

5 APPENDIX 5.5 – VISUAL ASSESSMENT OF VISIBLE AVIATION LIGHTING

5.1 Introduction

- 5.1.1 This Technical Appendix has been prepared to accompany Chapter 5: LVIA in Volume 2 of the Pen March Wind Farm (hereafter the Proposed Scheme) EIA Report. The Civil Aviation Authority (CAA) requires that 'en-route obstacles' at or above 150m above ground level are lit with visible lighting to assist their detection by aircraft. As such, there is potential that the Proposed Scheme may need to display visible red lights at night. The effect of the Proposed Scheme at night would result from visible medium intensity (2,000 candela) red coloured light fittings located on the nacelles and 32 candela red coloured light fittings located on the towers of all proposed turbines. It should be noted that all turbines would also include infra-red lighting on the turbine hubs which would not be visible to the human eye. The focus of this Appendix (5.5) is on the visual assessment of the visible aviation lighting requirements of the Proposed Development. For the assessment of lighting effects, the visual sensitivity and magnitude criteria described in Appendix 5.1 has been applied.
- 5.1.2 This visual assessment of turbine lighting is supported by a baseline light pollution map (Figure 5.5-2), ZTV map figures (Figures 5.5-1, 5.5-3 and 5.5-5), a Lighting Intensity ZTV (Figure 5.5-4) and night-time photomontage visualisations from three viewpoints (See visualisation Figures 5.26, 5.30, 5.41 and 5.44).

5.2 Regulations and Guidance

ICAO / Civil Aviation Authority (CAA) Regulations

- 5.2.1 ICAO (a 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).
- 5.2.2 ICAO Table 6.1 (page 6-4) identifies the international definitions of daylight; twilight and night based on measured background illuminance as follows.
- Daylight: Above 500 cd/m²
 - Twilight: 50-500 cd/m²
 - Night: Below 50 cd/m²
- 5.2.3 For 2,000 candela medium intensity steady or fixed red lights, ICAO indicates a requirement for no lighting to be switched on until 'Night' has been reached, as measured at 50 cd/m² or darker.
- 5.2.4 ICAO Table 6.3 (page 6-5) identifies minimum requirements and recommendations for 2,000 cd aviation lights on wind turbines at 150 m and above. In summary these are:
- 5.2.5 Minimum requirements:
- 0 to +3 ° from horizontal: 2,000 cd minimum average intensity (or 1,500 cd minimum intensity)

- -1 degree from horizontal: 750 cd minimum intensity
- 5.2.6 The European Aviation Safety Agency (EASA) implements ICAO in European airspace. In pursuit of international standards for use around the globe, a project team has been established to provide clearer direction to lighting manufacturers, as there is scope for interpretation of ICAO in different ways by manufacturers.
- 5.2.7 Within the UK, the ICAO/ EASA requirements for lighting wind turbines are implemented through CAA publication 'CAP 764: Policy and Guidelines on Wind Turbines', and 'CAP393: Air Navigation Order 2016'. The CAA have confirmed that UK policy broadly aligns with the International standards, including insofar as the point at which lights must be switched on at 'Night' rather than 'Twilight'.
- 5.2.8 The proposed turbines, at 200 m and 180 m to blade tip, would require lighting under Article 222 of the Air Navigation Order (ANO, 2016). This requires a single, medium intensity, 'steady' red aviation light (emitting 2,000 candela) to be fitted at nacelle level to each turbine. In addition, the CAA requires 3 low intensity lights to be fitted at the intermediate level on the turbine tower (CAA, 2017), to provide 360 degree visibility around the tower. The intermediate 'tower' lights will be 32 candela.
- 5.2.9 Air Navigation Order 2016 (CAP393) Article 223 (8) states that 'If visibility in all directions from every wind turbine generator in a group is more than 5km the light intensity for any light required by this article to be fitted to any generator in the group and displayed may be reduced to not less than 10% of the minimum peak intensity specified for a light of this type.' This reduction affords valuable mitigation of light intensity and allows the minimum intensities identified above to be dimmed to 10 % of their values if meteorological conditions permit (i.e. the 2,000 cd minimum intensity may be dimmed to 10 %, or 200 cd, if visibility is greater than 5km, i.e. in moderate to excellent or 'clear' visibility).

Guidelines for Landscape and Visual Impact Assessment (GLVIA3)

- 5.2.10 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.'*
- 5.2.11 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).'*

Institute of Lighting Professional Guidance

- 5.2.12 Guidance produced by the Institute of Lighting Professionals (ILP) (2011) (GN01:2011)¹ is useful in setting out some key lighting terminology that relates to potential visual effects.
- 5.2.13 **'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.'
- 5.2.14 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.'*
- 5.2.15 CPRE² also identifies these same broad terms as the three types of light pollution:
- **'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'.

NatureScot Guidance

Visual Representation Guidance

- 5.2.16 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.'*

¹ Institute of Lighting Professionals (ILP) - Guidance Notes for the Reduction of Obtrusive Light GN01:2011

² CPRE – 'What is Light Pollution' found at webpage - <https://www.nightblight.cpre.org.uk/what-is-light-pollution>

- 5.2.17 The night time photography has therefore been captured in low light conditions, when other artificial lighting (such as street lights and lights on buildings) is on, to show how the wind farm lighting would look compared to the existing baseline at night.
- 5.2.18 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.
- 5.2.19 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

- 5.2.20 Recent NatureScot workshops indicate that a proportionate and pragmatic approach is required, both in terms of the need to assess likely significant effects under the EIA regulations (complying with current civil aviation standards) and also in providing mitigation (on a project and site-specific basis).
- 5.2.21 Mitigation options to eliminate or reduce the need for, and effects of, visible lighting are evolving quickly and developers are exploring these with consultees and the CAA 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.
- 5.2.22 Ministers and planning authorities are using planning conditions to manage effects. It is recognised that the EIA 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.
- 5.2.23 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 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.

5.3 Assessment Parameters

Overview

5.3.1 A description of the proposed turbine lighting is found within Chapter 4 Proposed Scheme and Chapter 12.1 Aviation, based on this, the following assumptions have been made with regards to visible lighting of the Proposed Development for the LVIA:

- the CAA requires that all obstacles at or above 150 m above ground level are fitted with visible medium intensity lighting (2,000cd) located on the turbine nacelle;
- the CAA requires that a secondary light is fitted to the nacelle for use only when the primary light fails and would not be lit concurrently;
- there is an additional requirement for three lights to be provided at an intermediate level of half the nacelle height. These would need to be fitted around the towers to allow for 360degrees horizontal visibility; and
- The 2,000 cd medium intensity lights may be dimmed to 10 %, or 200 cd, if visibility is greater than 5km, i.e. in moderate to excellent or 'clear' visibility.

Worst Case Aviation Lighting Scheme

5.3.2 In relation to the Proposed Development, the worst-case scenario for night time effects includes the following parameters:

- all turbines would have red, medium intensity visible lights mounted on the nacelle (117 m based on the worst case hub height candidate turbine described in Chapter 4);
- 2,000 cd and 200 cd intensity nacelle lights have been assessed representing two differing worst case situations. 2,000 cd represents the maximum intensity possible. 200 cd represents the maximum intensity that would be used when visibility extending from the wind farm exceeds 5km;
- all turbines would also have low-intensity lights (32 candela) to be provided on the turbine towers at an intermediate level of half the nacelle height (58.5 m); and
- the steady red lighting fixed to the top of the nacelles and to the turbine towers may appear to flicker on and off with the blade movement. This would occur when the turbine blades pass between the lights and the observers.

5.3.3 On the basis of the CAA requirements, it is evident that the effect of the visible lights of the proposed Scheme will be dependent on a range of factors, including the intensity of lights used, the clarity of atmospheric visibility and the degree of negative/ positive vertical angle of view from the light to the receptor.

5.3.4 In compliance with EIA regulations, the likely significant effects of a 'worst-case' scenario for turbine lighting are assessed and illustrated in this visual assessment. A worst-case approach is applied which considers the effects of 2,000 cd and 200 cd scenarios during periods of clear visibility. It should be noted however, that as the required medium intensity lights are only likely to be operated at their maximum 2,000 cd during periods of poor visibility, that 2,000 cd intensity actually represents an unrealistic worst-case position, as it is unlikely to ever be experienced at that maximum illumination level.

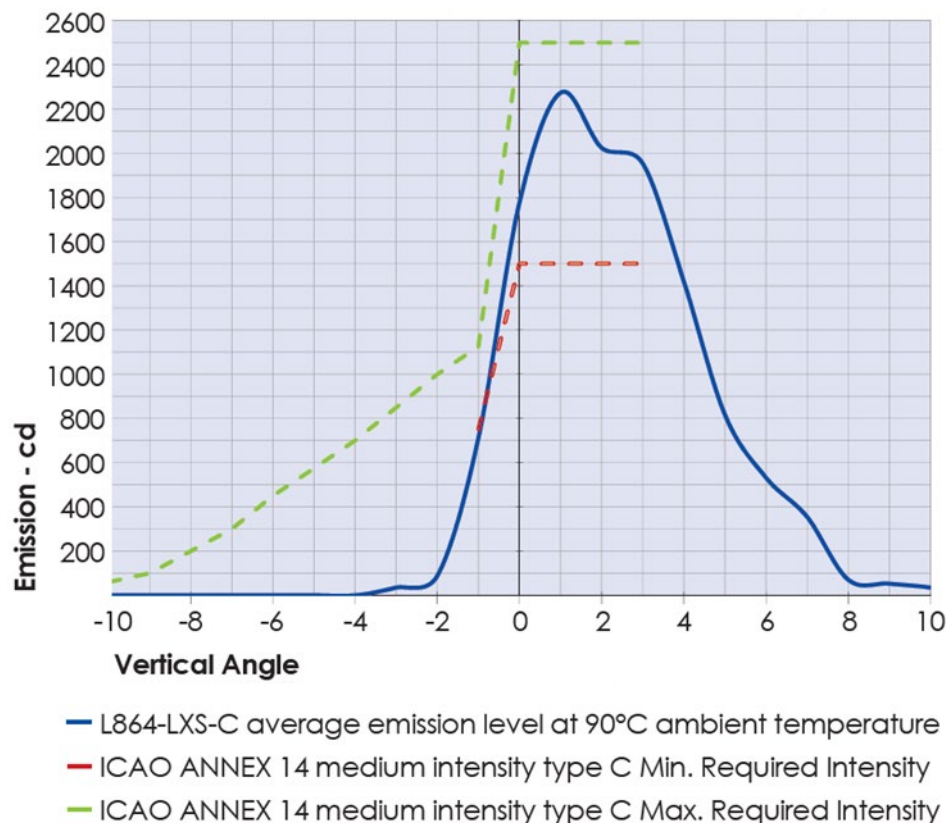
Light Intensity

5.3.5 The graph in Plate 5.5-1 below illustrates the ICAO (Annex 14) minimum required (red line) and maximum recommended (green line) light intensity emission that may be

experienced at various vertical angles, with the horizontal plane of the lights represented by 0 degrees vertical angle. The graph is an extract from the LuxSolar Medium Intensity Obstruction Light datasheet³. The average emission level of the LuxSolar Medium Intensity Obstruction Light is also shown (blue line), providing an illustration of the light emissions for one particular model of light.

- 5.3.6 Whilst the precise model of light to be used for the Proposed Scheme is not known at this time, the graph clearly demonstrates that the intensity of the aviation lights requires to be most intense between 0 to +3° from horizontal and that the intensity of emitted light required by IACO is lower below the horizontal. The use of a particular model of aviation light which offers a reduced light intensity below the horizontal and above +3° would provide mitigation of the intensity of the lights for receptors viewing them from areas below the horizontal.
- 5.3.7 Following the graph in Plate 5.5-1, the intensity of light emissions reduces as the vertical elevation angle changes. These calculations do not take account of the potential for some of the emitted light spilling onto the passing blades which would be visible at all negative angles, albeit as a less intense and diffuse reflected glow. At -10 negative elevation angle the reduction in intensity would result in a 2000 cd light being barely perceptible.

Plate 5.5-1: Lighting Intensity Graph - LuxSolar Medium Intensity Obstruction Light



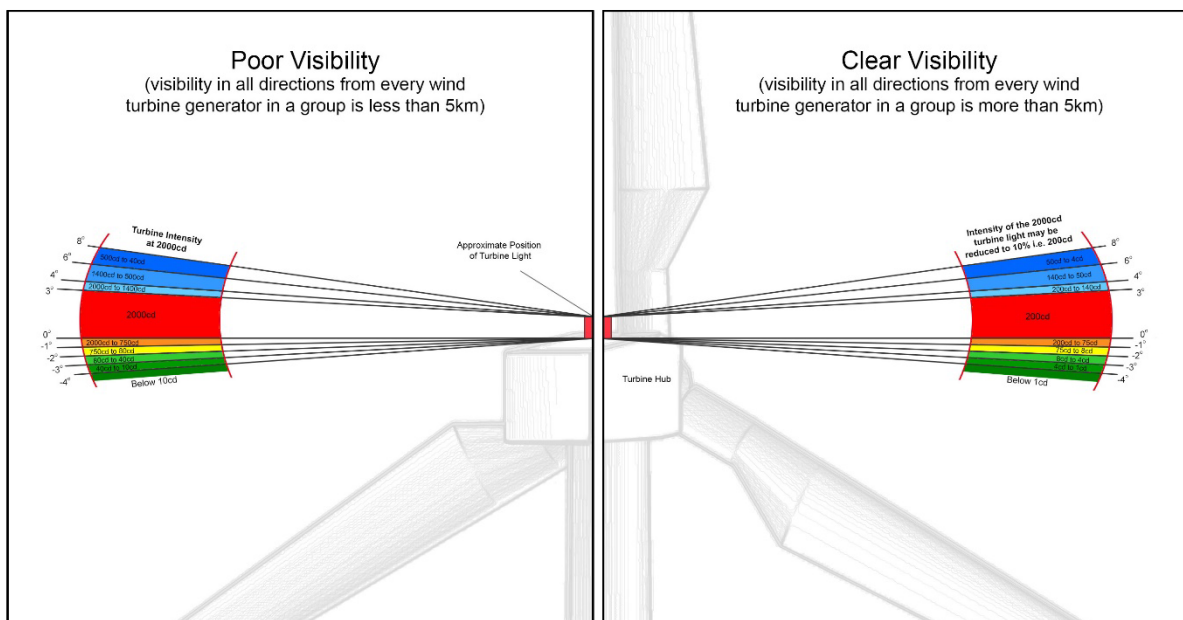
- 5.3.8 Figure 5.5-4 illustrates where negative elevation angles (ranging from 0 to 3 degrees vertical angle above the horizontal plane and 0 to -10 degrees vertical angle below the

³ LuxSolar Medium Intensity Obstruction Light CAP 168 MIOL-C: Data Sheet, January 2018.

horizontal plane) would occur within the predicted full extent ZTV for the proposed visible nacelle turbine lights.

- 5.3.9 Based on the Lux Solar Lighting Intensity Graph, a diagrammatic interpretation of the minimum requirements of ICAO/CAP393 along with the manufacturers measured intensity calculations is shown in Plate 5.5-1. It illustrates the potential light intensity from a medium-intensity nacelle mounted aviation light, based on the ICAO minimum standard of 2000cd minimum average intensity required over $+3^{\circ}$ beam spread from the horizontal. It also provides illustration of the likely light intensity in poor visibility $<5\text{km}$ (2,000cd) and clear visibility $>5\text{km}$ (200cd). Note the turbine in Plate 5.5-2 is only split vertically to illustrate the difference between the light intensity in poor visibility (2000cd) and clear visibility (200cd). The turbine light is designed to emit the same light intensity horizontally in 360° .

Plate 5.5-2 Diagrammatic interpretation of minimum requirements of ICAO/CAP393 and LuxSolar Medium Intensity Obstruction Light



Representative Night-Time Viewpoints

- 5.3.10 A hub height ZTV was used to identify where there could be direct line of sight from the surrounding area to the proposed turbine lights mounted on the turbine nacelle or hub (Figures 5.5-1 & 5.5-3). A tower light ZTV has also been produced (Figure 5.5-5). This ZTV does not take account of any intervening screening that may arise as a result of forestry or woodland cover.
- 5.3.11 Night-time visualisations have been produced for the four representative viewpoints. These were selected from the LVIA viewpoints and agreed with NRW, BBNPA, MTCC and CCBC, as follows:
- Viewpoint 3: Pant, Merthyr Tydfil (NCN46)
 - Viewpoint 7: Rhymney
 - Viewpoint 18: Beacons Way (Craig Y Fan Ddu)
 - Viewpoint 21: A4059

- 5.3.12 The precise locations of the viewpoints differ slightly from the daytime locations as they were captured on separate and specific visits. The viewpoint at Rhymey has also been captured further to the south than the daytime location in order to capture the baseline lighting of Rhymney in the baseline photograph.
- 5.3.13 Whilst aviation lighting manufacturers must meet the minimum requirements, their products may vary in relation to recommended limits set out in ICAO standards, which makes it difficult producing accurate visualisations as the lighting characteristics of different light fittings, of the same intensity, may vary outside the minimum requirements stipulated by ICAO. The night-time photomontages have been produced to show both 2,000 cd and 200 cd reduced intensity lighting, to inform the assessment of worst-case effects assessed. However, it should be noted that the night-time photography has been captured in periods of good visibility that is greater than 5km. As a result, the night-time photomontage representations of the 2,000 cd lights are therefore an unrealistic over-representation of the likely visibility of visible aviation lighting. This is because visibility on the site (and likely at the viewpoint itself) is very likely to be much poorer (<5 km) when they operate at that intensity.

5.4 Assessment of Effects

Types of Effect

- 5.4.1 The visual assessment of turbine lighting is intended to determine the likely effects that the Proposed Development 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.
- 5.4.2 The assessment of turbine lighting in this Appendix does not consider effects of aviation lighting on landscape character (i.e. landscape effects). For visible medium intensity steady or fixed red aviation warning lights, ICAO indicates a requirement for no lighting to be switched on until 'night' has been reached, as measured at 50 cd/m² or darker. This is helpful as it does not require them to be on during 'twilight', when landscape character may be clearly discerned. It is considered that visible aviation lighting will therefore not affect the perception of landscape character, which is not readily perceived at night in darkness, particularly in rural areas. The assessment of visible lighting is solely a visual effect. While aviation lighting will be visible and result in visual effects, as assessed in this Appendix, the effects of aviation lighting on the perception of landscape character are scoped out of this assessment. This decision to scope out landscape effects reflects the Scottish Ministers' recent finding in the Crystal Rig IV Wind Farm Public Inquiry.

Baseline Lighting

- 5.4.3 The existing baseline lighting levels have been mapped for the surrounding landscape (see Figure 5.5-2) based on Open Source data of Light Pollution across the UK. 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).
- 5.4.4 The Proposed Scheme is located in a swathe of colour band three 0.5-1 NanoWatts/cm²/sr which lies at the edges of the settled Heads of the Valleys which is of

generally moderate to high baseline light pollution. The highest pollution on the baseline map is found in the settlements themselves including in Merthyr Tydfil, Rhymney, Tredegar and Ebbw Vale and a small area of high pollution in the Pengarnddu Industrial Estate. These main concentrations of night-time lights are clearly indicated on the baseline map and follow the larger settled areas that surround the BBNP (particularly to the south), creating light pollution that spills up into the sky. In addition, the map also identifies transport infrastructure such as the transport corridor context at the Heads of the Valleys and connecting through the valleys themselves as having higher levels of light, particularly where they pass through settled areas. These connecting areas of higher light pollution result in an overall moderate to high level of light pollution across much of southeast Wales.

- 5.4.5 To the north of the site the broad plateau is at a similar level to that of the site before transitioning to the darkest colour band in the context of Talybont Reservoir which continues north across much of the BBNP with small patches of slightly less dark.

5.5 Detailed Assessment

Visibility of turbine lighting from Viewpoints

- 5.5.1 Table 5.1 below provides a summary of the potential visibility of nacelle lights for each of the LVIA viewpoints, this is based on the nacelle light ZTV and tower light ZTV, and details how many lit turbines will be theoretically visible from each of the viewpoints included in the LVIA.

Table 5.5.1 – Turbine Lighting Visibility and Light Intensity from LVIA Viewpoints

Table 5.1: LANDMAP Evaluation

Viewpoint	Distance to nearest turbine (km)	Lighting Visibility						Lighting intensity at each viewpoint allowing for vertical angle		
		1	2	3	4	5	6	Vertical Angle	2000cd Scenario	200cd Scenario
1 - PRoW (Gelligaer FP 101)	0.9	X	Xx	X	Xx	Xx	Xx	Below -4°	Below 10cd	Below 1cd
2 - A465 / Heads of the Valleys Road	1.2	Xx	Xx	Xx	Xx	Xx	Xx	Below -4°	Below 10cd	Below 1cd
3 - Pant, Merthyr Tydfil (NCN 46)	1.4	Xx	Xx	Xx	O	X	X	Below -4°	Below 10cd	Below 1cd
4 - A469 / Bute Town (NCN 468)	1.9	Xx	Xx	Xx	Xx	Xx	Xx	Below -4°	Below 10cd	Below 1cd
5 - Pontsticill	2.1	X	O	O	O	O	O	Below -4°	Below 10cd	Below 1cd

Viewpoint	Distance to nearest turbine (km)	Lighting Visibility						Lighting intensity at each viewpoint allowing for vertical angle		
		1	2	3	4	5	6	Vertical Angle	2000cd Scenario	200cd Scenario
6 - Pant Station, Brecon Mountain Railway	2.1	Xx	X	Xx	O	X	X	Below -4°	Below 10cd	Below 1cd
7 - Rhymney	2.6	Xx	Xx	Xx	Xx	Xx	Xx	Below -4°	Below 10cd	Below 1cd
8 - Cefn yr Ystrad	2.7	Xx	Xx	Xx	Xx	Xx	Xx	0° to 3°	2000cd	200cd
9 - Rhymney common	3.4	Xx	Xx	Xx	Xx	Xx	Xx	-3° to -4°	40cd to 10cd	4cd to 1cd
10 - Trefil	3.8	X	X	O	O	X	O	-2° to -3°	80cd to 40cd	8cd to 4cd
11 - Cyfartha Park	4.4	Xx	Xx	Xx	X	Xx	Xx	-3° to -4°	40cd to 10cd	4cd to 1cd
12 Trefechan	4.6	X	X	Xx	O	X	X	-3° to -4°	40cd to 10cd	4cd to 1cd
13 Fochriw	4.6	Xx	Xx	X	X	Xx	X	-2° to -3°	80cd to 40cd	8cd to 4cd
14 Tredegar, Deighton Playing Fields	5.0	X	Xx	O	X	X	O	-3° to -4°	40cd to 10cd	4cd to 1cd
15 Garn Ddu	5.2	Xx	Xx	Xx	X	Xx	Xx	-2° to -3°	80cd to 40cd	8cd to 4cd
16 Pen Garnbugail	6.7	Xx	Xx	Xx	Xx	Xx	Xx	0° to -1°	2000cd to 750cd	200cd to 75cd
17 Cefn Manmoel (Sirhowy Valley Walk)	7.7	Xx	Xx	Xx	Xx	Xx	Xx	-1° to -2°	750cd to 80cd	75cd to 8cd
18 Beacons Way (Craig Y Fan Ddu)	7.8	Xx	Xx	X	X	X	X	0° to 3°	2000cd	200cd
19 B4560, Cefn Pwll-coch	8.3	Xx	Xx	Xx	Xx	Xx	Xx	0° to -1°	2000cd to 750cd	200cd to 75cd
20 Mynydd Carn-y-cefn	9.6	Xx	Xx	Xx	Xx	Xx	Xx	0° to -1°	2000cd to 750cd	200cd to 75cd
21 A4059	10.4	Xx	Xx	Xx	X	Xx	X	0° to -1°	2000cd to 750cd	200cd to 75cd

Viewpoint	Distance to nearest turbine (km)	Lighting Visibility						Lighting intensity at each viewpoint allowing for vertical angle		
		1	2	3	4	5	6	Vertical Angle	2000cd Scenario	200cd Scenario
22 PRow (Bedwellty FP 28)	11.2	Xx	Xx	Xx	Xx	Xx	Xx	-1° to -2°	750cd to 80cd	75cd to 8cd
23 A4233 Meardy Rd	12.1	Xx	Xx	Xx	Xx	Xx	Xx	-1° to -2°	750cd to 80cd	75cd to 8cd
24 Pen y Fan	12.5	Xx	Xx	Xx	Xx	Xx	Xx	0° to 3°	2000cd	200cd
25 Black Mountains, Pen Cerrig-calch	17.3	Xx	Xx	Xx	Xx	Xx	Xx	0° to 3°	2000cd	200cd
26 Sugar Loaf	19.9	Xx	X-x	Xx	Xx	Xx	Xx	0° to -1°	2000cd to 750cd	200cd to 75cd

Table 5.5-1 Key

Xx	Theoretical visibility of nacelle and tower lights
X	Theoretical visibility of nacelle lights
O	No lights visible
*	Light Intensity is based on the intensity ZTV which is derived from the intensity calculations of the LuxSolar Medium Intensity Obstruction Light.
**	Vertical Angle is from Horizontal plane of light location to viewpoint location (degrees)

Viewpoint Lighting Intensity

- 5.5.2 With specific relevance to the Proposed Scheme, Figure 5.5-4 - Lighting Intensity ZTV, illustrates where the different intensities (depending on different vertical angles from the nacelle mounted aviation light) would be visible within the surrounding landscape. Figure 5.5-4 also illustrates the corresponding intensity reductions for each of the 2,000 cd and 200 cd situations.
- 5.5.3 It is clear from Figure 5.5-4 that the full intensity of the lights would only theoretically be experienced from a small proportion of the Study Area when on similar or more elevated terrain.
- 5.5.4 As described in the LVIA baseline, the ZTV itself is contained within the wider landscape by the hills of the Bannau Brycheiniog to the north, east and west and to the south by successive rows of ridges within the valleys landscape of southeast Wales. From these hills and ridges, the terrain is at a similar elevation to the nacelle aviation lighting and Figure 5.5-4 illustrates a vertical angle of between 3 and -1 degrees, which would result in an approximate range of lighting intensity of between 2000cd to 750cd when visibility <5km and 200cd to 75cd when visibility >5km.

- 5.5.5 Other than the elevated hilltops, theoretical visibility of the nacelle lights is very limited within the BBNP apart from areas of moorland plateau to the west and immediately to the north of the Proposed Scheme and the upper slopes of the Taf Fechan valley, which is forest covered. Figure 5.5-4 illustrates a vertical angle of between -1 and -3 degrees for these areas which would result in an approximate range of lighting intensity of between 750cd to 40cd when visibility <5km and 75cd to 8cd when visibility >5km.
- 5.5.6 Within a more localised area to the Proposed Scheme, Figure 5.5-4 shows theoretical visibility of the nacelle lights across the Heads of the Valley's road corridor between Merthyr Tydfil and Rassau Industrial Estate and also spreading along parts of the Rhymney and Taff valleys. These areas are shown on Figure 5.5-4 to have a vertical angle of between -3 and -4 degrees at the edges of these areas but for lower lying areas relative to the Proposed Scheme, which the majority of the immediately surrounding is, the vertical angle is calculated to be below -4 degrees.
- 5.5.7 For the majority of this area therefore, lighting intensity would be below 10cd when visibility <5km and below 1cd when visibility >5km. At the edges of these areas on settled valley slopes or neighbouring low lying grassland and moorland plateau, an approximate range of lighting intensity of between 40cd to 10cd when visibility <5km and 4cd to 1cd when visibility >5km would be experienced.
- 5.5.8 Many of the representative viewpoints within the areas closest to the Proposed Scheme, including those found within the settled Heads of the Valley will have reduced intensity as a result of the negative vertical angle in which the nacelle lights would be viewed. Table 5.5-1 provides a summary of the reduced intensity for the nacelle lights based on the ZTV in Figures 5.1-1 and 5.1-3.
- 5.5.9 Whilst it is noted that the actual intensity of light perceived at the majority of assessment viewpoints (and within the Study Area) is likely to be less intense than the maximum intensity of the light (2,000cd in visibility <5km and 200cd in visibility >5km), this Technical Appendix assesses the maximum possible intensity of light observed at each of the viewpoints considered and represents this maximum intensity in corresponding visualisations.
- 5.5.10 In reality, it is extremely unlikely that 2,000cd will ever be experienced at its full intensity as it will only operate when visibility is reduced by climatic conditions. Reduced visibility will also affect someone's perception of the intensity of the light fitting. Around half of the viewpoints are beyond 5km from the Proposed Scheme, therefore, the worst case intensity experienced at these viewpoints would likely be represented by the 200cd scenario. This is because the 2000cd intensity lights would only be in operation when visibility is less than 5km and in this situation they would appear far less intense due to the poor visibility surrounding the Proposed Scheme.
- 5.5.11 All residential properties assessed within the RVAA (2km Study Area) would have a vertical angle of below -4 resulting in an approximate range of lighting intensities of below 10cd - when visibility <5km and below 1cd when visibility >5km.
- 5.5.12 From elevated areas to the north within the BBNP between 5 and 10km there tends to be theoretical visibility of a higher number of the nacelle lights, including in views from the elevated hills within the DSR core area such as at Viewpoint 18 Beacons Way (Craig Y Fan Ddu), however, the worst case intensity of the aviation lights will likely be 200 cd in

‘clear’ visibility because in the 2000cd scenario, reduced visibility will reduce the perception of the intensity of the light fitting.

- 5.5.13 In distant views, over 10km, the aviation lights are still likely to be visible, based on experience of other operational wind farm aviation lights viewed in the field, however the distance and reduced intensity are mitigating factors with increasing distance.

5.6 Representative Viewpoints

Viewpoint 3: Pant, Merthyr Tydfil (NCN46)

Nearest Visible Turbine Light: 1.4 km

Night-Time Baseline Condition and Sensitivity

- 5.6.1 The viewpoint represents a close proximity view towards the Proposed Scheme at night from the edges of Pant, a northern suburb of Merthyr Tydfil on NCN 46.
- 5.6.2 The NCN 46 at this location is an uneven metalled track which the rear gardens of nearby properties of Pant back onto. The track takes the route of a dismantled railway and garden fences line one side of the track and a small embankment lines the other side. Evidence of fly-tipping was noted during site work, particularly at the access point from Pant. Given the uneven nature of this section of the NC46 it is not expected to be used in the hours of darkness and as such the assessment focusses on the night time visual effects of residential receptors. The nearby properties at the northeast edges of Pant share a similar view to that of the viewpoint, however, properties further into the residential area of Pant are of lower elevation and views towards the site would be limited by neighbouring (more elevated) properties and / or may not have views in the direction of the site.
- 5.6.3 The view to the northeast from the viewpoint during the day is across a landscape which is simple in pattern with improved grassland landcover in the foreground and rougher moorland grassland closer to the horizon. Overhead electricity lines cross the foreground landscape with the closest line carried on tall pylon towers and an adjacent line on wooden poles. A Telecommunication mast is also visible to the southeast of this viewpoint as well as the Pengarnddu electricity substation.
- 5.6.4 At night, however, individual landscape elements that create different landscape patterns in the view are difficult to discern, including the other infrastructure. The baseline night photography is captured at a time where the shape of the intervening moorland ridgeline can be distinguished against the sky.
- 5.6.5 There is some existing lighting in this view at the Blaen Morlais Farm and to the southeast at the Pengarnddu electricity substation. Whilst the lights of the settlement edge are not in the view northeast, they do form part of the lighting context in views west or for nearby receptors who are located within the settlement who would also have existing lighting in their views from neighbouring properties and street lighting.
- 5.6.6 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 has a diminished scenic quality and receptors would not have the same appreciation of the landscape which is dark and muted compared to what is evident during the day. Taking

these factors into account, the night-time sensitivity of residential receptors is considered to be **Medium-High**.

Night-Time Assessment

2,000 cd Light Intensity

- 5.6.7 Five of the six nacelle lights would be visible from this location and three of the tower lights would also be visible. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the lights on the hubs would at most times be seen behind the rotors and would therefore be intermittently obscured by intervening blades. On this basis they would appear to flicker as the turbine blades pass the hub and tower lights. The intensity of the nacelle lights in the 2,000cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be below 10cd.
- 5.6.8 The Proposed Development lights would be seen as an introduction of lights above the north eastern horizon to a part of the view where there are other lights visible below or on the horizon. The close proximity of the Proposed Scheme would tend to increase the visual impression that the turbine lights would have on receptors at this location. However, the vertical angle in which the lights are experienced greatly reduces their potential intensity and therefore potential effect.
- 5.6.9 Taking this into account, it is considered that these lights would form a relatively moderate addition to the existing baseline view and the magnitude of change is assessed as **Medium-Low**. The effect on residential receptors at this viewpoint is considered to be **Moderate and Not Significant**.

200 cd Light Intensity

- 5.6.10 The description of lights visible for 2,000cd also applies to the 200cd reduced intensity scenario. The intensity of the nacelle lights in the 200cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be below 1cd. The effect differs therefore, reducing the intensity of light experienced. Taking this into account the magnitude of change is assessed as **Low** resulting in a **Moderate-Minor and Not Significant** effect.

Viewpoint 7: Rhymney

Nearest Visible Turbine Light: 2.6 km

Night-Time Baseline Condition and Sensitivity

- 5.6.11 This viewpoint represents the views from the Rhymney settlement at night, 2.6km from the Proposed Scheme. The settlement is spread out along the valley in a north-south orientation largely to the east of the A469. The elevation of the northern settlement edge creates a particular vantage point in views from the settlement, albeit that the majority of views are orientated to the west due to their position on the valley side.
- 5.6.12 Views to the north during the day are across a foreground of nearby properties with views across the A469 / A465 road corridors beyond. During the day, the woods and trees that follow the Rhymney River, and small field compartments that have a mix of scrub, rough pasture and improved grassland can be seen beyond the settled edge. Scattered

properties and Bute Town are also visible, nestled into this context of trees and small field compartments. The A645 road corridor cuts across the view to the north separating the more settled landscape found to the south with the upland grassland of the site area to the north. Overhead electricity lines cross the view, following the road corridor and the pylon towers break the skyline to the north. The Pengrddu Industrial Estate can be seen to the northwest on the horizon along with the operational turbines at the Pengarnddu Industrial Estate and St Merryn Meat Factory.

- 5.6.13 At night, however, individual landscape elements that create different landscape patterns in the view are difficult to discern. The baseline night photography is captured at a time where the distant ridgeline of hills is discernible against the skyline, however, the intervening landscape is not readily visible. There is a notable level of existing lighting in this view associated with the edge of settlement in the foreground. Other lights can also be seen in the wider view related to traffic on the the busy A465 road corridor, individual properties in the intervening landscape and to the west lights associated with the Pengarnddu Industrial Estate. At the time of capturing the photography, floodlights can also be seen to the west associated with the Ffos-y-fran open cast mine.
- 5.6.14 During the night the landscape has a diminished scenic quality and receptors would not have the same appreciation of the landscape which is dark and muted compared with the landscape scenery evident during the day and particularly in muted contrast to the closer context of lighting within the settlement itself. Taking these factors into account, the night-time sensitivity of this location is considered to be **Medium**.

Night-Time Assessment

2,000 cd Light Intensity

- 5.6.15 All six of the nacelle lights and tower lights would be visible from this location. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the lights on the hubs would at times (when the wind is more southerly in direction) be intermittently obscured by intervening blades so that they would appear to flicker as the turbine blades pass the hub and tower lights. On this basis they would at times appear to flicker as the turbine blades pass the hub and tower lights. The intensity of the nacelle lights in the 2,000cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be below 10cd.
- 5.6.16 The Proposed Development lights would be seen as an introduction of lights above the north western horizon to a part of the view where there are other lights visible both in the foreground and in the intervening landscape. It is considered that the visible lights would form a new feature in the night-time view, however, they would be experienced within a foreground context of edge of settlement lighting which further moderates the effect. The vertical angle in which the lights are experienced greatly reduces their potential intensity and therefore potential effect. Taking this into account, it is considered that these lights would form a relatively moderate addition to the existing baseline view and the magnitude of change is assessed as **Medium-Low**. The effect on residential receptors at this viewpoint is considered to be **Moderate-Minor and Not Significant**.

200 cd Light Intensity

- 5.6.17 The description of lights visible for 2,000cd also applies to the 200cd reduced intensity scenario. The intensity of the nacelle lights in the 200cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be below 1cd. The effect differs therefore, reducing the intensity of light experienced. Taking this into account the magnitude of change is assessed as **Low** resulting in a **Minor and Not Significant** effect.

Viewpoint 18: Beacons Way (Craig Y Fan Ddu)

Nearest Visible Turbine Light: 7.8km

Night-Time Baseline Condition and Sensitivity

- 5.6.18 This viewpoint represents views from Craig Y Fan Ddu at night and is representative of views seen by hill walkers at night. This viewpoint is a remote location on an elevated ridge to the southeast of Pen y Fan on the southernmost point of the ridge that coalesces around the central Beacons to create the Horseshoe of scalloped ridges. The viewpoint is within the DSR core area within the BBNP.
- 5.6.19 Views during the day are panoramic including long views to the east and west across the wider landscape of the BBNP including to Sugar Loaf in the east and the long plateaux of Fan Fawr and Fan Llia to the west. Views to the south include an elevated view across the Talybont and Taf Fechan forested valleys and the wooded valley sides that follow the Pentwyn and Pontsticill Reservoirs. Beyond these valleys the north facing slopes of an intervening ridge (Cefn yr Ystrad) forms a broad upland that separates the landscape of the BBNP from the valleys landscape further to the south. The cut rock faces of the disused Cwar yr Ystrad quarry form a large and distinct feature across this ridge that breaks the otherwise smooth texture of the moorland plateau. Ffos y Fran opencast mine is a large feature clearly visible during the day beyond this ridge. The west side of Merthyr Tydfil is visible to the southwest of this viewpoint with other signs of settlement generally obscured by intervening landform.
- 5.6.20 At night, however, individual landscape elements that create these different landscapes both within the BBNP and to the south of it are difficult to discern. Existing lighting in the view south is beyond the edges of the BBNP and DSR and includes several distant masts, the light of the Merthyr Tydfil Hospital chimney, settlement lights of west Merthyr Tydfil, distant lights of individual properties and occasional car lights in the wider landscape. Some of the more distant lights are difficult to discern at distance and are not immediately apparent in the baseline photography as a result. They do however tend to draw the eye at night when observed from the viewpoint.
- 5.6.21 The contrast between land and sky on the southern skyline can be seen beyond dusk as the setting sun maintains a low glow against the skyline for a sustained period. The effect of this is more prolonged in summer months. The overall impression of the immediate night-time context at this location is of a very dark upland landscape, the landscape to the south of the BBNP has visible lighting of varying types, although this does not overly diminish the immediate sense of darkness experienced at this location.
- 5.6.22 The value and visual susceptibility of walkers at this location differs at night when compared to the assessment carried out for daytime conditions. During the night the

landscape has a diminished scenic quality and walking receptors would not have the same appreciation of the landscape which is dark and muted compared with the landscape scenery evident during the day. It is also the case that very few people would be walking in darkness in this remote area. However, receptors who decide to take considerable effort to reach this location are clearly doing so in which to view the night sky within the core DSR area and as such the sensitivity is predicted to remain **Medium-High**.

Night-Time Assessment

2,000 cd Light Intensity

- 5.6.23 All six of the nacelle lights and tower lights would be visible from this location. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the lights on the hubs would not be intermittently obscured by intervening blades and so would not appear to flicker due to turbine blades passing the hub and tower lights.
- 5.6.24 The intensity of the nacelle lights in the 2,000cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 2000cd. The Proposed Development lights would be seen as an introduction of lights to a part of the upland horizon to the south at 7.8km where there is a background context of occasional existing lighting.
- 5.6.25 The nacelle lights would be seen in a part of the panorama that has relatively high levels of darkness to the east of the settlement lighting found at the edges of Merthyr Tydfil.
- 5.6.26 The nacelle lights would be appear backdropped by the distant southern sky, which due to the elevation of the viewpoint is within a similar line of sight to the distant low lying coastal region of the Bristol Channel. This is important to the assessment at this location, since the aviation lights would be close to the skyline horizon and would therefore not interrupt the view of the stars in the night sky above. The nacelle lights would not therefore be detrimental to the overall experience of the dark skies within this part of the DSR. Whilst they would be visible as points of light in the distant view south and increase the influence of human/man made elements, the lights are not expected to result in obtrusive light that impedes the view of the night sky, nor result in brightening of the night sky (skyglow) that might be of detriment to the overall experience of the dark skies in this view.
- 5.6.27 Taking all of this into account, the magnitude of change is assessed as **Medium** resulting in a **Moderate and Significant** effect.

200 cd Light Intensity

- 5.6.28 The description of lights visible for 2,000cd also applies to the 200cd reduced intensity scenario. The intensity of the nacelle lights in the 200cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 200cd. The effect differs therefore, reducing the intensity of light experienced. Taking this into account the magnitude of change is assessed as **Medium - Low** resulting in a **Moderate and Not Significant** effect.

Viewpoint 21: A4059

Nearest Visible Turbine Light: 10.4km

Night-Time Baseline Condition and Sensitivity

- 5.6.29 This viewpoint represents views from the A4059 at night and is representative of views seen by road users at night. It is located on the A4059 on an elevated part of this remote road that crosses the eastern edges of Forest Fawr. The viewpoint is within the DSR core area within the BBNP.
- 5.6.30 During the day, the view to the south includes a distant view along Taf Fawr, past the settled landscape of Merthyr Tydfil and along the southern valley of the Taff River beyond. The Taff Trail follows Taf Fawr and the Taff River much of which is forested. The views from this location during daylight are of an exposed upland landscape apart from the A4059 road itself and the multiple wind farms that occupy the horizon to the south. Views to the north are scenic and include the steep sided slopes of Corn Du and Fan Fawr which together creates a distinctive 'v' shaped valley that cuts through the central beacons along the valley of the Taff and Tarrell. Towards the site, to the southeast, the view is unremarkable and consists of a broad upland created by the eastern slopes of Taf Fawr which has scalloped shaped plantation forestry rising up its slopes almost meeting the horizon.
- 5.6.31 At night, however, individual landscape elements that create these different landscapes both within the BBNP and to the south of it are difficult to discern. There is very little existing lighting in the night time view other than the headlights / taillights of passing cars. The overall impression of the immediate night-time context at this location is of a very dark upland landscape.
- 5.6.32 The value and visual susceptibility of road users at this location differs at night when compared to the assessment carried out for daytime conditions. During the night the landscape has a diminished scenic quality and road user receptors would not have the same appreciation of the landscape which is dark and muted compared with the landscape scenery evident during the day. Whilst within the DSR, taking into account the diminished scenic quality, road users are considered to have a Medium sensitivity at night.

Night-Time Assessment

2,000 cd Light Intensity

- 5.6.33 All six of the nacelle lights and four of the tower lights would be visible from this location. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the lights on the hubs would at times (when the wind is more westerly in direction) be intermittently obscured by intervening blades so that they would appear to flicker as the turbine blades pass the hub and tower lights. On this basis they would at times appear to flicker as the turbine blades pass the hub and tower lights. The intensity of the nacelle lights in the 2,000cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 2000cd. The Proposed Scheme lights would be seen as an introduction of lights to a part of the upland horizon to the southeast at 10.4km.

- 5.6.34 The nacelle lights would be appear backdropped by the distant southern sky and seen in a part of the panorama that has a simple upland horizon with an intervening foreground of relatively high levels of darkness. The aviation lights would be close to the skyline horizon and would have no influence on the view of the stars in the night sky above. The nacelle lights would therefore little influence on the overall experience of the dark skies within this part of the DSR.
- 5.6.35 The lights would introduce the influence of human/man made elements to the night sky as distant points of light close to the horizon. However, they are not expected to result in obtrusive light that impedes the view of the night sky, nor result in brightening of the night sky (skyglow) that might be of detriment to the overall experience of the dark skies in this view.
- 5.6.36 Taking all of this into account, the magnitude of change is assessed as **Medium** resulting in a **Moderate and Not Significant** effect.

200 cd Light Intensity

- 5.6.37 The description of lights visible for 2,000cd also applies to the 200cd reduced intensity scenario. The intensity of the nacelle lights in the 200cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 200cd. The effect differs therefore, reducing the intensity of light experienced. Taking this into account the magnitude of change is assessed as **Medium-Low** resulting in a **Moderate-Minor and Not Significant** effect.

5.7 BBNP Dark Sky Reserve

- 5.7.1 The Bannau Brycheiniog Dark Sky Reserve is a valued recreational destination as recognised within the BBNP website . The BBNP was awarded Dark Sky Reserve (DSR) status in 2013 by the International Dark-Sky Association, based in the USA. *'International Dark Sky Reserves are areas recognised as possessing an exceptional or distinguished quality of starry nights and nocturnal environment specifically protected for scientific, natural, educational, cultural, heritage or public enjoyment.'*⁴
- 5.7.2 The BBNP Lighting Management Plan⁵ states its key objective in Section 1.3 of the document as follows - *'This document has been commissioned with the prime objective of promoting the use of the intrinsic darkness of Bannau Brycheiniog to view the stars in the night sky. The document therefore concentrates on mitigating any obtrusive light elements which could cause a nuisance, from both the astronomers' and residents' viewpoint, by -*
- *Maintaining or improving the night sky darkness as a background to view the star constellations.*
 - *Promoting a good practice working document for Bannau Brycheiniog commercial and agricultural use, and to be accessible by residents, hoteliers and any other tourist related promotion.*
 - *Promoting the use of quality domestic lighting equipment with good light control.*

⁴ <https://www.beacons-npa.gov.uk/the-authority/press-and-news/archive/2013-2/february-2013/brecon-beacons-becomes-the-world2019s-5th-international-dark-sky-reserve/>

⁵ Bannau Brycheiniog National Park, International Dark Sky Reserve - Lighting Management Plan. Lighting Consultancy and Design Services Ltd. (no date)

- *Encouraging improvement, adaptation or changing of existing lighting equipment.*
- *Creating a benchmark to achieve International Dark Sky Reserve (IDSR) status for Bannau Brycheiniog National Park from the International Dark-Sky Association (IDA)*

5.7.3 It is clear from this document that in relation to the Proposed Scheme, the potential for effects to the darkness of the sky in relation to a view of star constellations is a key consideration in assessing the potential effects of the Proposed Scheme lighting proposals.

5.7.4 The DSR is composed of four regions within and around the BBNP. Each of these regions has differing constraints on the levels of permanent illumination permitted as outlined in BBNPA LDP Policy 12⁶ which states -

- *'Core Zone – It is the aspiration that within this area that there will be no additional permanent illumination as a part of new development within this region and that any necessary lighting will not be lit in a manner that increases upward light spill.*
- *Critical Buffer Zone – It is the aspiration that there will be no lighting projected from the buffer zone into the core zone. Luminaires in the Critical Buffer Zones using lamps greater than 1000 lumens will be expected to be installed as fully shielded.*
- *Buffer Zone (remainder of NP area) All new lighting resulting from development within the Buffer zone will be encouraged to be designed and installed to provide lower glare or intensity values, where possible, than that recommended by the institute of Light Professionals for night time Environmental Zones*
- *External Zone – (outside the NP park area) The NPA will utilise the contents of this guidance note as supported by the BBNP International Dark Sky Reserve Lighting Management Plan to provide the basis for discussion with neighbouring LPAs on lessening development proposals potential for light pollution.'*

5.7.5 The conditions for DSR status require stringent lighting guidance for the Core Zone. The Buffer Zone and Critical Buffer Zone are positioned around the Core Zone to protect the status of the Core but do not have such stringent requirements. In relation to these criteria, the Proposed Scheme is located within the External Zone, immediately to the south of the Core Zone. The DSR is considered to have High sensitivity to visible aviation lighting of the type proposed.

5.7.6 The park attracts people wishing to appreciate the night-time sky with an absence of night time light pollution. BBNPA promotes ten viewing locations within the DSR which offer stopping points to view the night sky. The sensitivity of the ten viewing locations to the potential effects of the turbine lights is higher than other areas of the DSR, as visitors will come to these sites with the express intention of viewing the night sky and this experience could be affected by other sources of light. Of the ten viewpoints locations promoted by BBNPA for the DSR, none would have visibility of the Proposed Scheme nacelle lights.

5.7.7 While these ten viewing locations are identified as being suitable viewing sites, people could feasibly be viewing the night sky from any part of the DSR. The vast majority of theoretical visibility within the core area of the DSR is located on upland landscapes including the hill summits of the central Beacons. Apart from the small area of theoretical visibility on the remote upland plateau immediately north of the Proposed Scheme (as far north as Cefn), the other hill tops and uplands within the DSR core with theoretical

⁶ Bannau Brycheiniog National Park Authority LDP Policy 12 - Light Pollution & Obtrusive Lighting, March 2015, Supplementary Planning Guidance.

visibility of the nacelle lights are also relatively distant and the effects of turbine lighting are therefore diminished.

- 5.7.8 The Central Beacons are remote upland areas and accessing potential locations within this area at night in order to view the night sky is challenging and as such is not considered to be an activity that attracts many observers at night (in general, people would tend to use the viewing locations or other similar locations that are easier to access in the hours of darkness). There are additional safety challenges in accessing the Central Beacons horseshoe ridge due to the difficulty in navigating the ridge in darkness on paths that are often close to very steep drops.
- 5.7.9 It is notable that of the 10 viewing locations 7 are located to the north of the Bannau Brycheiniog with views south into the DSR with the Bannau Brycheiniog creating the dark horizon beyond which the night sky can be viewed. Only 1 of the viewing locations is located with south facing views, on the south facing slopes of Sugar Loaf near the car park, from this location the night sky is viewed above a very distant horizon that also includes large areas of the settled (and lit) valleys landscape of South Wales and distant views of southwest England. The other 2 are within wide valleys to the west and east, which have an enclosed feel with valley sides creating nearby horizons above which the night sky is seen.
- 5.7.10 Viewpoint 18 Beacons Way (Craig Y Fan Ddu) and viewpoint 21 A4059 are representative night-time viewpoint locations that lie within the Core Area of the DSR, overlooking the southern edges of the BBNP and southern edges of the DSR Core Area. These are remote locations, albeit that the A4059 is accessible by road. For viewpoint 21 the visual assessment has concluded a not significant visual effect for both the 2000cd and 200cd scenarios. For viewpoint 18 the visual assessment assessed a significant effect for the 2000cd scenario reducing to not significant in the 200cd scenario.
- 5.7.11 The assessment also found that the nacelle lights would be appear backdropped by the distant southern sky and would be close to or lower than the skyline horizon and therefore have little or no influence on the view of the stars in the night sky above. The nacelle lights would therefore have little influence on the overall experience of the dark skies within the DSR. When viewed from elevated positions within the southern half of the DSR, the assessment has also found that existing lights are already experienced within the southern horizon, either as lights within settled areas, coms masts, or car lights on roads on the ridges and valley sides of the south Wales Valleys landscape. The lights of the Proposed Scheme would therefore intensify the influence of human/man made elements to the night sky as distant points of light close to the horizon. However, they are not expected to result in obtrusive light that impedes the view of the night sky, nor result in brightening of the night sky (skyglow) that might be of detriment to the overall experience of the dark skies in this view. It is considered therefore that the nacelle lights would not be detrimental to the overall experience of the dark skies within the DSR. Taking all of the above into account the overall effect of the Proposed Scheme turbine lights on the DSR is considered to be of a **Low** magnitude change resulting in a **Moderate – Minor and Not Significant** effect.
- 5.7.12 This is due to the following key moderating points -
- The majority of receptors within the DSR being largely unaffected, including the 10 BBNPA promoted DSR viewing locations;

- Visibility within the DSR largely occurs within remote locations which are not places people are likely to go to at night;
- Where visible from within the DSR, the visible aviation lights would appear as points of light, located at a low elevation, and viewed either close to or below the horizon;
- Where visible from outside of the DSR (to the south), the visible aviation lights would appear in front of a horizon that forms the backdrop to a settled and lit night time context;
- For locations where visibility does occur receptors visiting the DSR with the express intention of viewing the night sky would not have their view of the sky interrupted by the Proposed Scheme lighting as the lights would tend to appear close to or below the sky; and
- The visible aviation lights are not expected to result in obtrusive light that impedes the view of the night sky, nor result in brightening of the night sky (skyglow) that might be of detriment to the overall experience of the dark skies.

5.8 Conclusion

- 5.8.1 At night the turbines would not in themselves be conspicuous during times of darkness. Nevertheless, the assessment of night-time effects for the Proposed Scheme has predicted a significant effect for one of the four representative night-time viewpoints, namely at Viewpoint 18 Beacons Way (Craig Y Fan Ddu) as a result of the 2000cd scenario. For the other representative viewpoints, the effect is assessed as not significant.
- 5.8.2 The duration of the effect of the lights on receptors is likely to be over a relatively short period, more commonly experienced during evening and morning hours of darkness, around dusk and sunrise. The ICAO standard requires the lights to be switched on 30 minutes after sunset, and 30 minutes before sunrise, removing the likelihood of visible lighting during twilight. The visual effects of the Proposed Scheme at night would also 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.
- 5.8.3 Views from remote uplands and hills, rural farmland and footpaths etc. are visited infrequently at night therefore numbers of receptors affected will be low. Whilst receptors within remote areas of the DSR would also be affected (such as at viewpoints 18 and 21 assessed in this appendix) these are much less frequented locations within the DSR than the 10 recommended viewpoint locations from which to observe the night sky. The assessment concluded that effects on the DSR would be not significant.
- 5.8.4 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.

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