Appendix 6.4: Aviation Lighting Assessment

Car Duibh Wind Farm Limited

An Càrr Dubh Wind Farm EIA
LVIA - Appendix 6.4
Aviation Lighting Assessment

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Introduction

A6.4.1 In the interests of aviation safety, structures of ≥ 150m, including wind turbines, require steady red visible aviation lighting, as set out in Civil Aviation Authority (CAA) guidance[1].The Proposed Development comprises up to 13 turbines of up to 180m to tip and will therefore require visible aviation lighting which may be perceptible to receptors (people) from locations across the Study Area.

A6.4.2 The introduction of visible aviation lighting in rural locations, where there are fewer sources of artificial lighting, and where darkness or dark skies are an integral and valued aspect of the landscape, may lead to potentially significant landscape and visual effects. This appendix includes an assessment of the effects of visible lighting on landscape and visual receptors.

A6.4.3 The requirement for visible aviation lighting is an emerging consideration for the wind energy sector, and consequently the approach to the assessment of likely environmental effects which may arise is evolving.

A6.4.4 This technical appendix sets out the background to the requirements for visible aviation lighting, followed by an assessment of landscape and visual effects arising for representative receptors within the Study Area. Receptors considered in the assessment are identified based on the Landscape and Visual Impact Assessment (LVIA) presented in Chapter 6, and this appendix should be read with reference to the main assessment and the accompanying visualisations presented in Volume 3 of the EIA Report, along with **Appendix 6.1: Landscape and Visual Assessment Methodology.**

Regulatory Background

A6.4.5 The regulatory background to the requirements for visible aviation lighting on wind turbines is outlined in detail below.

Aviation Lighting Requirements

A6.4.6 As noted above, the UK Air Navigation Order (ANO) 2016, Article 222[2] , sets out the statutory requirement for the lighting of 'en-route obstacles', which applies to structures of 150m or more above ground level to assist their detection by aircraft. Article 222 (1) of the Civil Aviation Authority's (CAA) ANO 2016 and Regulations states:

'The person in charge of an en-route obstacle must ensure that it is fitted with medium intensity steady red lights positioned as close as possible to the top of the obstacle and at intermediate levels spaced so far as practicable equally between the top lights and ground level with an interval of not more than 52 metres.'

A6.4.7 Article 222 (8) defines an en-route obstacle as:

'an 'en-route obstacle' means any building, structure or erection, the height of which is 150 metres or more above ground level, but it does not include a building, structure or erection:

a) which is in the vicinity of a licensed aerodrome; and

b) to which section 47 of the Civil Aviation Act 1982 (warning of presence of obstructions near licensed aerodromes) applies.'

A6.4.8 For turbines of 150m or greater the exceptions listed in ANO Article 222 (8) a) and b) (set out above) would not apply, and therefore the regulations necessitate the installation of medium intensity (emitting 2000 candela) steady red lights on all turbines.

A6.4.9 This article has been incorporated into the CAA's Policy Statement[3] on the lighting of onshore wind turbines (June 2017), and states that *'The person in charge of the wind turbine generator must ensure that it is fitted with a medium intensity (2000 candela) red light positioned as close as practicable to the top of the fixed structure. A second light serving as an alternative should be provided in case of failure of the operating light.'* In practice this means the installation of lights on the top surface of the turbine hub/ nacelle.

A6.4.10 Additionally, the CAA requires that "*at least three (to provide 360 degree coverage) low-intensity Type B6 lights (32 candela) lights should be provided at an intermediate level of half the nacelle height."* However, the requirement for intermediate level lighting has been scoped out in agreement with the CAA, as set out in **Appendix 14.2: Aviation Lighting and Mitigation Report**.

Lighting Specification Requirements

A6.4.11 Informed by the International Civil Aviation Organisation (ICAO) Code - Annex 14[4] which sets out the technical specification requirements for medium intensity obstacle lights (MIOL), the CAA Policy Statement details the required and recommended minimum intensity lighting settings for 2000 candela lights (with the 200 candela rated option, for clear weather conditions, highlighted in brackets) at different vertical angles of elevation, relative to the lighting horizontal plane, which in this case will be the nacelle height of the wind turbines. The intensity of the light emitted from an aviation obstruction light is designed to vary with the observed angle. It aims to be at its brightest when observed from a similar level or just above, but less bright as the observer falls significantly below or above the light. Different manufacturers produce lights with slightly varying characteristics, though broadly similar in complying with international standards.

A6.4.12 The applicant commissioned a specialist aviation consultant (Wind Power Aviation Consultants (WPAC) Ltd) to design, in consultation with the CAA, the aviation lighting scheme for the Development. An Aviation Lighting Report has been prepared (refer to **Appendix 14.2**) which sets out the details of the lighting scheme and includes information on the actual intensity experienced at different vertical angles of elevation. This is outlined in **Table A6.4.1** below:

Table A6.4.1: Maximum candela at varying vertical angles

Vertical angle of lighting from nacelle (degrees)	Approximate maximum candela	Approximate candela at 10% (clear weather conditions)
Above 2	1500 to 750	150 to 75
1 to 2	2500 to 1500	250 to 150
0 to 1	2000 to 2500	200 to 250
0 to -1	2000 to 1000	200 to 100
-1 to -2	1000 to 400	100 to 40
-2 to -3	400 to 200	40 to 20
Below - 3	Below 200	Below 20

A.13 The ICAO sets out in Table 6.4 of Annex 14 the definitions for daylight, twilight and night based on measured background illuminance as:

- Daylight – Above 500cd/m2,
- Twilight – 50-500cd/m2m, and
- Night – below 50cd/m2.

[1] The Air Navigation Order 2016 (SI 2016/765). Available at http://www.legislation.gov.uk/uksi/2016/765/contents/made (Accessed: 07 July 2022).
[2] The Air Navigation Order 2016 (SI 2016/765). Available at http://www.legislation.gov.uk/uksi/2016/765/contents/made (Accessed: 07 July 2022).
[3] CAA Policy Statement (2017) Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150m Above Ground Level

[4] International Civil Aviation Organization (ICAO) (2018) Annex 14 to the Convention on International Civil Aviation – Aerodromes - Volume I Aerodrome Design and Operations

A6.4.14 The perceived minimum intensity of a 2000 candela light mounted on the turbine nacelle therefore reduces at vertical angles below the horizontal plane. This results in a reduction in visible lighting at elevations of less than -1 degree vertical angle. That is to say, the light would appear less bright to an observer looking up at the nacelle from below than it would to an observer at the same elevation as the nacelle. The intensity at angles below -1 degrees may also vary dependent on the specific obstacle lighting manufacturer's specification. Note that this does not take account of emitted light spill on to passing blades, which may be visible from all elevations as a reflected glow across the immediate surfaces of the turbine blades and nacelle.

A6.4.15 The CAA Policy Statement also includes provision for the medium intensity 2000 candela lights to be controlled by visibility sensors that may reduce the intensity of the light to not less than 10% of the minimum peak intensity (e.g. 200 candela) in times of clear meteorological conditions, where visibility exceeds 5km (as measured on sensors on the turbine hubs).

A6.4.16 In conditions of meteorological visibility of less than 5km, the perceived brightness of medium intensity lights illuminated at 2000 candela, whilst possibly still visible, is likely to be much reduced, and typically not visible at distances greater than 5km from turbines.

A6.4.17 Although the actuality of the lights remains constant, the apparent light intensity (brightness) and size of a light source as perceived by visual receptors (people) will vary dependent on distance, angle of view, and atmospheric conditions. As distances increase, the light source will appear smaller. As atmospheric conditions become less clear (a reduction in clarity with increased humidity, rain, drizzle, snow, or the presence of haze, mist, fog, or a low cloud base etc) the brightness will appear reduced. Clarity varies at different levels within the sky, and across different places. Decline in brightness over distance is not uniform. The brightness at which lights are perceived also depends on the background against which they are seen. They may seem brighter because of the stronger contrast when there is no moonlight for example, or when they are seen against a dark landmass rather than against a sky where there is some residual twilight. Perception of red lights by humans is also variable from person to person and is influenced by age.

Potential Mitigation

A6.4.18 A number of potential mitigation options are currently available or are being developed by the wind energy sector in collaboration with the CAA and other stakeholders. Mitigation options which may have the potential to influence the resultant landscape and visual effects which may occur from the introduction of visible aviation lighting are outlined below.

Cardinal or Peripheral Lighting

A6.4.19 The lighting of cardinal or peripheral turbines located at the outer extremities of a wind farm development is an established mitigation option for wind farms.

A6.4.20 Current ICAO Annex 14 guidance for lighting of wind turbines states that aviation lights should be installed to identify the perimeters of the wind farm, respecting the maximum spacing between lights '*not exceeding 900m*' (paragraph 6.2.3.15) unless in situations where '*a dedicated assessment shows that a greater spacing can be used*', and also that any wind turbines of significantly higher elevation are also identified.

A6.4.21 Through consultation with the CAA, a reduced lighting scheme has been secured for the Proposed Development. Detail of which turbines are proposed to be lit is described further below.

Lighting Design

A6.4.22 The technical specification for medium intensity obstacle lights set out in the CAA Policy Statement define the necessary requirements for both the minimum lighting intensity settings and minimum vertical angle range of medium intensity lights (as outlined above). Individual lights have slightly varying characteristics, though broadly similar in complying with international standards with sharply declining intensity when viewed from a lower level.

A6.4.23 As such, embedded mitigation within the design of the lights has the potential to much reduce the extent and perceived intensity of lights visible when viewed from different elevations (effectively the angle of view), when seen from either below (lower elevations) or above (higher elevations) the height of the turbine hub. Furthermore, embedded mitigation within the design may enable the low intensity lights installed at mid-mast level to be removed, as is the case here.

Radar Activated Lighting

A6.4.24 ICAO Annex 14 also details guidance on 'Visual Aids for Denoting Obstacles'. With specific reference to mitigation of effects on visual amenity, Note 2 outlines that *'An autonomous aircraft detection system may be installed on or near an obstacle (or group of obstacles such as wind farms), designed to operate the lighting only when the system detects an aircraft approaching the obstacle, in order to reduce light exposure to local residents.'*

A6.4.25 A number of manufacturers have developed radar activated aviation lighting systems (aviation obstruction lighting detection system), whereby the lights would only be switched on when aircraft approach within a specified airspace zone, and this technology is currently permitted by aviation authorities in EU countries (German Federal Aviation Office (LBA) and the Netherlands Aerospace Centre (NAC)) and the United States (United States Federal Aviation Authority (FAA)).

A6.4.26 This technology is not currently approved by the CAA and as such is not considered further as a potential mitigation option, at this stage. However, it may become available in the lifetime of this project, enabling the duration of visible lighting to be reduced if it were to be adopted.

Proposed Aviation Lighting

A6.4.27 Due to the height of the turbines proposed (180m to turbine blade tip) visible aviation safety lighting is required. The proposed aviation lighting included in this assessment has been agreed through consultation with the CAA. The lighting design is described in more detail in the WPAC Aviation Lighting Report (refer to **Appendix 14.2: Aviation Lighting and Mitigation Report**) and summarised below:

- Two medium intensity 'steady' red (2000 candela) lights on the nacelles of each of turbines 1, 2, 3, 7, 10, 11 and 13 (the secondary light on each turbine is fitted for use in the event of failure of the primary light, and will not be lit concurrently); and,
- Infra-red lights to MoD specification installed on the nacelles of perimeter turbines, which include all 13 turbines.

A6.4.28 Infra-red lights are required for military and emergency service aircraft flying at night, and these lights are not designed to be visible to the naked eye. As such, the visual effect of infra-red lighting is not assessed. The general requirement by the CAA for intermediate level 32 candela lights on the turbine towers has been scoped out in agreement with the CAA (**Appendix 14.2**), and visual effects are therefore not assessed.

A6.4.29 Mitigation will be implemented to dim the obstacle lights under conditions of good visibility. This is achieved with the installation of a sensor or sensors within the wind farm. These sensors measure prevailing atmospheric conditions and visibility range. Where atmospheric conditions limit visibility to distances of less than 5km (as measured at the location of the sensor) e.g. through the presence of low cloud cover, rain, mist, haze or fog), the lights are illuminated at the necessary medium intensity of 2000 candela. When clear atmospheric conditions result in visibility over distances of 5km or greater from the turbines, the lights will operate in a lower intensity mode of 200 candela (the equivalent of not less than 10% of the minimum peak intensity capable illumination).

Approach to Assessment of Lighting Effects

A6.4.30 The assessment of lighting effects follows the same approach detailed in **Appendix 6.1: Landscape and Visual Assessment Methodology**. However, it is important to note that the assessment is not a technical lighting assessment based on a quantitative measurement of light levels; it relies on professional judgement of what the naked human eye can reasonably perceive in the context of the baseline situation with regard to existing sources of artificial lighting.

A6.4.31 GLVIA3 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.'* (paragraph 6.12, page 103).

A6.4.32 The WPAC Aviation Lighting and Mitigation Report (**Appendix 14.2**) provides detailed information on the candela level emitted for each turbine nacelle light, at each LVIA viewpoint, dependent on the angle of view and distance. This detailed study highlights that the maximum intensity of any nacelle light experienced at any of the night-time assessment viewpoints is as follows:

- For the low-lying Viewpoint 2: Dalavich (4.4 km to nearest lit turbine (T1)), the maximum candela level emitted is 122 candela during the maximum illumination mode, and 12 candela during the reduced intensity mode (i.e. in clear meteorological conditions);
- For Viewpoint 4: Folly at Dun na Cuaiche (5.7 km to nearest lit turbine (T3)), the maximum candela level emitted is 448 candela during the maximum illumination mode, and 45 candela during the reduced intensity mode; and,
- For the more elevated Viewpoint 29: Beinn Bhuidhe (17.3 km to nearest lit turbine (T2)), the maximum candela level emitted is 2439 candela during the maximum illumination mode, and 244 candela during the reduced intensity mode.

A6.4.33 This assessment considers the effects of lights perceived at the reasonable maximum case candela levels as set out in **Appendix 14.2**, to reflect a more realistic account of the likely perceived brightness of aviation lighting due to the viewing angle and distance to the receptor. The assessment also considers the effects of lights perceived at the reasonable minimum case candela levels as set out in **Appendix 14.2.** The dusk photomontage visualisations provided in **Figure 6.2.2, Figure 6.2.4** and **Figure 6.2.29** reflect these scenarios. For completeness and to enable comparisons with visualisations prepared by other consultants, dusk visualisations are also provided showing candela values at 200 (minimum case) and 2000 (maximum case) which do not seek to represent changes in brightness as a result of viewing angle. These are provided in **Figure 6.2.2, Figure 6.2.4** and **Figure 6.2.29**. In practice, the angle intensity mitigation will be inbuilt and so such situations would not occur.

A6.4.34 Although the assessment is based on effects arising in relation to the steady red light fixed to the top of each turbine hubs, as illustrated in the supporting visualisations, it is acknowledged that in some situations a potential flicker effect may be experienced by receptors as blades pass the stationary lights. It is not possible to represent this situation in static photomontages. Furthermore, reflected glow across the immediate surfaces of the turbine blades and hub may be evident under certain conditions.

A6.4.35 When determining the magnitude of change associated with the Proposed Development, the methodology in **Appendix 6.1** considers the duration of the change. For operational effects this is deemed to be long term (but subject to removal or change upon decommissioning, or future alteration of the Proposed Development or lighting requirements, such as the potential for adoption of transponder activated solutions). However, and with relevance to night-time effects, the frequency and duration of the effect should also be considered. Aviation lighting will only be apparent during hours of darkness (below 500cd/m2) which changes with the seasons. As such in the summer months the duration of visibility of aviation lighting will reduce. It will also be activated much later at night, when fewer people may be around to experience the lighting. In the winter the converse will be the case. The period when visibility is greater than 5km is also likely to be longer in summer, due to generally better weather conditions.

A6.4.36 The night-time baseline against which the effects of the Proposed Development are assessed, includes operational/ under construction wind farms only. There are currently no operational / under construction wind farms in the Study Area which require aviation lighting due to the height of the turbines. Several proposed wind farms are also likely to require aviation lighting, should they be constructed, as follows:

- Blarghour (17 turbines at 180m to tip);
- Eredine (26 turbines at 230m to tip);
- Ladyfield (18 turbines at 200 m to tip); and,
- Musdale (26 turbines at 200m to tip).

A6.4.37 Whilst the scenario of illuminated proposed wind farms is not represented in the night-time visualisations (these schemes are shown in the cumulative wirelines) this is acknowledged in the assessment text, where relevant.

A6.4.38 The assessment of effects does not consider the potential implications of further mitigation options which may be feasibly adopted in the future to reduce the extent, frequency and perceptibility of the necessary visible aviation lighting (such as radar activated lighting). While the effects of Aircraft Detection Lighting Systems (ADLS) have not been assessed in the EIA Report, the adoption of such a system would greatly reduce the incidence of night-time aviation lighting compared to the scenarios assessed here. This is illustrated, with the caveat that the circumstances may differ for the Proposed Development, by a study undertaken for a proposed wind farm located in the Highland Council area - Kirkan Wind Farm – which estimated the frequency with which the lights on the turbines would be switched on by passing aircraft if a transponder-activated lighting system was fitted to that wind farm.

A6.4.39 This study, prepared by Aviatica for Kirkan Wind Farm Limited, was reported as Appendix 4 to the Additional Information submitted for Kirkan Wind Farm in October 2021. Kirkan Wind Farm proposes 17 turbines with a maximum blade tip height of 175m, located 5.8km northwest of Garve, and is located within Allocated Region 1B East (AR1BE) in the military Night Low Flying System. The study assumed activation criteria advised by CAA (i.e. an aircraft entering a 4km radius bubble around the outer perimeter of the wind farm at an altitude less than 300m (1000ft) above the blade tips of the highest turbine and higher than 150m (500ft) above the ground level at the lowest turbine) and reviewed flight data for military fixed wing, military helicopter, search and rescue (SAR) helicopter, air ambulance helicopter, police helicopter and other night low level aircraft traffic over the period 2016-2021. The study determined that, on worst-case estimates, the transponder-activated lights would be switched on for less than 0.1% of the periods of official night (Sunset +30 minutes until Sunrise -30 minutes), or 225 minutes per year. The study referred also to comparative data for 11 wind farms with operational TALS/ADLS in Germany and Austria where lighting was activated for an average 2.31% of night-time, although five of the 11 wind farms had activation times within a similar range to Kirkan (between zero and 0.1% of night-time).

A6.4.40 At the present time the proposed manufacturer or precise model and specification of aviation light to be used is not known. Precise details of mitigation will vary according to the exact light used, but the same principles as assumed in this report will apply (i.e. decline in intensity with increased angle from the horizontal).

Zone of Theoretical Visibility Mapping

A6.4.41 The hub height (102.5m height) Zone of Theoretical Visibility (ZTV) prepared as part of the LVIA, shown on **Figure A6.4.1**, highlights the areas across the Study Area from which aviation lighting installed on the turbine hubs may be apparent. This ZTV does not take account of potential screening provided by vegetation or built form. To illustrate the potential variability in lighting intensity in relation to vertical viewing angle, the lighting intensity scale is also shown on this figure.

A6.4.42 To illustrate the potential variability in candela levels emitted in relation to vertical viewing angle, a lighting intensity ZTV is shown on **Figure A6.4.2** (with a focused area to 20km radius on **Figure A6.4.3**). The ZTV does not show the reduction in the brightness of lights over distance, given it would be highly variable depending upon atmospheric conditions. As illustrated by the ZTV, visibility of the nacelle lights at their greatest candela level (1500-2500 candela) would generally be limited to elevated summits within the Site itself (notably Beinn Bhreac) and the wider Study Area. This includes Cruach Mhor to the north, within 2 km of the nearest turbine, and much more distant higher summits in the north and east including Beinn Bhuidhe, Ben Cruachan, Ben Lui, Ben Ime. These areas are likely to be rarely frequented during the hours of darkness, given the challenging terrain.

A6.4.43 From well frequented lower lying settlements along the shores of nearby Loch Awe and Loch Fyne, as well as locations in closest proximity to the turbines (within 5km), the lights will generally be perceived at a much reduced intensity, given viewers will be well below the lights.

Visualisations

A6.4.44 It is important to note that visualisations represent just one source of information that informs a landscape and visual impact assessment (LVIA). Visualisations were produced for three representative assessment viewpoints, agreed through consultation with NatureScot and Argyll and Bute Council (ABC) and presented in accordance with the industry standard guidance prescribed in NatureScot[5] and Landscape Institute[6] guidance. The methodology for the preparation of night-time photomontage visualisations is detailed at the end of **Appendix 6.1: Landscape and Visual Assessment Methodology**.

A6.4.45 The NatureScot guidance 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.'* (paragraphs 174 – 177, page 35 and 36). It is noted however that the rate at which darkness falls after sun set varies considerable with the time of year.

A6.4.46 Photography taken at this time represents a relatively small window (during periods of dusk and dawn, the length of which varies with the time of year) when the landform is visible along with existing and proposed light sources, and perception of landscape character under conditions of fading light or darkness is possible. The actual night-time view, for most of the proposed hours when the turbines are lit, will usually be darker. The proposed lighting and other natural and manmade light sources will be seen against a dark sky or dark landform. In such conditions, the landscape character is harder to perceive. Bright moonlit conditions, or periods when

[5] Visual Representation of Wind Farms Guidance - Version 2.2. (February 2017) Scottish Natural Heritage

[6] Technical Guidance Note 06/19 Visual Representation of Development Proposals (September 2019)

the landscape is snow covered, may provide an exception to this. It is noted that some other light sources will be switched off when people go to bed, and that at this time people may be less susceptible to experiencing views of lighting.

A6.4.47 Baseline dusk photography was undertaken in accordance with NatureScot guidance for each of the representative viewpoints. Photography was captured at dusk in clear atmospheric conditions and sought to capture the presence of existing baseline sources of artificial lighting (e.g. lighting associated with settlement, street lighting, motor vehicles and other sources) present in the landscape as closely as is experienced by the human eye as is feasible.

A6.4.48 The representative visualisations (dusk photomontage visualisations provided in **Figure 6.2.2, Figure 6.2.4** and **Figure 6.2.29**, which sit at the end of each viewpoint package) are presented in Volume 3 and aim to represent the appearance of the proposed visible aviation lighting at dusk during clear viewing conditions at:

- Viewpoint 2: Dalavich Jetty;
- Viewpoint 4: Folly at Dun na Cuaiche; and,
- Viewpoint 29: Beinn Bhuidhe.

A.49 NatureScot guidance also states that '*The developer should attempt to formally agree the lighting requirements with the aviation authorities in advance of the application. Where this is not possible the visualisations should illustrate the lighting as described in the current legislation*.' (paragraphs 177, page 36). The visualisations showing the reasonable maximum and minimum case scenarios were created by setting the candela level at the light source within the visualisation software using the candela values set out for each turbine and for each night-time viewpoint in **Appendix 14.2**. These visualisations seek to represent the reasonable maximum case scenario candela level for the lighting, taking account of the reduction in light emitted in relation to the vertical elevation angle at which they are viewed. They do not take into account the reduction in lighting intensity over distance given this varies considerably with atmospheric distance. They show a 'maximum case' scenario and a more realistic scenario, given the clear weather conditions in which photography was taken, at 10% of the candela value. It should be noted that the maximum case scenario is considered to be unrealistic and is unlikely to occur in practice under clear weather conditions, except infrequently for example when visibility exceeds 5km, perhaps beneath a low cloud base. For completeness, dusk visualisations are also provided showing candela values at 200 (minimum case) and 2000 (maximum case). These do not consider changes in brightness as a result of viewing angle. In addition, as set out in **Appendix 14.2**, it should be noted that based on meteorological data (visibility and cloud cover) obtained for the last 30 years for the closest meteorological stations (Tiree and Glasgow Airport), it is expected that the lights will operate at 200 cd (or candela at 10%) for about 93% of the time when not obscured by cloud cover[7].

Effects on Landscape Character at Night

A6.4.50 In terms of effects on landscape character, and as noted previously, there will usually be a relatively small window of time, at dawn and dusk, or in conditions of bright moonlight or under snow cover, during which the landform is apparent along with existing and new light sources, and when an appreciation of landscape character and associated skyscapes is perceptible. Perception of landscape character in the true darkness of night and for most of the hours when it is proposed that turbines will be lit, will be limited, albeit that the skyscape with its stars, planets, satellites etc will be seen when it is clear. Only the proposed lighting, other human light sources, and human and natural sources in the night sky will be readily apparent when it is dark. As such, the main window during which effects on landscape character, and effects on many of the associated key characteristics will be experienced will be limited to the short period of twilight (shorter in winter, and more extended in summer), or moonlight (particularly under snow). Many key characteristics, and the experience of landscape character can only readily be appreciated during the day.

A6.4.51 Informed by **Figure A6.4.1** and **A6.4.2** the presence of aviation lighting positioned on the hubs of seven turbines will be theoretically perceptible from a more widespread area within 5km (though at a lower intensity where below the turbines); across site facing hills on the moorland to the west of Loch Awe, and east of Loch Fyne within approximately 15km; and in a more intermittent pattern from higher site facing hill flanks and summits within the wider Study Area.

A6.4.52 In general terms and focusing on Landscape Character Types (LCT) within 15km where significant effects on landscape character due to aviation lighting are more likely, perception of this change from the lower lying Rocky Mosaic LCT will be limited (refer to **Figure 6.1.4**). This is with the notable exception of the area around Inverinan (refer to **Figure 6.2.7**), to the north-west of the Proposed Development. From here, lighting on the hubs of certain turbines will be apparent above the horizon enclosing Loch Awe to the east, at distances of approximately 5.5km. In this area, scattered houses and the vehicle lights of occasional traffic on the minor road to the west of Loch Awe, contribute to artificial light sources already present as part of the baseline landscape character. When apparent, four hub lights experienced in middle distance views above the horizon to the south-east are unlikely to significantly alter the key characteristics of the LCT. Furthermore, and due to the viewing angle from the LCT generally being below the horizontal, the intensity of aviation lighting experienced from this area will be reduced. Overall, the night-time effects anticipated in the Inverinan area would be similar to that illustrated at Dalavich (refer to **Figure 6.2.2**), albeit at a slightly greater distance. Refer to **Figure A6.4.2** and **Appendix 14.2.**

A6.4.53 From more upland landscape within 15km, including the Craggy Uplands, Loch Fyne Upland and Mosaic and Steep Ridgeland and Mosaic LCT's, theoretical visibility is generally focused across site facing hills flanks around Loch Fyne. Theoretical visibility is also identified across the moorland plateau to the west of Loch Awe. As noted above, theoretical visibility is more widespread within 5km of the site, particularly to the north and north-east, and south, albeit of reduced intensity when below the turbines.

A6.4.54 From these more remote upland landscapes, unnatural sources of light from within undeveloped areas are limited. Light sources, when visible, tend to be more distant views of subdued lighting from settlements and houses, and lights from vehicles moving along the A83 and A815, and minor road network. None of the Craggy Uplands, Loch Fyne Upland and Mosaic and Steep Ridgeland and Mosaic LCT's have key characteristics which specifically relate to dark skies.

A6.4.55 Two of the three night-time assessment viewpoints are representative of landscape and skyscape character experienced from more remote upland landscapes/ higher ground around Loch Fyne within upland LCTs. Significant (moderate) visual night-time effects were identified from these viewpoints under the maximum case scenario, but not under the reduced case scenario where Not Significant (minor) effects are identified. It is recognised that the Proposed Development will introduce additional light sources into skyscapes from certain parts of these more remote upland landscapes (refer to **Figure A6.4.2**). However, given the small number of lights and the distance over which they will be experienced, this is unlikely to significantly erode the more 'remote' and 'wild' characteristics of these LCTs, even when seen at full intensity.

A6.4.56 When visible, the Proposed Development will tend to be experienced in large scale and long-distance panoramas, where other occasional light sources in surrounding lower lying LCTs are also apparent, notably settlements such as Inveraray and on the vehicles of road users. The Proposed Development will be seen in closer views from within 5km of the scheme. Much of this ground is at a lower than the seven hub lights, which will help to reduce the intensity at which aviation lights are experienced. However, some localised areas to the north-west, south and from within the Site itself (Beinn Bhreac) are higher than the hub lights and as such any lighting would be seen at a greater intensity than from surrounding lower lying areas.

A6.4.57 Overall, in summary, no significant effects on landscape character are predicted at night. Effects of lighting will primarily affect views rather than landscape character.

Effects on Designated Landscapes, LLTNP and Wild Land Areas

A6.4.58 In terms of effects on Areas of Panoramic Quality (APQs), Loch Lomond and the Trossachs National Park (LLTNP) and Wild Land Areas (WLAs), and as noted previously, there will be a relatively small window of time, during dawn and dusk, when the landform is apparent along with existing and new light sources, and when landscape character can still be appreciated before darkness falls. At night-time, during most of the hours when turbines will be lit, the landscape will be under darkness, with only the proposed lighting and other light man made and natural light sources being apparent. As such, the window over which effects on APQs, LLTNP and WLAs, and effects on many of the associated Special Landscape Qualities (SLQs), or key attributes and qualities of WLAs, many of which can only be appreciated during the day-time, will be limited. Essentially, as for landscape character, the effects on designated landscapes, LLTNP and WLAs will primarily be visual.

A6.4.59 When seen from the upland areas of East and West Loch Fyne APQ (e.g. Viewpoint 4: Dun na Cuaiche, 5.7km from the nearest proposed turbine); LLTNP; North Argyll APQ and Ben Lui WLA (e.g. Viewpoint 29 – Beinn Bhuidhe (17.3km from nearest proposed turbine)), the Proposed Development will tend to be experienced in large scale and long-distance views, where other occasional light sources in surrounding lower lying landscapes outside these areas are also apparent. All of the APQs except a very small part of the area of theoretical visibility within West Loch Fyne APQ is beyond 5km from the turbine lights within the Proposed Development (refer to **Figure 6.1.6**). Theoretical visibility of aviation lighting will primarily be experienced at greater than 7.5km distance, across elevated site facing slopes (refer to **Figure A6.4.1**), and so when lighting is usually at the reduced intensity 10% candela rating. Some very localised areas of theoretical visibility within APQs are indicated from the elevated location of Dun na

[7] WPAC (2022) Wind Farm Aviation Lighting and Mitigation Report for An Carr Duibh Wind Farm V3.0 (paragraphs 29-30)

Cuaiche and Dun Corr-Bhile in the West Loch Fyne Coast APQ, at distances of approximately 5.5km from the Proposed Development. Areas within the APQs, LLTNP, and WLA already enable visibility of artificial light sources, including subdued lighting from houses and in some cases within the settlement of Inveraray, as well as lights from vehicles moving along the road network.

A6.4.60 It is noted that the Proposed Development will introduce additional light sources in views, again usually at the much lower 10% candela rating, seen from limited parts of the East Loch Fyne APQ, beyond 8km distance from lit turbines, and larger elevated areas of the North Argyll APQ at distances of 7.5km (refer to **Figure A6.4.1**). Distant visibility of up to seven lights which would primarily be seen at the 10% candela rating (i.e. given they would not usually be seen at the same brightness at greater distances if atmospheric visibility was under 5km), will not have a significant effect on the SLQs, or affect the overall integrity or reasons for designation of these landscapes.

A6.4.61 With regard to the Ben Lui WLA, Viewpoint 29 – Beinn Bhuidhe was selected as a night-time assessment viewpoint to aid understanding of night-time effects upon this area. A detailed assessment of effects on the 'Wild Land Qualities' of WLA 06: Ben Lui is provided in **Appendix 6.3**. None of the 'Wild Land Qualities' specifically relate to dark skies. This viewpoint also falls within North Argyll APQ as noted above. Beinn Bhuidhe is a remote summit location within the North Argyll APQ and Ben Lui WLA. This type of remote elevated view is likely to be experienced by a relatively limited number of recreational receptors making their way out of a WLA at dusk or camping near summits. The Proposed Development will tend to be experienced as part of large scale and long-distance panoramas, where other very occasional light sources in surrounding lower lying landscapes are also apparent. The 'Wild Land Qualities' of Ben Lui WLA, none of which specifically refer to dark skies, are unlikely to be materially altered.

A6.4.62 As is the case for effects upon landscape character, effects at night-time will predominantly alter views of night skies rather than influence the landscape character of designated landscapes, LLTNP or WLAs. Changes to views are described below.

Effects on Visual Amenity

Aviation Lighting Visibility from Assessment Viewpoints

A6.4.63 The table below details the predicted visibility of the proposed turbine lighting from each LVIA assessment viewpoint (informed by **Appendix A** of the **Aviation Lighting and Mitigation Report**). The table also indicates the potential influence of coniferous forestry in further screening the theoretical visibility of turbine lighting from each viewpoint location informed by the baseline photography and observations from fieldwork.

A6.4.64 As noted above the frequency of the effect should also be considered. Aviation lighting will only be apparent during hours of darkness which changes with the seasons. As such in the summer months the length of time subject to visible aviation lighting will reduce.

Table A6.4.2: Summary of Turbine Lighting Visibility

Summary of Turbine Aviation Lighting Visibility							
Hub lighting potentially visible (i.e. one medium intensity hub light)	•	Turbine hub lighting obscured from viewpoint but may be visible in the vicinity of the viewpoint		△	Turbine hub lighting potentially screened by vegetation		
Viewpoint	T1	T2	T3	T7	T10	T11	T13
Viewpoint 1 - Loch Awe			△		•	•	•
Viewpoint 2 - Dalavich Jetty			•		•	•	•
Viewpoint 3 - B840, North of Balliemeanoch							
Viewpoint 4 - Folly at Dun na Cuaiche (Inveraray Castle GDL)	•	•	•	•			
Viewpoint 5 - Minor road to west of Loch Awe (north of Dalavich)	•	•	•	•	•	•	•
Viewpoint 6 - Beinn Dearg			•		•	•	•
Viewpoint 7 - Core Path above Inverinan					•	•	•
Viewpoint 8 - Loch Fyne		•					
Viewpoint 9 - Kilmaha Viewpoint		•	•	•	•	•	•
Viewpoint 10 - Jetty at St. Catherine's	△	•					
Viewpoint 11 - Loch Avich, east of Loch Avich House			•			•	•
Viewpoint 12 - Parking spot, Loch Awe					•	△	△
Viewpoint 13 - Loch Avich	•	•	•	•	•	•	•
Viewpoint 14 - A886 at Strachur							
Viewpoint 15 - Fincharn Castle, Loch Awe			•	•	•	•	•
Viewpoint 16 - B840, East of Ford		•	•	•	•	•	•
Viewpoint 17 - North of Ford		•	•	△	△	△	•
Viewpoint 18 - Cruachan Dam			•	•			
Viewpoint 19 - Beinn Bheula	•	•	•	•			•
Viewpoint 20 - Ben Cruachan (1126m)	•	•	•	•	△		△
Viewpoint 21 - Ben Ime	•	•	•	•	•	•	•
Viewpoint 22 - Beinn Mhor (Cowal Peninsula and LLTNP)	•	•	•			•	•
Viewpoint 23 – The Cobbler (Ben Arthur)	•	•	•	•	•	•	•
Viewpoint 24 – B845, Loch Etive		•	•				
Viewpoint 25 - Troisgeach		•		•		•	•
Viewpoint 26 - Ben Lui (1130m)	•	•	•	•		•	•

Summary of Turbine Aviation Lighting Visibility							
Viewpoint 27 - Bridge on Old Military Road							
Viewpoint 28 - Road summit view travelling SW on minor road to west of Loch Awe							
Viewpoint 29 - Beinn Bhuidhe	•	•	•	•		•	•
Viewpoint 30 - Ben Donich	•	•	•	•	•	•	
Viewpoint 31 - Waverley Paddle Boat			•				

Representative Assessment Viewpoints

A6.4.65 Whilst the potential visibility of aviation lighting is summarised for each of the LVIA assessment viewpoints (as set out in **Table A6.4.2**) the following assessment focuses on representative viewpoints agreed through consultation with Argyll and Bute Council and NatureScot.

A6.4.66 The three assessment viewpoints represent views from settlements and hill summits within 20km. One of the assessment viewpoints is taken from a beach on the edge of a settlement (Dalavich). Given its proximity to areas where people live, this viewpoint is more likely to be frequented during the hours of darkness, by visual receptors, including residents. The other two assessment viewpoints represent elevated views from within designated landscapes. These locations are less likely to be frequented during the hours of darkness. When experienced, this is likely to be by recreational receptors of higher sensitivity.

A6.4.67 Night-time photomontage visualisations have been produced for the following three assessment viewpoints:

- Viewpoint 2: Dalavich Jetty;
- Viewpoint 4: Folly at Dun na Cuaiche; and,
- Viewpoint 29: Beinn Bhuidhe.

A6.4.68 Photomontage visualisations illustrate the aviation lighting at both the 'maximum case' scenario and the more realistic representation of 10% of maximum emitted light during clear weather conditions (noting that this is measured at the location of the sensor). The representative visualisations take account of the potential reduction in light emitted in relation to the relevant vertical elevation angle at which they are viewed, as detailed in the WPAC Aviation Lighting Report (**Appendix 14.2**), but do not account for the reduction in light emitted over distance due to the variability of this decline with changing atmospheric conditions. The methodology for the preparation of night-time visualisations is detailed in full in **Appendix 6.1.**

Table A6.4.3: Viewpoint 2: Dalavich Jetty

Viewpoint 2: Dalavich Jetty			
Grid Reference	197029, 712770	Figure Number	6.2.2
LCT	LCT 7 – Craggy Upland	Landscape Designation	None
Direction of View	East	Distance to nearest turbine	4.6km
Number of hubs theoretically visible	10	Number of turbines with blades theoretically visible	13

Viewpoint 2: Dalavich Jetty	
Location, description of existing view and potential receptors	The viewpoint is located at the edge of the settlement of Dalavich, on the beach by the lochside. The viewpoint is representative of views experienced by the residents of Dalavich and nearby properties, and recreational land and water-based users of Loch Awe. Easterly views overlook Loch Awe, with the enclosing hills providing a distinctive skyline above the loch. Views to the north, south and west are largely confined by vegetation and the steep embankments leading up to the settlement. There is no artificial lighting present in views towards the Proposed Development, to the east of Loch Awe. However, it is noted there are some scattered properties located on the eastern side of Loch Awe (visible in the day) which may introduce lights at night-time. The embankment west of the viewpoint screens views of the nearby properties, and therefore most of the artificial lighting associated with them. Views from elsewhere on the beach (e.g. closer to the shore) may have greater visibility of these properties and their lights. It is also noted that the glamping pods located further north along the beach, as well as visitors with torches, may introduce sources of artificial lighting at times.
Night-time sensitivity	Recreational and residential receptors are considered to be of **high** susceptibility to changes in night-time views. The viewpoint is not located within a designated landscape, and there is no specific value attached to night-time views. In the context of the settlement the value of the night-time view is judged to be **medium.** On balance, taking account of the judgements of susceptibility and value, the overall sensitivity of receptors at this viewpoint is judged to be **medium.**
Assessment of visual effects	**Figure 6.2.2** illustrates the view of the Proposed Development at night with a maximum candela level of 122 candela during the maximum illumination mode and a minimum candela level of 12 candela during the reduced intensity mode. When lit at maximum illumination, lighting on the hubs of 4 of the 7 lit turbines will be visible above the dark horizon to the east at a distance of 4.6km from the nearest lit turbine. The lights will introduce artificial lighting into a view that is currently unaffected by artificial lighting, with the exception of subdued lighting from scattered residential properties to the east and human activity at glamping pods to the north. When lit at minimum illumination (10%), lighting on the turbines will be barely perceptible due to the distance and vertical angle of the view. The visibility and perceived intensity of lighting will vary at different times dependant on viewing conditions, whilst the duration over which the visible lighting is evident will vary seasonally, in relation to the hours of relative darkness. Overall, the scale of change associated with visible aviation lighting is judged to be medium for the maximum candela level of 122 candela, however this will only occur when atmospheric conditions such as low cloud cover and mist limit visibility to distances of less than 5km, but when the lights can still be seen for example from below the cloud base. At times of clear atmospheric conditions when the lights will appear at the minimum candela level of 12 candela, the scale of change is judged to be small. The geographical extent of the change is judged to be small. The overall magnitude of change is judged to be **medium** and taking account of the medium sensitivity will result in a **Significant (Moderate)** visual effect when turbines are lit at reasonable maximum illumination, reducing to **Not Significant (Minor)** at reasonable minimum illumination. The visual effects of the 200 candela (minimum) illumination scenario which does not consider changes in perceived brightness as a result of changes in viewing angle would result in a **Significant (Moderate)** visual effect. Although brighter, the 2000 candela (maximum) illumination scenario would also result in a **Significant (Moderate)** visual effect. Given the angle intensity mitigation will be inbuilt into the lights, in practice this would not occur.
Potential for future cumulative effects	Under Scenario 2, aviation lighting on the proposed Blarghour Wind Farm (now scoping for larger turbines) will be theoretically visible to the east at a distance of approximately 5.6km. There is no information about how many lights would be required on this scheme. The vertical angle, and perceptible brightness of the lights is likely to be similar to the Proposed Development. Aviation lights on the Proposed Development will add 4 additional lights in combined views with the

Viewpoint 2: Dalavich Jetty	
	aviation lights on Blarghour, and would increase the horizonal extent of the night-time view that is occupied by artificial lighting, a view that is largely currently unaffected by artificial lighting. The introduction of aviation lighting on both the Proposed Development and Blarghour will result in a large-scale change over a small geographical extent. The magnitude of change is considered to be **medium** and as such the cumulative visual effect under Scenario 2 will be **Significant (Moderate**) when the lights are at maximum illumination, remaining a **Significant (Moderate**) cumulative effect when at minimum illumination, but with both present. It is however expected that a combined mitigation scheme could be developed for the two projects taken together, if both are consented, reducing **additional** effects to not significant.

Table A6.4.4: Viewpoint 4: Folly at Dun na Cuaiche

Viewpoint 4: Folly at Dun na Cuaiche			
Grid Reference	210016, 710131	Figure Number	6.2.4
LCT	LCT 4 – Mountain Glens	Landscape Designation	West Loch Fyne (Coast) APQ
Direction of View	West	Distance to nearest turbine	5.7km
Number of hubs theoretically visible	8	Number of turbines with blades theoretically visible	11
Location, description of existing view and potential receptors	The viewpoint is located on the summit of the prominent Dun na Cuaiche hill located towards the head of Loch Fyne, to the north of Inveraray. The viewpoint is located just north of Inveraray Castle and within the Inveraray Castle Garden and Designed Landscape and features a folly which overlooks Loch Fyne. This location offers long-ranging elevated views to the south, east and west. The landform of Dùn Còrr-Bhile to the north of the viewpoint, prevents longer ranging views in this direction. The focus of the view is looking to the south, along Loch Fyne. There is no artificial lighting present in views to the west, towards the Site, however artificial lights from properties, streetlights and vehicular lights are visible around the shores of Loch Fyne in the south and south-east. The settlement of Inveraray, immediately south of the viewpoint, is prominent in night-time views, with Strachur visible further south on the eastern banks of Loch Fyne and St. Catherine's to the east.		
Night-time sensitivity	Receptors at this viewpoint are recreational users, who are considered to be of **high** susceptibility to changes in the view as their attention is focused on their surroundings. The number of recreational receptors at this viewpoint at dusk or at night however is likely to be small. The viewpoint is located within the West Loch Fyne Coast APQ and is therefore considered to be of **high** value. On balance, taking account of the judgements of susceptibility and value, the overall sensitivity of receptors at this viewpoint is judged to be **high.**		
Assessment of visual effects	**Figure 6.2.4** illustrates the view of the Proposed Development at night with a maximum candela level of 448 candela during the maximum illumination mode and a minimum candela level of 45 candela during the reduced intensity mode. When lit at maximum illumination, lighting on the hubs of 4 of the 7 lit turbines will be visible along the horizon to the west, at a distance of 5.7km from the nearest lit turbine. The lights will introduce artificial lighting into a view direction that is currently dark and unaffected by artificial lighting. The lights however will be seen in successive views with existing artificial lighting from properties, streetlights and vehicles around the shores of Loch Fyne in the south and south-east. When lit at minimum illumination, lighting on the turbines will be barely perceptible due to the distance and vertical angle of the view. The visibility and perceived intensity of lighting will vary at different times dependant on viewing conditions, whilst the duration over which the visible lighting is evident will vary seasonally in relation to the hours of relative darkness.		

Viewpoint 4: Folly at Dun na Cuaiche	
	Overall, the scale of change associated with visible aviation lighting is judged to be medium for the maximum candela level of 448 candela due to the lack of existing artificial lighting in views to the west. This however this will only occur infrequently, for example when atmospheric conditions such as low cloud cover and mist limit visibility to distances of less than 5km, but when the lights might still be seen from below the cloud base. Even at this maximum illumination, the turbine lights will not appear notably brighter than existing artificial lights to the south and south-east. For the minimum candela level of 45 candela during clear atmospheric conditions, the scale of change is judged to be small. The geographical extent of the change is judged to be small. The overall magnitude of change is judged to be **medium** and taking account of the high sensitivity will result in a **Significant (Moderate)** visual effect when turbines are lit at reasonable maximum illumination, reducing to **Not Significant (Minor)** at reasonable minimum illumination. The visual effects of the 200 candela (minimum) illumination scenario which does not consider changes in perceived brightness as a result of changes in viewing angle would result in a **Significant (Moderate)** visual effect. Although brighter, the 2000 candela (maximum) illumination scenario would also result in a **Significant (Moderate)** visual effect. Given the angle intensity mitigation will be inbuilt into the lights, in practice this would not occur.
Potential for future cumulative effects	Under Scenario 2, aviation lighting on the proposed Ladyfield Wind Farm (scoping) will be theoretically visible in views to the north at a distance of approximately 6.4km. Aviation lighting on the proposed Blarghour (scoping), approximately 7.3km to the north-west, and the proposed Eredine (scoping), approximately 9.2km to the south-west will also be theoretically visible. There is no information about how many lights would be required on these schemes, however since the Proposed Development is the closest of these proposed wind farms to the viewpoint it is likely that the turbine lights on the Proposed Development will appear brightest. The Proposed Development in combination with the other proposed wind farms with aviation lighting visible from this viewpoint will introduce new sources of artificial light into a view direction that is currently unaffected, increasing the horizontal extent of the part of the view that is influenced by artificial lighting, as lights will be visible to the north, west and south-west. The introduction of aviation lighting on the Proposed Development and the other proposed wind farms with aviation lighting will result in a large-scale change over a small geographical extent. The magnitude of change is considered to be **medium** and as such the **additional** cumulative visual effect under Scenario 2 will be **Significant (Moderate)** when turbines are lit at maximum illumination, reducing to **Not Significant (Minor)** at minimum illumination.

Table A6.4.5: Viewpoint 29: Beinn Bhuidhe

Viewpoint 29: Beinn Bhuidhe			
Grid Reference	220364, 718719	Figure Number	6.2.29
LCT	LCT 2 – High Tops	Designated Landscape	North Argyll APQ, Ben Lui WLA
Direction of View	South-west	Distance to Nearest Turbine (km)	17.3km
Number of hubs theoretically visible	12	Number of turbines with blades theoretically visible	13
Location, description of existing view and potential receptors	This is an elevated viewpoint located at the summit of Ben Bhuidhe, which at 948m AOD is a Munro. The viewpoint is within the North Argyll APQ, and Ben Lui WLA, and is representative of views experienced by recreational receptors, such as hillwalkers. From the summit there is a 360° panorama that extends over the vast expanse of upland hills and ridges. The skyline from this viewpoint comprises mountains and upland hills with several intervening ridges visible in the middle-distance. Loch Fyne and Loch Awe are visible in views to the south-west and north-west. Artificial lighting is present within views, generally concentrated along the edges of these lochs. Artificial lights		

Viewpoint 29: Beinn Bhuidhe	
	from properties, streetlights and vehicular lights are visible around the shores of Loch Fyne at Inveraray, in the south-west. In north-westerly views, artificial lighting is visible at the settlement of Lochawe, along the northern banks of Loch Awe.
Night-time sensitivity	Receptors at this viewpoint are recreational users, who are considered to be of **high** susceptibility to changes in the view as their attention is focused on their surroundings. The number of recreational receptors at this viewpoint at dusk or at night however is likely to be very small. The viewpoint is located within the North Argyll APQ and Ben Lui WLA and is therefore considered to be of **high** value. On balance, taking account of the judgements of susceptibility and value, the overall sensitivity of receptors at this viewpoint is judged to be **high.**
Assessment of visual effects	**Figure 6.2.29** illustrates the view of the Proposed Development at night with a maximum candela level of 2439 candela during the maximum illumination mode and a minimum candela level of 244 candela during the reduced intensity mode. When lit at both maximum and minimum illumination, lighting on the hubs of all 7 turbines will be visible along the horizon to the south-west, at a distance of 17.3km from the nearest lit turbine. The lights will introduce artificial lighting into a view direction that is already influenced by distant sources of artificial lighting as noted above. When lit at maximum illumination, the turbine lights will appear brighter than existing artificial light visible to the south-west and will form notable new artificial lights in these views. When lit at minimum illumination however, the lights will appear more subdued than the existing artificial light in the view due to the distance between the Proposed Development and the viewpoint. The visibility and perceived intensity of lighting will vary at different times dependant on viewing conditions, whilst the duration over which the visible lighting is evident will vary seasonally in relation to the hours of relative darkness. Overall, the scale of change associated with visible aviation lighting is judged to be medium for the maximum candela level of 2439 candela, due to the perceived brightness at this viewpoint in comparison to existing artificial light in the view, which appears more subdued. This however will only occur infrequently, for example when atmospheric conditions such as low cloud cover and mist limit visibility to distances of less than 5km, when at the distance of 17.3km, the lights are unlikely to be seen. Exceptions may occur e.g. if atmospheric visibility is only reduced by cloud cover at the point of measurement to below 5km to the west of the Proposed Development. For the minimum candela level of 244 candela during clear atmospheric conditions, the scale of change is judged to be small. The geographical extent of the change is judged to be small. The overall magnitude of change is judged to be medium and taking account of the high sensitivity will result in a **Significant (Moderate)** visual effect when turbines are lit at reasonable maximum illumination, reducing to **Not Significant (Minor)** at reasonable minimum illumination. The visual effects of the 200 and 2000 candela (minimum and maximum) illumination scenarios which do not consider changes in perceived brightness as a result of changes in viewing angle would remain as identified for the reasonable maximum and minimum scenarios. Given the angle intensity mitigation will be inbuilt into the lights, in practice this would not occur.
Potential for future cumulative effects	Under Scenario 2, aviation lighting on the proposed Ladyfield Wind Farm (scoping) will be theoretically visible in views to the south-west at a distance of approximately 9km. Aviation lighting on the proposed Blarghour (scoping), approximately 16.3km to the south-west, Eredine (scoping), approximately 22.4km to the south-west and Musdale (scoping), approximately 22.1km to the north-west, will also be theoretically visible. These proposed wind farms will introduce an unknown number of aviation lights along the horizon to the south-west and north-west. Lights on the Proposed Development will introduce 7 additional lights on the horizon in views to the south-west. The **additional** effect of these lights to the cumulative baseline will not give rise to a significant cumulative effect as lights on the Proposed Development will be seen beyond aviation lights on the proposed Ladyfield Wind Farm, which would be located closer to the viewpoint. Despite visibility of existing sources of artificial light in views to the south-west however, the introduction of aviation lighting on all the proposed wind farms under Scenario 2 is considered to give rise to a medium scale change over a small geographical extent as the addition of these wind farms will widen the extent of the view altered by artificial light. The magnitude of change is therefore

Viewpoint 29: Beinn Bhuidhe	
	considered to be **medium** and the cumulative visual effect under Scenario 2 will be **Significant (Moderate)** when turbines are lit at maximum illumination, reducing to **Not Significant (Minor)** at minimum illumination.

Summary of Lighting Effects

A6.4.69 A reduced lighting scheme has been agreed through consultation with the CAA and includes seven hub lights only.

A6.4.70 No significant effects on landscape character, designated landscapes or WLA are anticipated. Whilst dark sky qualities are not specifically recognised for any LCT, designated landscape or WLA considered in this assessment, many of these landscapes have wild, remote and naturalistic characteristics to which dark skies contribute. However, at the distances concerned, it will be infrequent for the maximum candela lighting to be seen, given this will typically be used when atmospheric visibility is below 5km (as measured at the location of the sensor). More usually, clear conditions will be required for lighting to be seen over these distances, in which case the 10% candela lighting will be activated. There will be some exceptions to this e.g. when atmospheric visibility is reduced by small or sporadic cloud at the point of measurement on the turbines, but is clear beyond this and at the location of the viewpoint, or for example when the cloud base is below the sensor, but visibility is good beneath it and at the location of viewpoints. In this instance though, there will still be some attenuation of the light by the cloud that it is within.

A6.4.71 Occasional significant visual effects are predicted for each of the three assessment viewpoints, under the maximum case scenario (understood to be infrequent), but not under the more typical reduced case scenario which will be in operation for the majority of the time. When visible, the Proposed Development will tend to be seen in large scale and longer distance views, where other occasional light sources in surrounding lower lying landscapes are apparent.

A6.4.72 When viewing the lights from lower viewpoints, then the intensity that will be seen will be much reduced. The night-time visualisations from Dalavich illustrate the reduced light intensity which would be experienced due to the difference between the angle of a horizonal plane extending from hub height, and the angle of a plane extending from the elevation of the viewpoint. Visualisations are also provided which show the lighting without considering reductions in brightness due to viewing angle. The representative visualisations do not take account of the influence of weather conditions which are often not as clear as when the photography was captured. In conditions of meteorological visibility of less than 5km, the perceived brightness of maximum intensity lights, whilst possibly still visible, are likely to be much reduced. In such conditions the lights will typically not be visible at distances much greater than 5km from turbines.

A6.4.73 Weather conditions therefore will influence the actual brightness of the lights perceived. This will include from remote mountain summits in the LLTNP and WLA, where the increased viewing distance will further reduce the actual brightness of the light perceived.

A6.4.74 It is anticipated that if Blarghour and the Proposed Development are both consented, then given they would be adjacent to one another, a combined reduced lighting scheme could potentially be developed to reduce the in combination cumulative effects of the two projects.