



Foel Fach Wind Farm Limited.

Foel Fach Wind Farm – Environmental Statement Volume III

Appendix 9.2: Visualisation Information

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APPENDIX 9.2 – VISUALISATION INFORMATION

1.1 Introduction

- 1.1.1 This appendix provides background information in relation to the production of Zones of Theoretical Visibility (ZTVs) and the visualisations presented in supporting figures in Environmental Statement (ES) **Volume IV** and supporting appendices in **ES Volume III**.
- 1.1.2 The following list of figures have been produced in relation to Zones of Theoretical Visibility (ZTVs) and are presented at **ES Volume IV, Chapter 9 Figures**:

Primary ZTV Analysis:

- Figure 9.3: Blade Tip ZTV to 35 km with Viewpoints
- Figure 9.4: Blade Tip ZTV to 20 km with Viewpoints
- Figure 9.5: Hub Height ZTV to 35 km with Viewpoints
- Figure 9.6: Hub Height ZTV to 20 km with Viewpoints

Detailed Quadrant ZTV Analysis:

- Figure 9.7: Blade Tip ZTV to 20 km (NE Quadrant) with Viewpoints
- Figure 9.8: Blade Tip ZTV to 20 km (SE Quadrant) with Viewpoints
- Figure 9.9: Blade Tip ZTV to 20 km (SW Quadrant) with Viewpoints
- Figure 9.10: Blade Tip ZTV to 20 km (NW Quadrant) with Viewpoints
- Figure 9.11: Hub Height ZTV to 20 km (NE Quadrant) with Viewpoints
- Figure 9.12: Hub Height ZTV to 20 km (SE Quadrant) with Viewpoints
- Figure 9.13: Hub Height ZTV to 20 km (SW Quadrant) with Viewpoints
- Figure 9.14: Hub Height ZTV to 20 km (NW Quadrant) with Viewpoints

ZTV with Landscape Context:

- Figure 9.17: Landscape Designations to 20 km with Blade Tip ZTV with Viewpoints
- Figure 9.22: LANDMAP Landscape Habitat Evaluation with Blade Tip ZTV
- Figure 9.24: LANDMAP Visual and Sensory Overall Evaluation with Blade Tip ZTV with Viewpoints
- Figure 9.26: LANDMAP Historic Landscape Overall Evaluation with Blade Tip ZTV
- Figure 9.29: National and Local Landscape Character Areas with Blade Tip ZTV to 20 km
- Figure 9.31: Principal Visual Receptors to 20 km Blade Tip ZTV and Viewpoints



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Aviation Lighting ZTV:

- Figure 9.34: Hub Height ZTV for Lit Turbines T01, T04, T05 and T10 to 20 km with Viewpoints
- Figure 9.35: Lighting Intensity ZTV for Lit Turbines T01, T04, T05 and T10 to 20 km with Viewpoints

Cumulative ZTV Analysis:

- Figure 9.36: Cumulative ZTV with Operational Pen Y Bryn, Moel Maelogen (Phase 1) and Moel Maelogen (Phase 2)
- Figure 9.37: Cumulative ZTV with Operational Tir Mostyn & Foel Goch, Hafodty Ddu, Brenig and Clocaenog Forest
- Figure 9.38: Cumulative ZTV with Operational Hafoty Ucha Repowering, Bryn Ffynon, Disgarth Ucha etc.
- Figure 9.39: Cumulative ZTV with Operational Cemmacs 2
- Figure 9.40: Cumulative ZTV with Consented Pant Y Maen
- Figure 9.41: Cumulative ZTV with Scoping Alwen Forest and Moel Chwa
- Figure 9.42: Cumulative ZTV with Scoping Gaerwen and Mynydd Mawr Energy Park
- Figure 9.43: Cumulative ZTV with Scoping Esgair Ddu Energy Park, Carnedd Wen etc.

1.1.3 The visualisations are presented at **ES Volume III, Appendix 9.11: Visualisations: Viewpoints 1 to 21.**

1.1.4 The following sections explain how the visualisations have been prepared and presented; including instructions for how the visualisations should be viewed and explaining the limitations of the visualisation material.

1.1.5 The visualisations in this ES have been prepared in accordance with the published best practice, Visual Representation of Wind Farms, Version 2.2 (February 2017) Scottish Natural Heritage (SNH, renamed NatureScot) to support the **ES Volume III, Appendix 9.1: Landscape and Visual Impact Assessment Criteria**. This is widely used as best practice for wind farm visualisations across the UK.

1.2 Production of ZTVs

1.2.1 ZTVs are generated assuming a 'bare ground' terrain model. This means that the ZTVs presented within the LVIA have been generated from topographical data only, and they do not take any account of vegetation or the built environment which may act to screen views of the Proposed Development. It is, as such, a 'worst case' zone of visual influence, and considerably over-emphasises the actual visibility of the Proposed Development. In reality, trees, hedges and buildings may restrict views of the Proposed Development from many of the areas rendered as within the ZTV.



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- 1.2.2 A further assumption of the ZTV is that climatic visibility is 100% (i.e., visibility is not impeded by moisture or pollution in the air). In reality, such atmospheric conditions are relatively rare in this part of the country. Mist, fog, rain and snow are all common weather occurrences, which would regularly restrict visibility of the Proposed Development from some of the areas within the ZTV; this being an incrementally more significant factor with distance from the Site. Although atmospheric pollution is not as significant as it is in other parts of the country, it is still present enough to restrict actual visibility on some occasions, again more so with distance from the Proposed Development.
- 1.2.3 The ZTVs were generated using Geographic Information System (GIS) software. The programme used topographical height data (OS Terrain 50) to build a terrain model. The programme then rendered the model using a square grid to illustrate whether the turbines would be visible in each 50 m x 50 m square on the grid for a specified distance, in every direction from the Proposed Development.
- 1.2.4 Digital ZTVs have been prepared to illustrate the theoretical visibility of the turbine for a radius of up to 35 km around the Proposed Development. Various sets of ZTVs have been produced showing visibility of the turbines to blade tip when the blade is at its highest possible position; visibility of the turbines at hub height; and visibility of turbines proposed to be installed with visible aviation lighting. Enlargements of the ZTVs have also been produced.
- 1.2.5 Cumulative ZTVs have been produced to show locations where the ZTVs of two or more operational, consented or proposed wind farm developments overlap (in certain cases a number of wind farms which are at the same stage in development have been grouped together). In the cumulative ZTVs, one colour has been used to illustrate the theoretical visibility of the Proposed Development, and a second colour to illustrate the visibility of another proposed wind farm. Where the ZTVs of the two developments overlap, a third colour has been used to illustrate this potential cumulative visual influence.
- 1.2.6 As well as outlined above, it should be noted that there are several limitations to the use of ZTVs, discussed in Visual Representation of Wind farms – Version 2.2 (Scottish Natural Heritage, February 2017). In particular, it should be noted that the ZTV plans simply illustrate theoretical visibility and do not imply or assign any level of significance to those areas identified as being within the ZTV.
- 1.2.7 The ZTVs are therefore a tool to assist the Landscape Architect to identify from where the proposed wind farm would potentially be visible. The assessment of landscape and visual effects in this chapter does not rely solely on the accuracy of the ZTVs. The ZTVs have been ground proofed, and professional judgement has been used to evaluate the significance of effects.



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1.4 Viewpoint Photography

1.4.1 The following text explains how the baseline photography was taken for each viewpoint:

- Baseline photographs of the existing view were taken using either a high-quality Canon R5 Mark I digital camera with a Canon EF 50 mm f/1.4 USM lens or Canon 5D Mark III in accordance with the NatureScot guidance (2017), these cameras both have a full frame digital sensor.
- Neutral density graduated filters were used, as appropriate, at some viewpoints to balance the exposure within some scenes – typically where there was a contrast between bright sky and darker landform. Other than this, no other filters were used during photography.
- Photographs were captured in high resolution JPEG and RAW format.
- At each viewpoint, the camera was mounted on a levelled tripod at a height of approximately 1.5 m above ground level (providing an approximation of average adult eye level).
- The camera was set up on a panoramic rotating head and photographs were taken at 30-degree increments of rotation from left to right.

1.4.2 In each case, the camera focus was locked on the distant horizon (infinity). In doing so, the photographs are in each case focussed on the Site on which the Proposed Development is proposed to be located, whilst very close objects in the foreground may in some cases be out of focus. This approach is in line with best practice photography techniques. The exposure was set correctly for the centre of the Site and then locked off so that it remained constant as the camera was rotated through the panorama.

1.4.3 As far as possible, photographs were taken in good weather and clear visibility conditions in attempt to indicate a best visibility scenario. However, all photography collected remains suitable for the production of visualisations in line with best practice guidance. Wherever possible, photographs were taken with the sun behind the camera, although this was not possible for all viewpoints, i.e., those that are broadly north of the Site.

1.4.4 Inevitably with distance from the Site, atmospheric moisture increasingly reduces the clarity of visibility, and therefore photographs, from the distant viewpoints typically depict the Site less clearly than the nearby viewpoint photographs. This is an unavoidable limitation of viewpoint photography.

1.4.5 In relation to dark sky hours photography, NatureScot (November, 2024) advises that:

"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. It is only necessary to illustrate visible lighting, not infrared or other alternative lighting requirements".



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1.4.6 It goes on to note that:

"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. It is important that the photographs represent the levels of darkness as seen by the naked eye at the time and the camera exposure does not make the image appear artificially brighter than it is in reality. It can also be helpful to note the intensity of other lights in the area to enable comparison (e.g. television transmitters) as this can aid the assessment process".

1.4.7 Dark sky photography has been collected for Viewpoints 5, 9 and 10 in accordance with NatureScot guidance.

1.5 Stitching of Panoramas and Post-Photographic Processing

1.5.1 Each of the panoramic images presented in **ES Volume III, Appendix 9.11: Visualisations: Viewpoints 1 to 21**, is comprised of three single frame photographs stitched together in PTGui and then cropped down to a particular horizontal and vertical field of view.

1.5.2 The panoramic baseline photographs that illustrate a 90-degree horizontal angle of view are stitched in cylindrical projection as per the NatureScot guidance (2017). For some viewpoints, more than one 90-degree horizontal angle of view are included to provide additional baseline context.

1.5.3 The photomontages that show a 53.5-degree horizontal field of view have been based on the same single frame panoramic photographs but have been stitched in planar projection in accordance with the NatureScot guidance (2017).

1.5.4 A limited amount of post photography processing of the image files has been undertaken, and only to enhance the quality of the baseline photographs. As stated in the NatureScot guidance (2017):

"Photographic processing involves judgements - there is no process by which a 'pure' photograph can be produced without the application of human decision-making, from exposure timing to the specification of the camera, and whether this is applied manually or automatically."

"In reality there is no way to avoid a photograph being enhanced as this is an integral part of photography and photomontage production."

"Overall, there should be a minimum of post-processing image enhancement."



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- 1.5.5 The extent of image enhancement undertaken in the production of the photomontages has been limited to that which would conventionally occur in a darkroom to improve the clarity of an image and does not, in each case, change the essential character of the image. Overall, there has been minimal post-photography image enhancement as per the NatureScot guidance (2017), and during the stitching process none of the photographs were distorted in terms of scaling (other than that which is an inherent and unavoidable product of stitching photography in planar projection).

1.6 Wirelines

- 1.6.1 A wireline visualisation (sometimes also referred to as a wireframe visualisation) is a computer-generated 3D outline of a particular structure (in this case, the Proposed Development) placed on top of a 3D ground terrain model, which again is represented by a wireline. No rendering is given to any of the surfaces.
- 1.6.2 The wireline images of the Proposed Development (as well as any other cumulative turbines modelled) were generated utilising the actual dimensions of the proposed turbines and a model of the structures was placed in position over a ground terrain model generated from Ordnance Survey (OS) Landform Panorama height data.
- 1.6.3 The coordinates of the viewpoints were recorded using a Global Positioning System (GPS) in the field. Checks on these coordinates were made with reference to Google Earth. These coordinates were used to set up viewpoints in the model from which to view the turbines. The wirelines were generated using Resoft Windfarm software.
- 1.6.4 The wireline images are generated on a bare ground model and therefore do not take account of any vegetation or the built environment between the viewpoint and the proposed wind turbines. As such, they represent a worst-case view. Each of the wirelines was checked through a field survey to ascertain the extent of any screening of the view caused by vegetation or buildings.
- 1.6.5 For each viewpoint, a 90-degree cylindrical projection wireline is presented to scale beneath the baseline photograph to illustrate the view from each viewpoint. This wireline illustrates the proposed wind turbines with other operational, consented and proposed wind farms (including those under construction).
- 1.6.6 In addition, for each viewpoint an enlarged 53.5-degree planar projection wireline is presented on a second sheet to correspond in scale with the subsequent photomontage.
- 1.6.7 The wireline images only illustrate the anticipated scale and position of the turbines in relation to the terrain. Whilst every effort has been made to ensure the accuracy of the images, it must be appreciated that no wireline image could ever claim to be 100% accurate as there are a number of technical limitations to the model which are discussed further in **Section 1.9**.



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- 1.6.8 It should be noted that wirelines are just a ‘snapshot’ of the view from a single fixed location and the wirelines presented in this ES represent only a small number of locations where the Proposed Development will be visible from. In reality, views will change as receptors move through the landscape. Therefore, the wirelines are not an indication of significance, they are simply a tool to assist the Landscape Architect in their assessment of effects. The assessment of visual effects in this chapter does not rely solely on the accuracy of the wireline images. Professional judgement has been used to evaluate the significance of effects.

1.7 Photomontage

- 1.7.1 In simple terms, a photomontage is the superimposition of a rendered, photorealistic, computer-generated model of a Proposed Development on to a baseline photograph, to illustrate how it will appear in the surrounding landscape context.
- 1.7.2 A 3D wireline model was generated of the turbines as described above. Resoft Windfarm software was used to generate the 3D model of the turbines. The model of the structures was rendered, and lighting was set appropriate to the date, time and orientation on which the photograph was taken.
- 1.7.3 A digital ground terrain model was generated in Resoft Windfarm, and the proposed wind turbines were overlaid on top of it. Using world coordinates in the computer modelling programme, the photographic viewpoints were replicated such that a view was set up looking at the turbines from exactly the same location as where the baseline photograph was taken from. The view from the model was then superimposed over the original photograph and edited as necessary in Adobe Photoshop to give a final photomontage.
- 1.7.4 Whilst every effort has been made to ensure the accuracy of the photomontages, it must be appreciated that no photomontage could ever claim to be 100% accurate as there are a number of technical limitations in the model relating to the accuracy of information available from OS and from the GPS. In particular, it should be recognised that baseline photographs on which photomontages are based can, at best, only ever be a ‘flattened’ 2D representation of what the eye sees in 3D in each location. A photograph will never capture as much detail as the eye would see in the field, it therefore follows that a photomontage can never truly capture the sense of perspective and detail which would be possible in reality. In some of the photomontages, the visibility of the turbines has been slightly digitally enhanced to ensure that they are visible upon printing. Taking account of the inherent technical limitations in producing and presenting photomontages, the photomontages have been produced according to best practice.
- 1.7.5 The photomontages do not indicate significance of the Proposed Development and are simply a tool to assist the Landscape Architect in his/her assessment of effects. The assessment of visual effects in this assessment does not rely solely on the accuracy of the photomontages. Professional judgement has been used to evaluate the significance of effects. Each of the photomontages should be viewed flat and at a comfortable arm’s length for the most accurate interpretation.



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- 1.7.6 In relation to dark sky hours photomontages, the lighting levels have been set appropriate to the date, time and orientation on which the photograph was taken. Additionally, it has been established during the field work undertaken for previous similar studies that dark sky photographs of visible lighting do not always capture the extent to which the eye perceives light sources during the dusk period. Often photography will appear to show the lighting to be more recessive than it is actually perceived in the field. The photomontages therefore do not seek to replicate the manner in which a dusk period photograph would capture the aviation lighting, rather they seek to replicate the manner in which the lighting is perceived when it is viewed in the field.

1.8 Presentation of Visualisation Sheets

- 1.8.1 The following visualisation sheets are presented in the ES (**ES Volume III, Appendix 9.11: Visualisations: Viewpoints 1 to 21**).

Sheet A: Viewpoint Location Plan

- 1.8.2 This sheet provides a plan illustrating the location of the viewpoint being illustrated in the subsequent sheets. It includes OS mapping showing the immediate context surrounding the viewpoint and illustrations of the various angles of view shown. The mapping includes a Blade Tip Zone of Theoretical Visibility (ZTV) Plan to illustrate those areas in the area surrounding the viewpoint where there would be the potential for visibility of the Proposed Development.

Sheet B: Baseline Photograph

- 1.8.3 This sheet provides a cumulative wireline image of the Proposed Development including all operational, consented and proposed wind farms directly beneath a baseline view. Both images present a 90-degree horizontal field of view and a 14.2-degree vertical field of view. This sheet presents the information required of the 'Baseline Panorama and Wireline' as set out in Annex C of the NatureScot guidance (2017). Both of the images on this sheet are presented in cylindrical projection and the principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 500 mm, when the image is curved through the same radius.
- 1.8.4 For the purposes of clarification, the cumulative wireline on this sheet illustrates the Proposed Development and other operational, consented wind farms/turbines and any schemes in planning.



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Sheet C: Wireline of the proposed wind turbines

- 1.8.5 This sheet provides an enlarged and cropped wireline image of the proposed wind turbines. The image illustrates a 53.5-degree horizontal field of view and an 18-degree vertical field of view. Whilst it is essentially an enlargement of the wireframe presented in Sheet 1, with the exclusion of other cumulative wind farms, this wireframe is presented in planar projection. As such, the image should be viewed on a flat surface. The principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 812.5 mm. This sheet presents the information required of the 'Wireline' as set out in Annex C of the NatureScot guidance (2017).

Sheet D: Photomontage of the proposed wind turbines

- 1.8.6 This sheet provides an enlarged and cropped photomontage of the proposed wind turbines. The image illustrates a 53.5-degree horizontal field of view and an 18-degree vertical field of view. It is presented in planar projection and, as such, the image should be viewed on a flat surface. The principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 812.5 mm. This sheet presents the information required of the 'A1 Panorama' as set out in Annex C of the NatureScot guidance (2017).
- 1.8.7 For the purposes of clarification, this sheet illustrates only the proposed wind turbines and does not show other consented but as yet unbuilt turbines, or any schemes that are in planning.

Sheet E: Viewpoint Location Plan (For LVIA Viewpoints 5, 9 and 10 only)

- 1.8.8 This sheet provides a plan illustrating the location of the viewpoint being illustrated in the subsequent sheets. It includes OS mapping showing the immediate context surrounding the viewpoint and illustrations of the various angles of view shown. The mapping includes a Turbine Lighting Intensity Zone of Theoretical Visibility (ZTV) Plan to illustrate those areas in the area surrounding the viewpoint where there would be the potential for visibility of the aviation lighting associated with the Proposed Development and the relative intensity of that visibility.

Sheet F: Dark Sky Baseline Photograph and Wireline of the Proposed Scheme (For LVIA Viewpoints 5, 9 and 10 only)

- 1.8.9 In addition to a dark sky hours baseline photograph, this sheet includes a wireline image of the Proposed Development alone and highlights which turbines are proposed to be lit. Both images present a 90 degree horizontal field of view and a 14.2 degree vertical field of view. This sheet presents the information required of the 'Baseline Panorama and Wireline' as set out in Annex C of the NatureScot guidance (2017). Both of the images on this sheet are presented in cylindrical projection and the principal viewing distance (the distance at which one should view the image to



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obtain a geometrically accurate impression) is 500 mm when the image is curved through the same radius.

Sheet G: Wireline of the proposed wind turbines (For LVIA Viewpoints 5, 9 and 10 only)

- 1.8.10 This sheet provides an enlarged and cropped wireline image of the proposed wind turbines. The image illustrates a 53.5-degree horizontal field of view and an 18-degree vertical field of view. Whilst it is essentially an enlargement of the wireframe presented in Sheet 1, with the exclusion of other cumulative wind farms, this wireframe is presented in planar projection. As such, the image should be viewed on a flat surface. The principal viewing distance (the distance at which one should view the image to obtain a geometrically accurate impression) is 812.5 mm. This sheet presents the information required of the 'Wireline' as set out in Annex C of the NatureScot guidance (2017).

Sheet H: Dark Sky Hours Photomontage of the Proposed Development (For LVIA Viewpoints 5, 9 and 10 only)

- 1.8.11 This sheet comprises a photomontage of the Proposed Development showing 200 candela visible aviation lighting on the turbines proposed to be lit. This has been modelled in the wind farm software and the lighting levels have been set appropriate to the date, time and orientation on which the photograph was taken.
- 1.8.12 For the purposes of clarification this photomontage illustrates only the Proposed Development and does not show other consented but as yet unbuilt turbines, or any schemes that are in planning.

1.9 Limitations of Visualisations

- 1.9.1 As well as those outlined in sections above, Annex A of 'Visual Representation of Wind Farms', Version 2.2 (SNH, February 2017) aforementioned SNH guidance (2017):

"Visualisations of wind farms have a number of limitations which you should be aware of when using them to form a judgement on a wind farm proposal. These include:

*A visualisation can **never show exactly** what the wind farm will look like in reality due to factors such as: different lighting, weather and seasonal conditions which vary through time and the resolution of the image;*

*The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can **never be 100% accurate**;*

A static image cannot convey turbine movement, or flicker or reflection from the sun on the turbine blades as they move;



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The viewpoints illustrated are representative of views in the area, but cannot represent visibility at all locations;

*To form the best impression of the impacts of the wind farm proposal these images are **best viewed at the viewpoint location shown**;*

*The images **must be printed at the right size** to be viewed properly (260mm by 820mm);*

*You should **hold the images flat at a comfortable arm's length**. If viewing these images on a wall or board at an exhibition, you should stand at arm's length from the image presented to gain the best impression.*

It is preferable to view printed images rather than view images on screen. If you do view images on screen you should do so using a normal PC screen with the image enlarged to the full screen height to give a realistic impression. Do not use a tablet or other device with a smaller screen to view the visualisations described in this guidance”.

1.10 References

NatureScot (February 2017). *Visual Representation of Wind farms – Version 2.2*. Available at: <https://www.nature.scot/doc/visual-representation-wind-farms-guidance>