wind farms, including the presentation of visible aviation lighting. In the absence of equivalent Irish specific guidance, in relation to how to conduct a lighting assessment for an offshore windfarm, the Applicant had regard to this NatureScot Guidance.

Visual Representation Guidance

2.5.2 In terms of how lighting is captured in visualisations, the main change in the latest version of the NatureScot guidance *'Visual Representation of Wind Farms' (Version 2.2, February 2017) is in paragraphs 174-177, which states: 'The visualisation should use photographs taken in low light conditions, preferably when other artificial lighting (such as street lights and lights on buildings) are on, to show how the wind farm lighting will look compared to the existing baseline at night'… 'We have found that approximately 30 minutes after sunset provides a reasonable balance between visibility of the landform and the apparent brightness of artificial lights, as both should be visible in the image.'*

2.5.3 The night-time photography has therefore been captured in low light conditions, when other artificial lighting (such as streetlights and lights on buildings) is on, to show how the wind farm lighting would look compared to the existing baseline at night (including situations where no existing lighting is visible in the view).

2.5.4 Existing lights shown in the photographs appear larger and more blurred than those seen to the naked eye in the field when the photographs were captured. The term used in photography to describe this effect is 'Bokeh' which has been defined as *'the way the lens renders out-of-focus points of light'.* This has proved difficult to avoid when taking photographs of light at varied distances across a view. The blurred nature of the lights is also exacerbated by their movement, particularly on vehicle headlights. Where the lights of the proposed development have been added to the night-time views this effect has been emulated.

2.5.5 The turbine blades, when they intermittently pass in front of the aviation lights, would cause randomised flickering when the lights are switched 'on'. The turbines used in the night-time visualisations have been positioned so that their blades face away from the viewpoint so that all the lights are visible and on within the visualisations, representing a worst-case impression. The flickering effect caused by the blades interacting with the lights would be most usually apparent from a south westerly direction due to the prevailing south-westerly wind.

Evolving NatureScot Approaches to Turbine Lighting

2.5.6 NatureScot workshops indicate that a proportionate and pragmatic approach is required, in providing mitigation (on a project and site-specific basis).

2.5.7 Mitigation options to eliminate or reduce the need for, and effects of, visible lighting are evolving quickly, and developers are exploring these with consultees in relation to specific sites. NatureScot has offered a perspective on the efficacy of different mitigation options, noting that the most effective appears to be radar activated, albeit accepting the considerable cost implications inherent in this potential option.

2.5.8 Ministers and planning authorities are using planning conditions to manage effects. It is recognised that the EIA Report should not necessarily specify one mitigation option, as these are evolving rapidly, and developers need flexibility to utilise the most appropriate mitigation once they are ready to start discharging conditions. Conditions provide some flexibility for developers to identify the most appropriate mitigation option(s) post consent and prior to construction, and to agree these with the relevant decision maker.

2.5.9 In terms of visual effects, NatureScot's view (as expressed at a seminar in November 2019) is that lengthy debate about the exact brightness of lights (including in visualisations) is potentially not helpful and that it is better to focus on where they will be visible, how many lights will be visible and the level of change from the baseline situation. This is recognised in the visual assessment in this Appendix. NatureScot has also taken a proportionate and pragmatic view with night-time visualisations, requesting that decision makers, consultees and communities require visualisations from a small number of relevant viewpoints to understand these effects. NatureScot also recognises the challenges of capturing night-time photography and accept that some post photographic manipulation of images to provide a good representation is acceptable. See also Appendix 15.1 which provides further detail on the production of visualisations.

3 Assessment Parameters

3.1.1 The description of proposed lighting is found within Volume 2, Chapter 6: Project Description, Volume 3, Chapter 12: Aviation and Radar, and Volume 3, Chapter 10: Shipping and Navigation. Based on this description, this appendix assesses two turbine lighting scenarios – a 2,000cd Red Aviation Warning Light Scenario and 2,000cd White Aviation Warning Light Scenario. Both scenarios also contain marine navigation lighting, and the following assumptions and maximum parameters are applied to both scenarios:

- Aviation warning lights comprising 2,000cd red or white lights will be located on top of the hub (170.6m above LAT) of all peripheral turbines - 1, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14, 15, 16, 17, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33, 34, 36, 37, 38 & 39, as shown on Figure 3.15.22.
- Aviation warning lights will flash simultaneously with a Morse W flash pattern and be able to be switched on and off by means of twilight switches.
- Aviation warning lights will have reduced intensity above and below the horizontal.
- Marine navigational lights will be fitted at the platform level (15m above LAT) of turbines 1, 4, 5, 6, 9, 14, 15, 16, 20, 21, 23, 24, 32, 36, 37 and 39, as shown on Figure 3.15.23.
- Search and rescue (SAR) lighting will be located on each of the turbines. These low intensity lights are not assessed or shown in the night-time photomontages, as they will not be switched on during normal operations and only during SAR operations.
- Infra-red lighting will also be located on each of the turbine hubs. The infra-red lighting is not visible to the human eye and so are not assessed as part of this appendix. Details of the infra-red lighting will be agreed with the Department of Defence.

3.1.2 The effect of the visible lights is dependent on a range of factors, including the intensity of lights used, clarity of atmospheric visibility and the degree of negative/ positive vertical angle of view from the light to the receptor.

4 Assessment of Effects

4.1 Types of Effect

4.1.1 The two scenarios assessed in this assessment reflect the differences in the requirements between the ICAO and IAA guidance on aviation lighting. At the time of writing, as it is not clear which guidance will take precedence post-consent, both requirements have been applied. In addition to the difference between the colour of the red and white lights, the IAA guidance also requires the white lights to be on 24 hours, while the ICAO guidance requires the red lights to be switched on when 'night' has been reached, as measured at 50 cd/m^2 or darker (typically 30 minutes before sunrise or after sunset).

4.1.2 This assessment focuses on the visual effects of the red and white lights during night-time. The visual assessment of visible turbine aviation lighting during the night-time is intended to determine the likely effects that Dublin Array offshore infrastructure will have on the visual resource i.e. it is an assessment of the effects of visible aviation lighting on views experienced by people at night.

4.1.3 The assessment of night-time aviation lighting in this Appendix does not consider effects of aviation lighting on landscape / seascape character (i.e. landscape effects). Night-time lighting will not affect landscape or seascape character as the landscape or seascape character will not be readily discernible at night. It is, therefore, considered that night-time aviation lighting will not affect the perception of landscape or seascape receptors, which are not readily differentiated at night, particularly in rural areas where artificial light levels are typically low. The assessment of night-time aviation lighting is solely a visual effect albeit that it may refer to the perception of special qualities present in the landscape at night, such as an important enclosing skyline, with that perception being a facet of visual effects. While aviation lighting will be visible and result in visual effects, as assessed in this Appendix, the effects of night-time aviation lighting on the perception of landscape or seascape receptors are scoped out of this assessment. This decision to scope out landscape effects at night-time reflects the Scottish Ministers' recent finding in the Crystal Rig IV Wind Farm Public Inquiry which agreed with the professional judgement that night-time aviation lighting would only have a visual effect and not an effect on landscape character.

4.1.4 The IAA requirement to have the white lights on 24 hours presents the potential for day-time effects to arise should this requirement be implemented. During the daytime, the effect on landscape and visual receptors will relate principally to the presence of the Dublin Array offshore infrastructure, in particular the WTGs and the movement of their blades during operation, and the presence of the emerging WTGs and the construction vessels and cranes during construction. The influence of white lights during daytime will appear less prominent owing to the relative brightness of the sky, compared to the influence of red or white lights seen within a dark night-time sky, and this will moderate the effect during daytime. While the influence of the white lights during daytime will have an additional effect on landscape and visual receptors, this will form a component part of the more substantial overall effect of the Dublin Array offshore infrastructure and will not alter the ratings for magnitude of change and assessment of significant effects presented in the SLVIA Chapter.

4.2 Baseline Lighting

4.2.1 The existing baseline lighting levels have been mapped for the surrounding landscape (see Figure 3.15.21) based on Open Source data of Light Pollution. This Open Source data has been used to help understand and illustrate the existing baseline lighting levels of the study area. Each pixel in the mapping shows the level of radiance (night lights) shining up into the night sky, which have been categorised into nine colour bands to distinguish between different light levels, from low level light pollution colour band one (darkest) to high level light pollution nine (brightest).

4.2.2 Figure 3.15.21 shows that the Dublin Array is located in an area within the lowest level of light pollution (darkest). The surrounding Irish Sea is also at this lowest level which accounts for a large part of the study area. The area surrounding the Wicklow Mountains (between 15 and 50km from the nearest turbine) is also shown to be at this lowest level of light pollution. The shape of Irelands coastline is clearly identifiable on Figure 3.15.21 as areas of moderate to bright light pollution follow the coastline, where built up areas and road networks combine to contribute to the overall baseline of light pollution. Areas of higher light pollution creating light pollution that spills up into the sky are found in larger settlements, particularly within Dublin where the highest levels of light pollution can be seen in central Dublin and within a few surrounding areas such as at Dublin Airport, Blanchardstown, Walkinstown, Clondalkin and Tallaght.

4.3 Extent of Visibility of Turbine Lighting

4.3.1 ZTV maps have been generated to demonstrate the extent to which the Dublin Array turbine lighting is theoretically visible from any point in the study area. See Figures 3.15.22 – Hub lighting ZTV and 3.15.23 – Marine Navigation Lighting ZTV.

Aviation Lighting Visibility

4.3.2 Figure 3.15.22: Hub lighting ZTV shows where the aviation lighting is theoretically visible. The ZTV shows that theoretical visibility spreads continuously across the Irish Sea to the north, east and south of the array area and extends beyond the extent of the 50 km study area. It also shows how theoretical visibility spreads continuously across the sea to the west, north-west and south-west for around 10km to the eastern Irish coastline.

4.3.3 Theoretical visibility is found on coastal landscapes within 20km of the nearest Dublin Array turbine, beyond which the landform of the hinterland gradually reduces the levels and extents of theoretical visibility and headlands restrict visibility further to the north and south along the coast. The extent of this potentially affected coastline stretches from Loughshinney in the north to Wicklow in the south (approximately 65 km).

4.3.4 Within this extent, theoretical visibility typically spreads inland from the coast by approximately 5 to 10km. Beyond which the elevated landform of the coastal slopes obscures much of the theoretical visibility further to the west. The main exception to this occurs in the north-west sector of the Study area, where the lower-lying landform of Dublin City and its surrounds. Note that the extent of urban development in this area will substantially reduce the extents of actual visibility by screening seaward views. The existing lighting within these urban areas combined with distance would also reduce the intensity of light potentially experienced.

4.3.5 The likelihood of significant effects occurring in respect of landscape and visual receptors in this north-west sector will therefore be largely reduced by the presence and influence of the city and the large-scale developments in the city centre and harbour areas, which are all lit during the hours of darkness.

Marine Navigation Visibility

4.3.6 Figure 3.15.23 – Marine Navigation Lighting ZTV shows where the marine navigational lighting is theoretically visible. The marine navigation lighting is located on the turbine platforms which are at the substantially lower elevation of 15m LAT. A comparison between the extent of theoretical visibility of the marine navigation lighting (Figure 3.15.23) with the theoretical visibility of the aviation lighting (Figure 3.15.22) illustrates the much more contained extents of the Marine Navigation lighting owing to its lower elevation. Although the extent to which these lights will be visible also relates to the reduction in their intensity, which will drop off with distance, this reduction is not factored into the production of the ZTV.

4.3.7 While theoretical visibility associated with the aviation lighting extends out to the edge of the 50km study area on the seaward side and select parts of the landward side, theoretical visibility of the marine navigation lighting extends only to 21km on the seaward site and is largely contained within 20km on the landward side, albeit with patches extending to the 30km and 40km radii across the north-west of the study area. The lower level and distant location of the marine navigation lighting means they will appear comparable to lights on ships, although static and permanent.

4.4 Representative Viewpoint Assessment

Viewpoint 4: Greystones Harbour

Night-Time Baseline Condition and Sensitivity

4.4.1 This viewpoint represents the views of visitors to the harbour, as well as local residents and road-users on the sea front. It is located on the harbour wall which encloses the recently redeveloped Greystones Harbour. The viewpoint is 8.92km to the south-west of the nearest proposed turbine of the Dublin Array.

4.4.2 Greystones is an attractive seaside town that is popular with visitors. Coastal views are a key feature of the area including views along the coast and out to sea. During the day, the view is characterised by the contrasting simple, open and expansive outlook of the seascape to the east and the more complex landscape and urban fabric to the west and along the coast to the north and south. The recent developments around the harbour are especially notable owing to their larger scale.

4.4.3 Whilst it is appreciated that visitors to this location may be present at night, the scenic aspects of this view are diminished in the hours of darkness. At night, the characteristics of seascape that create different patterns in the view are difficult to discern, however, at times when the skyline is still visible the landform profile is silhouetted and provides an indication of view direction within the wider panorama. The baseline night photography is captured at a time where the seaward horizon can be observed and the shape of the surrounding landform, urban fabric and coastal edge can be distinguished against the sky.

4.4.4 Existing lighting in the view includes - on the harbour itself; streetlights and lights in buildings within the nearby urban areas (including close to the coastal edge to the south); and the vehicle lights on roads to the north of the settlement. There are also occasional lights in the seaward direction from passing boats and ships (as can be seen in the baseline photography). The overall baseline lighting level is considered darker in the seaward direction where there are fewer baseline lights, however, considering the closely surrounding existing lighting of the harbour and settlement the overall baseline light levels at the viewpoint are considered to be moderately dark.

4.4.5 The value and visual susceptibility of receptors at night differs when compared to the assessment carried out for daytime conditions. During the night the landscape / seascape has a diminished scenic quality, and receptors would not have the same appreciation of the landscape / seascape which is dark and muted compared with the landscape / seascape characteristics evident during the day. The presence of baseline lighting associated with the harbour and settlement lowers the susceptibility at this location.

4.4.6 Value of the viewpoint is reduced and whilst the coastal aspect is the principal defining feature in the town of Greystones during the day, it is less apparent at night. Susceptibility is also reduced due to seaward views becoming much less of a focus for views at night, appreciating that during the hours of twilight, the attention of receptors could be particularly focussed in a seaward direction. Taking these factors into account, the night-time sensitivity of this location is considered to be medium.

Assessment of Visible Lighting

2,000cd Red Aviation Warning Light Scenario

4.4.7 Aviation and marine navigation lighting of the Dublin Array would be visible in the view at night, from 8.92 km to the nearest proposed turbine, including both the red medium intensity turbine lighting at nacelle height and yellow marine navigational lighting at turbine platform level. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the aviation lighting on the hubs would at most times be seen behind the rotors and so would be intermittently obscured by intervening blades. On this basis they would appear to flicker as the turbine blades pass the hub lights.

4.4.8 The lights would occupy a relatively wide part of the seaward panorama and would be seen as an unfamiliar feature during the hours of darkness. The lights would help to indicate the position of the horizon within the dark view to the east in contrast to the existing view at night that only has the occasional lights of passing ships as an indication.

4.4.9 The Dublin Array lighting would introduce points of light above the seaward horizon to the east. In relation to views of the night-sky, the aviation lights are low to the horizon and do not extend high into the sky, thus limiting the amount of the night-sky that is impeded. The position of the lights in this regard is therefore considered to have limited influence on the view of stars in the night-sky. The aviation lights are not expected to result in obtrusive light that impedes the wider expanse of night sky, which can be experienced readily above the aviation lights, nor result in brightening of the night sky (skyglow) or glare on to the sea surface and will therefore not be of detriment to the overall experience of the night skies in this view.

4.4.10 Taking all of this into account, the magnitude of change is considered to be medium-high. As a result, and when combined with the medium sensitivity, the effect is considered to be **Moderate-Major and Significant.** The visible turbine lighting will be readily visible appearing at variance with the baseline view which is currently dark in nature. The introduction of a relatively wide extent of lights within the sea will form a new focus in views from this section of coastline.

2,000cd White Aviation Warning Light Scenario

4.4.11 The description of lights visible for 2,000 cd medium intensity red light scenario also applies to this white light scenario. The white aviation lights in this scenario are considered to be slightly more visually conspicuous slightly increasing the intensity of the light experienced. However, the magnitude of change is still considered to be medium-high and the effect is considered to remain **Moderate-Major and Significant.**

Viewpoint 11: Vico Road seating area

Night-Time Baseline Condition and Sensitivity

4.4.12 This viewpoint represents the views of visitors to the seating area, road-users on Vico Road and residents in this area. It is located at the seating area on Vico Road, which traverses the middle slopes of the coastal hill side. The viewpoint is 10.50 km to the west of the nearest proposed turbine of the Dublin Array.

4.4.13 Coastal views are a key feature of the area including views along the coast and out to sea. During the day, the view is characterised by the open and expansive outlook of the seascape to the east which is framed by the nearby slopes and surrounding coastal landscape of Killiney Bay. While the rising landform of Killiney and Dalkey Hills contains views to the north, to the south they open up across the seascape, extending as far south as the prominent coastal landform of Wicklow Head. Whilst located in an urban area, the low density of the residential properties combined with the presence of the coastal hills and associated vegetation, moderates the urban influence. The principal view from the viewpoint and surrounding properties is east across the sea and Killiney Bay.

4.4.14 Whilst it is appreciated that visitors to this location may be present at night, the scenic aspects of this view are diminished in the hours of darkness. At night, the characteristics of seascape and coastal landscape are difficult to discern, however, at times when the skyline is still visible the landform profile is silhouetted and provides an indication of view direction within the wider panorama. The baseline night photography is captured at a time where the seaward horizon is barely visible but with parts of the coastal landscape horizon discernible to the north and south where it more clearly contrasts with the sky.

4.4.15 Existing lighting in the view includes – street lighting on Vico Road; lights of passing and parked vehicles; and streetlights and lights in buildings within the urban areas along the coast to the south, particularly within the settlements of Shankill and Bray. There are also occasional lights in the seaward direction from passing boats and ships. The overall baseline lighting level is considered darker in the seaward direction where there are fewer baseline lights. Given the vegetation and topographical screening from nearby urban areas the overall baseline light levels at the viewpoint are considered to be relatively dark.

4.4.16 The value and visual susceptibility of receptors at night differs when compared to the assessment carried out for daytime conditions. During the night the landscape / seascape has a diminished scenic quality, and receptors would not have the same appreciation of the landscape / seascape which is dark and muted compared with the landscape / seascape characteristics evident during the day. The presence of baseline lighting associated with coastal settlement only slightly lowers the susceptibility at this location.

4.4.17 Value of the viewpoint is reduced and whilst the coastal aspect is the principal defining feature at this viewpoint during the day, it is less apparent at night. Susceptibility is only slightly reduced as seaward views become less of a focus for views at night, appreciating that views along the coast towards coastal settlement are still a focus for visitors to this location. Taking these factors into account, the night-time sensitivity of this location is considered to be medium-high.

Assessment of Visible Lighting

2,000cd Red Aviation Warning Light Scenario

4.4.18 Aviation and marine navigation lighting of the Dublin Array would be visible in the view at night, from 10.50 km to the nearest proposed turbine, including both the red medium intensity turbine lighting at nacelle height and yellow marine navigational lighting at turbine platform level. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the aviation lighting on the hubs would at most times be seen behind the rotors and so would be intermittently obscured by intervening blades. On this basis they would appear to flicker as the turbine blades pass the hub lights.

4.4.19 The lights would occupy a relatively wide part of the seaward panorama and would be seen as an unfamiliar feature during the hours of darkness. The lights would help to indicate the position of the horizon within the dark view to the east in contrast to the existing view at night that only has the occasional lights of passing ships as an indication.

4.4.20 The Dublin Array lighting would introduce points of light above the seaward horizon to the east. In relation to views of the night-sky, the aviation lights are low to the horizon and do not extend high into the sky, thus limiting the amount of the night-sky that is impeded. The position of the lights in this regard is therefore considered to have limited influence on the view of stars in the night-sky. The aviation lights are not expected to result in obtrusive light that impedes the wider expanse of night sky, which can be experienced readily above the aviation lights, nor result in brightening of the night sky (skyglow) or glare on to the sea surface and will therefore not be of detriment to the overall experience of the night skies in this view.

4.4.21 Taking all of this into account, the magnitude of change is considered to be medium-high. As a result, and when combined with the medium-high sensitivity, the effect is considered to be **Moderate-Major and Significant.** The visible turbine lighting will be readily visible appearing at variance with the baseline view which is currently dark in nature. The introduction of a relatively wide extent of lights within the sea will form a new focus in views east from this section of coastline detracting from the night view along the coast to the south.

2,000cd White Aviation Warning Light Scenario

4.4.22 The description of lights visible for 2,000 cd medium intensity red light scenario also applies to this white light scenario. The white aviation lights in this scenario are considered to be slightly more visually conspicuous slightly increasing the intensity of the light experienced. However, the magnitude of change is still considered to be medium-high and the effect is considered to remain **Moderate-Major and Significant.**

Viewpoint 18: Howth Head

Night-Time Baseline Condition and Sensitivity

4.4.23 This viewpoint represents the views of visitors to the summit car park, walkers on the nearby cliff walk and local residents. It is located at the Howth Head Scenic Viewpoint, which is situated in the south-east of the peninsula, at the edges of the summit car park which has elevated seaward views to the east. The view is between occasional trees at the car park but is generally open in nature and is not restricted on the cliff walk. The viewpoint is 11.77 km to the north-west of the nearest proposed turbine of the Dublin Array.

4.4.24 Coastal views are a key feature of the area including views along the coast and out to sea. During the day, the steep fall of the landform to the east and south, allows views to expand across the vast openness of the Irish Sea. To the south, the cliff-edged coastline and Bailey lighthouse set on the southern headland form close range features, while the distant outline of the Wicklow Mountains forms a distant backdrop. Dublin City is screened from the viewpoint by the intervening upland landform from the viewpoint, however, the eastern docks are visible from parts of the cliff walk near to the lighthouse.

4.4.25 Whilst it is appreciated that visitors to this location may be present at night, the scenic aspects of this view are diminished in the hours of darkness. At night, the characteristics of seascape and landscape that create different patterns in the view are difficult to discern, however, at times when the skyline is still visible the landform profile is silhouetted and provides an indication of view direction within the wider panorama. The baseline night photography is captured at a time where the seaward horizon can be distinguished against the sky and the shape of the surrounding landform is silhouetted against the sea and Dublin Bay.

4.4.26 Existing lighting in the view includes – occasional lighting columns within the car park; lights of parked vehicles; and the distant streetlights and lights in buildings of the settled coast to the south as viewed across Dublin Bay. There are also occasional lights in the seaward direction from passing boats and ships. The overall baseline lighting level is considered darker in the seaward direction where there are fewer baseline lights. Given the distant location of existing settlement lighting the overall baseline light levels at the viewpoint are considered to be relatively dark.

4.4.27 The value and visual susceptibility of receptors at night differs when compared to the assessment carried out for daytime conditions. During the night the landscape / seascape has a diminished scenic quality, and receptors would not have the same appreciation of the landscape / seascape which is dark and muted compared with the landscape / seascape characteristics evident during the day. The presence of baseline lighting associated with coastal settlement only slightly lowers the susceptibility at this location.

4.4.28 Value of the viewpoint is reduced and whilst the coastal aspect is the principal defining feature at this viewpoint during the day, it is less apparent at night. Susceptibility is only slightly reduced as seaward views become less of a focus for views at night, appreciating that views along the coast towards coastal settlement are still a focus for visitors to this location. Taking these factors into account, the night-time sensitivity of this location is considered to be medium-high.

Assessment of Visible Lighting

2,000cd Red Aviation Warning Light Scenario

4.4.29 Aviation and marine navigation lighting of the Dublin Array would be visible in the view at night, from 11.77 km to the nearest proposed turbine, including both the red medium intensity turbine lighting at nacelle height and yellow marine navigational lighting at turbine platform level. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the aviation lighting on the hubs would occasionally be seen behind the rotors and so would only occasionally be intermittently obscured by intervening blades. On this basis they would only occasionally flicker as a result of turbine blades passing the hub lights.

4.4.30 The lights would occupy a relatively wide part of the seaward panorama and would be seen as an unfamiliar feature during the hours of darkness. The lights would help to indicate the position of the horizon within the dark view to the west in contrast to the existing view at night that only has the occasional lights of passing ships as an indication.

4.4.31 The Dublin Array lighting would introduce points of light above the seaward horizon to the south-east. In relation to views of the night-sky, the aviation lights are low to the horizon and do not extend high into the sky, thus limiting the amount of the night-sky that is impeded. The position of the lights in this regard is therefore considered to have limited influence on the view of stars in the night-sky. The aviation lights are not expected to result in obtrusive light that impedes the wider expanse of night sky, which can be experienced readily above the aviation lights, nor result in brightening of the night sky (skyglow) or glare on to the sea surface and will therefore not be of detriment to the overall experience of the night skies in this view.

4.4.32 Taking all of this into account, the magnitude of change is considered to be medium-high. As a result, and when combined with the medium-high sensitivity, the effect is considered to be **Moderate-Major and Significant.** The visible turbine lighting will be readily visible appearing at variance with the baseline view which is currently dark in nature. The introduction of a relatively wide extent of lights within the sea will form a new focus in views from this section of coastline.

2,000cd White Aviation Warning Light Scenario

4.4.33 The description of lights visible for 2,000 cd medium intensity red light scenario also applies to this white light scenario. The white aviation lights in this scenario are considered to be slightly more visually conspicuous slightly increasing the intensity of the light experienced. However, the magnitude of change is still considered to be medium-high and the effect is considered to remain **Moderate-Major and Significant.**

5 Conclusion

5.1.1 This assessment has considered the visual effects of visible, turbine lighting during night-time. As it is currently not known which guidance on aviation lighting will take precedence post-consent, the two scenarios assessed consider the requirements of the ICAO for 2,000cd red aviation lighting and the requirements of the IAA for 2,000cd white aviation lighting. The ICAO standard requires red aviation lights to be switched on 30 minutes after sunset, and switched off 30 minutes before sunrise, removing the likelihood of visible lighting during twilight and reducing the period over which visual effects will be experienced. In contrast the IAA standard requires the white aviation lights to be on 24 hours. The focus of this assessment is the night-time effects on visual receptors. During daytime, the landscape and visual effects will relate principally to the effects of the Dublin Array offshore infrastructure of which the lighting will form only a component part and will therefore not increase the rating of magnitude of change or the assessment of significant effects.

5.1.2 The visual effects of the proposed development at night would be limited by the activity of receptors at night. Receptors that experience views at night are generally limited to residents of settlements, rural properties and motorists using the road network. Views from within properties are likely to be restricted by the use of window coverings, particularly in winter. The assessment of night-time effects is also based on clear night-time viewing conditions. At dusk and sunrise, it may be possible to identify the formation of the turbines with the lighting switched on, but only in conditions of good and excellent visibility. At sunrise it may also be possible, in views from the west, to see the turbines with lights switched on whilst backlit by the rising sun.

5.1.3 At night the turbines would not in themselves be conspicuous during times of darkness. Nevertheless, the assessment of night-time effects for the proposed development has predicted significant effect for each of the three representative viewpoints. This is largely as a result of the wide extent of view from coastal viewpoints affected by the Dublin Array turbine lighting and its proximity to the coastline receptors. Away from the coast, the visual effect is more limited either due to reduced levels of theoretical visibility or as a result of increased levels of baseline lighting pollution which would moderate the magnitude of change experienced (for instance in built up areas of Dublin).

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