DBS Offshore Wind

RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Nighttime Lighting Visualisation Technical Note

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Company:	**RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited**	Asset:	**Development**
Project:	**Dogger Bank South Offshore Wind Farms**	Sub Project/Package	**Consents**
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Glossary

Term	Definition
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Project (NSIP).
High Voltage Alternating Current (HVAC)	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
High Voltage Direct Current (HVDC)	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.
Onshore Converter Stations	A compound containing electrical equipment required to transform HVDC and stabilise electricity generated by the Projects so that it can be connected to the electricity transmission network as HVAC. There will be one Onshore Converter Station for each Project.
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).

Acronyms

Acronym	Definition
DCO	Development Consent Order
ExA	Examining Authority
FOV	Field of View
HV	High Voltage
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IES	Illuminating Engineering Society
ISO	International Organisation for Standardisation
LUC	Land Use Consultants Ltd
LVIA	Landscape and Visual Impact Assessment
NPS	National Policy Statement
TGN	Technical Guidance Note

1 Introduction

1. In the Examining Authority's Second Written Questions (ExQ2) the Applicants were asked:

   "*NPS EN-1 paragraph 5.9.12 states that the applicant should ensure that the extent of the impact of the proposed development on the significance of any heritage assets affected can be adequately understood from the application and supporting documents. Historic England stated [REP3-043] that it does not know what the initial light level would be from the converter stations and therefore cannot judge the degree of harm it would cause to the scheduled ant-aircraft gunsite. At present, the ExA therefore does not consider that the requirements of NPS EN-1 paragraph 5.9.12 have been fulfilled.* ***The ExA requests that a nighttime visualisation showing the potential effects from the converter stations on the gunsite, on a worst-case scenario basis is provided***." ([PD-022], reference HE.2.4, emphasis added).

2. In **The Applicants' Response to ExQ2** [REP5-036], the Applicants reiterated that the Onshore Converter Station would not be lit during normal operation, and that the requirement for an operational lighting design is secured by Requirement 22 of the **Draft Development Consent Order (DCO) (Revision 8)** [REP5-002].

3. The Applicants' Response to question HE.2.4 confirms the Applicants' view that a night-time visualisation of the Onshore Converter Stations is not necessary. However, to assist the Examining Authority, the Applicants agreed to produce a visualisation.

4. This Technical Note sets out the basis for the nighttime visualisation, which is included in the accompanying figures.

2 Lighting at the Onshore Converter Stations

2.1 Arrangement of lighting and lighting types

5. In order to develop an indicative lighting design for use in a nighttime visualisation the lighting scheme from another comparable RWE High Voltage Direct Current (HVDC) project, currently under construction, was used to provide an indicative lighting design for the Projects. This approach was taken because this level of engineering design for the Projects is not available at this stage, prior to the selection of a Contractor for the HVDC Converter Stations.

6. Typical locations, types and spacing of lighting elements were extrapolated from this layout and applied to the indicative layout of the HVDC Converter Station(s) for the Projects. This included consideration for the access routes and lighting in proximity to key areas including the internal access roads, building perimeters and external High Voltage (HV) equipment areas.

7. It should be noted the permanent access road from the A1079 to the Onshore Converter Station site will not be lit at night (other than motion activated security lighting at the entrance points and any lighting required at the A1079 Junction), therefore no lighting of this road is included in the visualisation. Only internal access roads within the secured Converter Station footprints, would be lit as described below.

8. The lighting is primarily provided for Operational Staff to ensure safe navigation when undertaking general activities while visiting the site. Additional local task lighting would be deployed, if required. As an unmanned site the design philosophy is to install lighting that is suitable and sufficient for when it is accessed as a workplace in line Health and Safety requirements[1]. Key access routes would be provided with lighting activated by motion sensors to transit to the building's location where manual lighting can be activated for the required working area.

9. As detailed in section 5.7.2.5 of **Chapter 5 Project Description (Revision 3)** [REP1-009] the site is only likely to be accessed for routine maintenance activities, at an average of one visit per week. It will not be lit at night when operational staff are not present.

[1] Regulation No.8 of the Workplace Regulations Act 1992 and HSG38 Lighting at work - HSE and Lighting - HSE

10. The site will likely have differing levels of access control in place and would be divided by an internal fence into general areas, where the majority of access would take place and the larger HV areas housing the HVDC and High Voltage Alternating Current (HVAC) equipment, which would not be typically accessed while the site is operational. Lighting has been grouped into zones.

11. A number of installed lighting types were considered within the Onshore Converter Station Boundary Fence with both lamppost and structural mounted elements, as detailed in **Table 2-1**. As detailed above, this will not include lighting of the operational access road.

Table 2-1 Indicative Lighting Schedule

Description	Mounting	Lighting Element Codes	Assumed Output (Lm)
Road Lighting	8m high Lamppost double mounted	EX8	5100
Road Lighting	8m high external structure mounted	EX3	5100
Area Lighting	8m high Lamppost double mounted	EX7	33,850
Area Lighting	8m high external structure mounted	EX9	5,100
Building Lighting	3.5m high external structure mounted at regular intervals	EX10	1,500

2.2 Lighting Scenarios

12. A number of lighting scenarios were developed based on the operational task that could result in a requirement to access to the site outside of daytime hours. It is anticipated that normal scheduled visits would occur during daylight hours in line with typical working hour patterns for an unmanned HVDC Onshore Converter Station of this type.

13. A general description of the tasks were developed along with a step by step sequence of how lighting zones could be activated and de-activated during the type of visit. Lighting would only be operated in the area of work being accessed which may include provision of a lit access route.

14. The likelihood has been calculated by estimated days per annum visited. Where low likelihood scenarios have been considered a conservative period has been applied (e.g. 1 in 4 years) and the fraction of days have been used.

15. Due to the independent operation of the Projects it is assumed any operational visit requiring lighting would only occur at a single Onshore Converter Station site at time.

2.3 Scenarios Modelled

2.3.1 Scenario 0 - Normal Unmanned Operation

16. This scenario presents the normal unmanned operation of the Onshore Converter Station. This scenario is representative of the vast majority (>99%) of operational time. As shown on **Plate 1** no lights are on. The visualisation for Scenario 0 is shown on Figure 1b, in Appendix A.

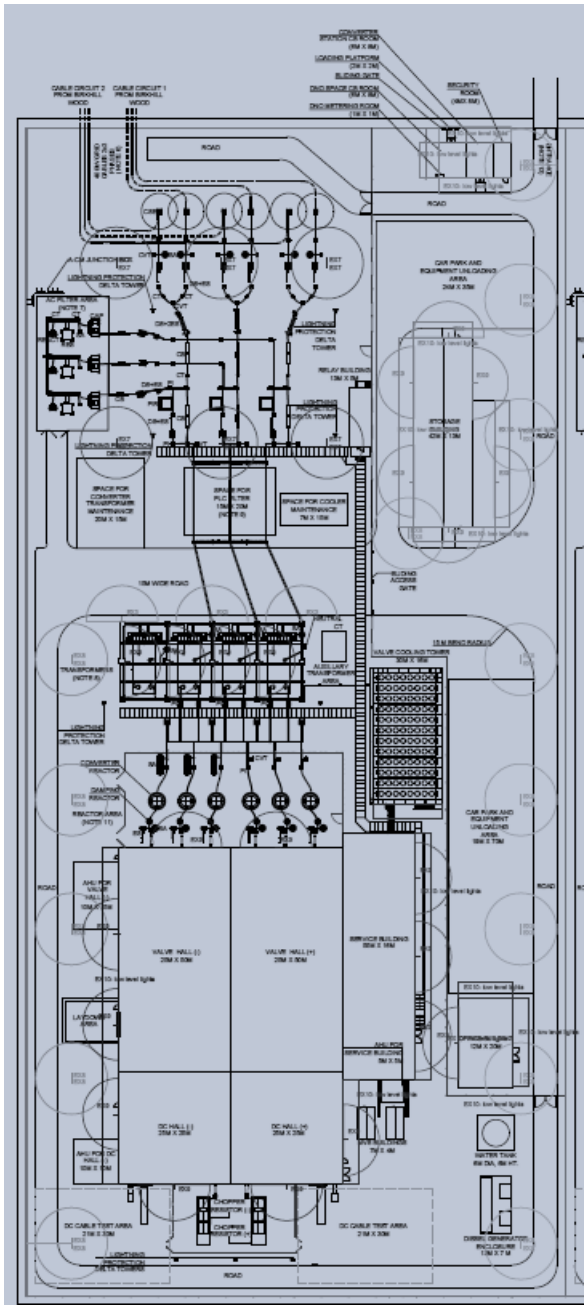
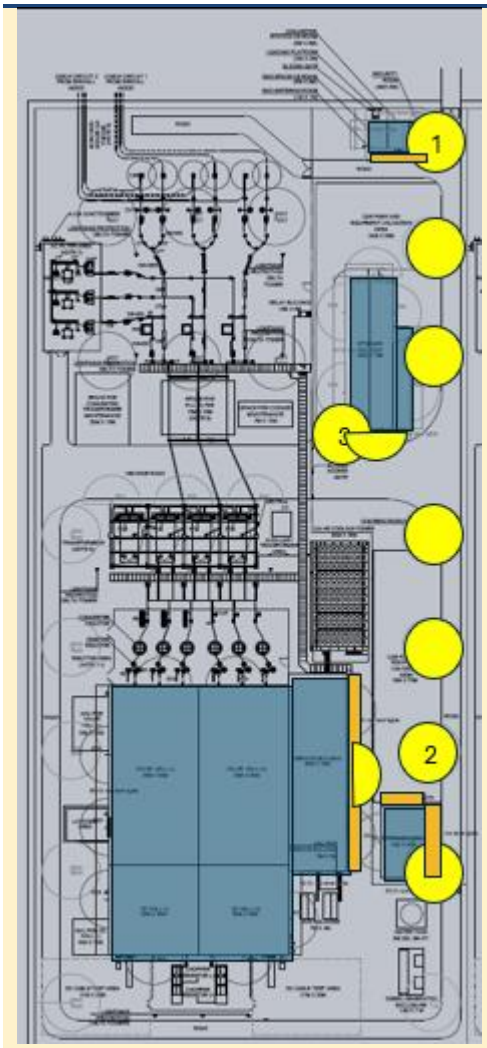


Plate 1 Scenario 0 - Unlit

17. **Plate 2** presents a worst case visualisation of occasional evening or nighttime visits, most likely during late afternoon/early evening in winter months. Operational and maintenance visits are expected to be required weekly, and would normally occur during daytime hours. Should there be a requirement for dusk or evening visits, external lighting may be activated during these visits. It is assumed that this may occur for a 2-hour site attendance period, approximately 4 days per annum (<1% of operational time). The worst case lighting scenario is depicted in in Figure 1c (visualisation at Year 1) and Figure 1d (visualisation at Year 10 with mitigation planting), in Appendix A.

18. Figures 1c and 1d show all lighting activated at the same time (in reality this is likely to be staggered sequentially as operatives move around the site). Details of a typical assumed lighting scenario is described:

- Vehicle approaches access gate to single project Onshore Converter Station at a time;
- Motion Sensor activates at access gate (1), lights Eastern access area for timed period, visiting either:
  - (2) Admin / Service Building; or
  - (3) Stores
- If single visitor assumed Northern access road lights turn off after a period of time;
- Site attendance for two hours is assumed to undertake activity within one of the buildings, some exterior lights on points of access activate, or manually activated;
- No access carried out to wider High Voltage area;
- Prior to exit manual lights are powered off motion sensor at 1/2/3 activate path to access gate for timed period; and
- Upon leaving site lighting switches off after prescribed period e.g. 5 min with no detected activity.



Key

Lighting Element		
(Off)	(On)	Description
1	1	Master with motion detector 8m Columns, double lamps assumed road only (EX8)
		8m Columns, double lamps assumed, either road (EX8) of General (EX7)
		8m high building mounted,(EX3 or EX9)
		General external lights 3.5m high building mounted, at 6m centres, (EX10)
Shaded (Yellow/Orange) elements are assumed to be illuminated in the scenario		

Plate 2 Scenario 1 – Lighting Plan

2.4 Assumptions for Visualisation

19. The following assumptions were made:

- Only one of the two Onshore Converter Stations would be accessed and lit at any given time. To illustrate worst case, the Onshore Converter Station closer to the Butt Farm Anti-Aircraft gun battery (scheduled monument) was assumed to be lit in the illustrated scenarios (i.e. the western footprint).
- The most likely scenario that a viewer would experience would be to see the Onshore Converter Stations in darkness, since for the majority of the time there would be no activity and no lighting on site 'Scenario 0', as detailed in section 1.2.3.1.
- A reasonable worst case would be 'Scenario 1', as detailed in section 1.2.3.2 where access is required to the eastern part of the Onshore Converter Station only.

- Scenarios involving emergency works to the western parts of the Onshore Converter Station are considered to be so rare as to represent an unrealistic worst case, therefore no visualisation has been included.
- It was concluded therefore that 'Scenario 0' and 'Scenario 1' would be represented in the visualisations in Figures 1a to 1d.

3 Preparation of the Visualisations

20. The purpose of the visualisation is to illustrate the appearance of lighting at the Onshore Converter Stations at night, from the Butt Farm Anti-Aircraft gun battery (scheduled monument). This required a site visit to capture night-time photography, followed by modelling of the lighting scenarios and rendering of the visualisations.

21. In preparing the visualisation, the following guidance has been referred to:

- Nature Scot (2024) Guidance on Aviation Lighting Impact Assessment;
- Nature Scot (2017) Visual Representation of Wind Farms (Version 2.2); and
- Landscape Institute (2019) Visual Representation of Development Proposals. Technical Guidance Note (TGN) 06-19.

22. Guidance published by Nature Scot is intended primarily for use in Scotland, but is widely used across the UK. Nature Scot (2024) was developed with particular reference to assessing the effect of aviation lights on wind turbines, but contains applicable advice on the approach to night-time visualisations in general. It advises that visualisations of lighting have limitations since it is "*not possible to accurately capture light emissions in a photograph, and also because humans perceive light in different ways depending on their individual vision*." (paragraph 81)."

3.1 Photography

23. A site visit was undertaken on 15th May 2025. Photographers visited the Butt Farm Anti-Aircraft gun battery (scheduled monument) and captured panoramic photography from the same location that was used to represent day time views (refer to Figures 23-15a and 23-15a1-a4 in **Chapter 23 Landscape and Visual Impact Assessment Figure 23-1 to Figure 23-17 (Revision 4)** [REP4-039]).

24. The general approach to photography is set out in section 23.4.4.7 of **Chapter 23 Landscape and Visual Impact Assessment (LVIA)** [APP-192]. Specific considerations for night-time photography are noted as follows.

25. Nature Scot (2024) advises that night-time photography "*should normally be carried out 30 minutes after sunset*", but that timing will vary with the seasons, weather and viewing conditions (Appendix 4, paragraph 25). Photography was therefore undertaken at regular intervals, starting shortly before sunset with subsequent ranges taken as natural light faded and existing artificial light sources became visible.

26. Exposure settings were carefully optimised at each viewpoint with shutter speed, aperture and International Organisation for Standardisation (ISO) levels balanced to ensure the photography provided an accurate representation of the conditions at the time. Nature Scot (2024) advises that "*it is important that photography represent the levels of darkness as seen by the naked eye at the time*" (Appendix 4, paragraph 24).

27. The selected range was taken at 9.26 PM. At this time there was sufficient light in the sky that the skyline and local vegetation can be seen, but the general level of darkness can be appreciated. Street lights along the A164 represent the only clearly visible light source in this view direction.

3.2 Modelling and Rendering

28. The general approach to visualisations is set out in section 23.4.4.7 of **Chapter 23 LVIA** [APP-192]. Specific considerations for night-time visualisations are noted as follows.

29. 3DS Max software was used to render the lighting on the Onshore Converter Stations. Light sources were created, using Illuminating Engineering Society (IES) Profiles for products noted in the specification sheet supplied to Land Use Consultants Ltd (LUC), to match the specifications provided in terms of luminous intensity (candela units), colour and position. Where necessary, features such as light poles were added to the 3D model at the positions indicated by the illustrative lighting design.

30. Real-time camera data was imported into the 3DS Max physical cameras within the model environment including F-stop and FOV (Field of View) values. The sunlight and daylight system within the software was set to accurately simulate the natural light still present at the date, time and geographical location of night-time photography. Glare effects were simulated using Vray Frame Buffer to produce comparable lighting effects with those a camera might capture from light sources of a similar brightness.

31. As with the daytime images the exported renders were then composited and aligned with the baseline photographic view using Adobe Photoshop© software.

32. The dusk visualisations aim to be representative of the visual appearance of the proposed lighting described in this Technical Note, at dusk in clear viewing conditions. They are prepared to demonstrate the worst case scenario. It should be noted that due to limitations in software, distance to the lights and atmospheric conditions cannot be modelled in the 3D environment.

4 Commentary

34. The following Figures accompany this technical note:

- Figure 1 Viewpoint Location Map;
- Figure 1a Night-time Baseline Photograph;
- Figure 1b Photomontage Scenario 0 (no lighting), Year 1;
- Figure 1c Photomontage Scenario 1 (worst case lighting), Year 1; and
- Figure 1d Photomontage Scenario 1 (worst case lighting), Year 10.

35. In Figure 1b (Scenario 0) the massing and extent of the Onshore Converter Stations can clearly be seen against the remaining light in the sky. Their presence in the view would be similar to how it is perceived by day. As the sky darkens, the visibility of the Onshore Converter Stations may recede further, depending on weather or the availability of moonlight.

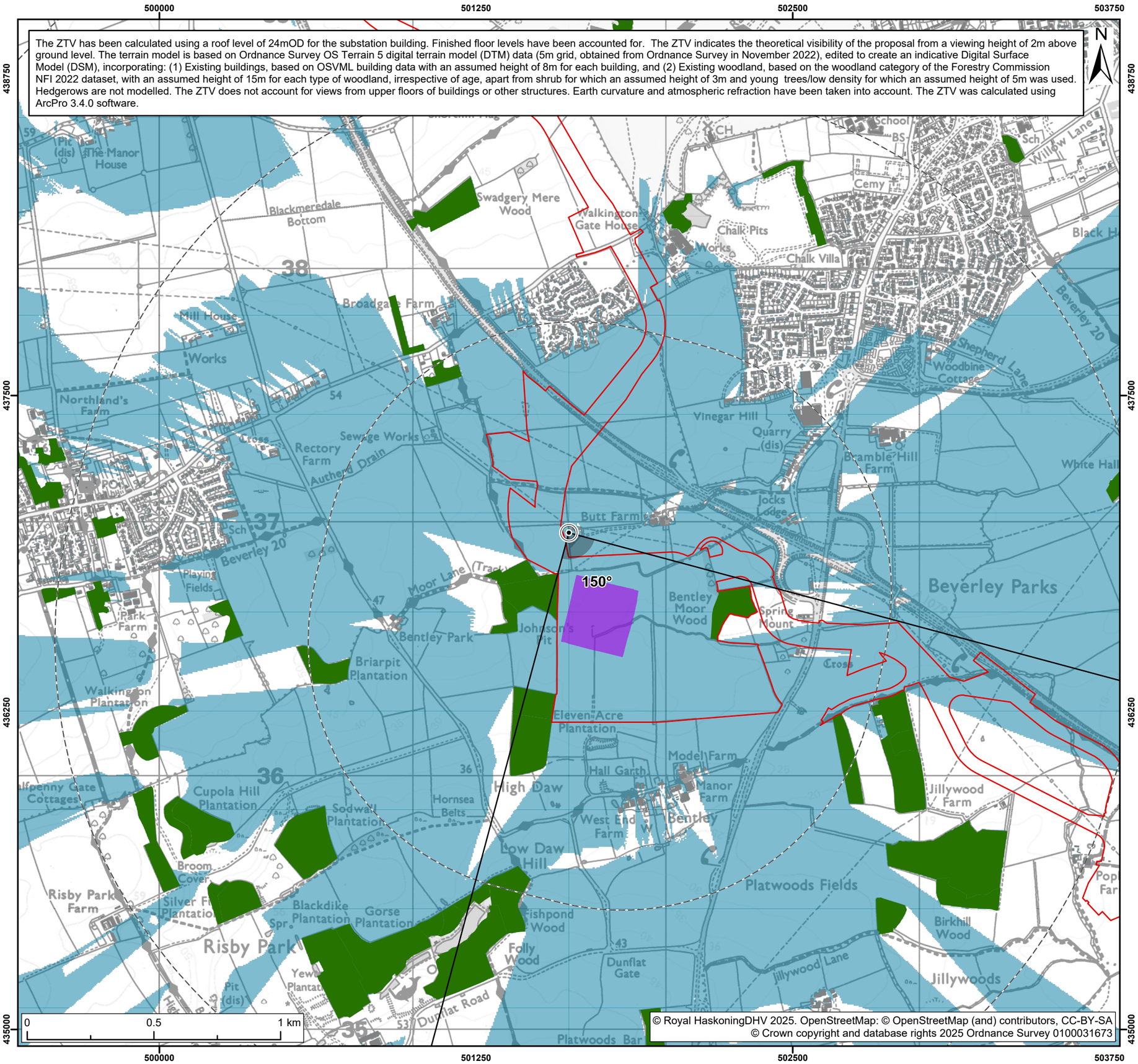
36. In Figure 1c (Scenario 1), a number of lights are clearly visible along the eastern part of the Onshore Converter Station. Both column lights and building-mounted lights can be seen through and above the existing hedgerow in the foreground. This level of lighting is anticipated to be present on approximately four occasions per year, with each visit lasting around 2 hours. Lighting would be mainly sensor-controlled, and once staff have left site, the lighting will switch off after a prescribed period.

37. Figure 1c shows the same scenario at year 10, once woodland planting along the northern boundary has begun to mature. This shows that, in summer conditions, visibility of the lights will be filtered by the vegetation. It is likely that some lighting will be seen, and in winter the filtering will be much more limited.

38. Due to the level of visible lighting, and the limited frequency of night-time operations at the Onshore Converter Stations, no significant effects are predicted on views from the Butt Farm anti-aircraft gun battery (scheduled monument), as a result of the operational lighting that forms part of the Projects.

Appendix A - Figures

The ZTV has been calculated using a roof level of 24mOD for the substation building. Finished floor levels have been accounted for. The ZTV indicates the theoretical visibility of the proposal from a viewing height of 2m above ground level. The terrain model is based on Ordnance Survey OS Terrain 5 digital terrain model (DTM) data (5m grid, obtained from Ordnance Survey in November 2022), edited to create an indicative Digital Surface Model (DSM), incorporating: (1) Existing buildings, based on OSVML building data with an assumed height of 8m for each building, and (2) Existing woodland, based on the woodland category of the Forestry Commission NFI 2022 dataset, with an assumed height of 15m for each type of woodland, irrespective of age, apart from shrub for which an assumed height of 3m and young trees/low density for which an assumed height of 5m was used. Hedgerows are not modelled. The ZTV does not account for views from upper floors of buildings or other structures. Earth curvature and atmospheric refraction have been taken into account. The ZTV was calculated using ArcPro 3.4.0 software.



Legend:

- Onshore Development Area
- Indicative Onshore Converter Station Footprint
- 1km intervals from Indicative Onshore Converter Station Footprint
- 5km from Indicative Onshore Converter Station Footprint
- Viewpoint
- Existing woodland screening
- Existing building screening
- Proposed Converter Station theoretically visible
- 90° field of view

SUI	REV	DATE	DESCRIPTION	DRW	CHK	APR
S1	P07	10/06/2025	Suitable for Information	MS	NS	PM

Title:

Viewpoint CH2: Anti Aircraft Battery at Butt Farm (dusk view)

Figure: 1	Drawing No: PC2340_LUC_ON_ZZ_DR_Z_01		
Co-ordinate system: British National Grid		Page Size: A3	Scale: 1:15,000
Project: Dogger Bank South Offshore Wind Farms		Report: Dogger Bank South: Environmental Statement	

Royal HaskoningDHV
Enhancing Society Together

RWE

LUC

OS reference:	501617 E 436960 N
AOD (Above Ordnance Datum):	38.55 m
Direction of view:	155°
Horizontal field of view:	90° (cylindrical projection)

Vertical field of view:	27°
Image Enlargement Factor:	96%
Paper size:	841 x 297 mm (half A1)
Correct printed image size:	820 x 250 mm

Camera:	NIKON D600
Lens:	Nikkor AF 50mm f/1.8D
Camera height:	1.5 m (above AOD)
Date and time:	15/05/2025 21:26

Data Sources:
Topography to inform AOD heights: 1m National LiDAR programme DTM (2020), Environment Agency
3D model informed by Site option layouts and development height parameters provided by applicant.

Dogger Bank South Offshore Wind Farms: Environmental Statement Report
Figure 1a
Cultural Heritage Viewpoint 2: Anti Aircraft Battery at Butt Farm (dusk view)

LUC

OS reference:	501617 E 436960 N
AOD (Above Ordnance Datum):	38.55 m
Direction of view:	155°
Horizontal field of view:	90° (cylindrical projection)

Vertical field of view:	27°
Image Enlargement Factor:	96%
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Data Sources:
Topography to inform AOD heights: 1m National LiDAR programme DTM (2020), Environment Agency
3D model informed by Site option layouts and development height parameters provided by applicant.

Dogger Bank South Offshore Wind Farms: Environmental Statement Report
Figure 1b
Cultural Heritage Viewpoint 2: Anti Aircraft Battery at Butt Farm (dusk view)

LUC

OS reference:	501617 E 436960 N
AOD (Above Ordnance Datum):	38.55 m
Direction of view:	155°
Horizontal field of view:	90° (cylindrical projection)

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Data Sources:
Topography to inform AOD heights: 1m National LiDAR programme DTM (2020), Environment Agency
3D model informed by Site option layouts and development height parameters provided by applicant.

Dogger Bank South Offshore Wind Farms: Environmental Statement Report
Figure 1c
Cultural Heritage Viewpoint 2: Anti Aircraft Battery at Butt Farm (dusk view)

LUC

OS reference:	501617 E 436960 N
AOD (Above Ordnance Datum):	38.55 m
Direction of view:	155°
Horizontal field of view:	90° (cylindrical projection)

Vertical field of view:	27°
Image Enlargement Factor:	96%
Paper size:	841 x 297 mm (half A1)
Correct printed image size:	820 x 250 mm

Camera:	NIKON D600
Lens:	Nikkor AF 50mm f/1.8D
Camera height:	1.5 m (above AOD)
Date and time:	15/05/2025 21:26

Data Sources:
Topography to inform AOD heights: 1m National LiDAR programme DTM (2020), Environment Agency
3D model informed by Site option layouts and development height parameters provided by applicant.

Dogger Bank South Offshore Wind Farms: Environmental Statement Report
Figure 1d
Cultural Heritage Viewpoint 2: Anti Aircraft Battery at Butt Farm (dusk view)

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