Technical Appendix 5.3
Visualisation Information

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1 Appendix 5.3 – Information To Be Read In Conjunction With ZTVs And Visualisations

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 the Environmental Impact Assessment Report (EIA Report).

1.1.2 The following text explains how the visualisations have been prepared and presented; includes instructions for how the visualisations should be viewed and explains the limitations of the visualisation material.

1.1.3 The visualisations in this EIA Report 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) (Ref 1).

1.2 Production of ZTVs

1.2.1 ZTVs are generated assuming a 'bare ground' terrain model. This means that the ZTVs presented within this LVIA have been generated from topographical data only, and they do not take any account of vegetation or the built environment which may 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 development from many of the areas rendered as within the ZTV.

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 Proposed Development. Atmospheric pollution is not as significant as it is in other parts of the country but is still present and would also restrict actual visibility on some occasions, again more so with distance from the Proposed Development.

1.2.3 The ZTVs were generated using GIS software. The programme used topographical height data (OS Terrain 5) to build a terrain model. The programme then renders the model using a square grid to illustrate whether the turbines would be visible in each 5 m x 5 m square on the grid for a specified distance in every direction from the Proposed Development.

1.2.4 For the northern development area, the following ZTVs have been prepared:

- A blade tip ZTV illustrating the theoretical visibility of the turbines when the blade is at its highest possible position (**Figure 5.3**).
- A hub height ZTV illustrating the theoretical visibility of the worst-case hub heights used in the LVIA for the purpose of assessing effects during daylight hours (**Figure 5.4**).
- A hub height ZTV illustrating the theoretical visibility of the worst-case hub heights during the hours of darkness (**Figure 5.5**).
- A hub height ZTV illustrating the theoretical visibility of the turbines proposed to be fitted with a visible aviation warning light (**Figure 5.8**).

- A turbine lighting intensity ZTV (**Figure 5.9**) that takes into account the difference in elevation between the lights and any point in the surrounding study area and the resulting reduced candela. Further explanation of this ZTV is provided in **Technical Appendix 5.2**.
- A ZTV illustrating the combined visibility of the proposed turbines, substation and Battery Energy Storage System (BESS) located within the northern development area (**Figure 5.6**).

1.2.5 For the southern development area, the following ZTVs have been prepared:

- A ZTV illustrating the combined visibility of the solar array, substations, long duration BESS and short duration BESS (**Figure 5.10**).
- A ZTV illustrating the combined visibility of the solar array, substations, long duration BESS, short duration BESS and proposed turbines located in the northern development area (**Figure 5.11**).

1.2.6 An overall combined ZTV illustrating the theoretical visibility of proposed infrastructure located in both the northern development area and the southern development area is provided at **Figure 5.12**.

1.2.7 Cumulative ZTVs have been produced to show locations where the ZTVs of two or more operational/under construction, consented or in planning 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 a second proposed development. Where the ZTVs of the two proposed developments overlap, a third colour has been used to illustrate this potential cumulative visual influence.

1.2.8 It should be noted that there are several limitations to the use of ZTVs. For a discussion of these limitations please refer to Visual Representation of Wind farms – Version 2.2 (February 2017) [(Ref 1)]. 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. The ZTVs are a tool to assist the Landscape Architect to identify from where the Proposed Development 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.

1.3 Viewpoint Photography

1.3.1 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 5D Mark II digital camera with a Canon EF 50 mm f/1.4 USM lens or a high quality Nikon D600 with a 50 mm f/1.4 lens. In accordance with the NatureScot guidance (2017) [(Ref 1)], both cameras 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 20 degree increments of rotation from left to right.

1.3.2 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 Proposed Development site, 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 Proposed Development site and then locked off so that it remained constant as the camera was rotated through the panorama.

1.3.3 As far as possible, photographs were taken in good weather and clear visibility conditions. 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.

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

1.3.5 In relation to dark sky hours photography, NatureScot 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'.*

1.3.6 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'.*

1.3.7 Dark sky photography has been collected for viewpoints 1, 3, 6 and 9 in accordance with NatureScot guidance. Further information is provided in **Technical Appendix 5.2**.

1.4 Stitching of Panoramas – NatureScot Visuals

1.4.1 Each of the panoramic images presented is comprised of five single frame photographs stitched together in PTGui for both cylindrical projection and planar projection images and then cropped down to a particular horizontal and vertical field of view.

1.4.2 The panoramic baseline photographs which illustrate a 90 degree horizontal angle of view are stitched in cylindrical projection as per the NatureScot guidance (2017) [(Ref 1)].

1.4.3 The photomontages which 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).

1.4.4 A limited amount of post photography processing of the image files has been undertaken to enhance the quality of the baseline photographs. As stated in the NatureScot guidance (2017) [(Ref 1)]:

> *'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'.*

1.4.5 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 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).

1.5 Photomontage

1.5.1 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.

1.5.2 A 3D wireline model was generated of the proposed turbines located within the northern development area using Resoft Windfarm. The model of the proposed turbines was rendered and lighting was set appropriate to the date, time and orientation on which the photograph was taken.

1.5.3 A digital ground terrain model was generated in Resoft Windfarm and the Proposed Development was overlaid on top of it. Using real 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.

1.5.4 For the relevant viewpoints where the proposed solar array, long duration BESS, short duration BESS and substations within the southern development area are potentially visible, a ground terrain model was generated in ArcGIS Pro and a massing model of these elements was created based on the worst-case heights of these structures. Using real world coordinates in the GIS, the photographic viewpoints were replicated such that a view was set up from exactly the same location as where the baseline photograph was taken from.

1.5.5 The views from these models were then superimposed over the original photograph and edited as necessary in Adobe Photoshop to give a final photomontage.

1.5.6 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 Ordnance Survey 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 on site. 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 when printed out. Taking account of the inherent technical limitations in producing and presenting photomontages, the photomontages have been produced according to best practice.

1.5.7 The photomontages 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.

1.5.8 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.

1.5.9 In some cases, the visibility of the turbines may also be slightly digitally enhanced to ensure that they are visible when printed out.

1.6 Presentation of Visualisation Sheets – NatureScot Visuals

1.6.1 The following visualisation sheets are presented in line with the requirements of NatureScot's Visualisation Guidance [(Ref 1)].

Sheet A: Baseline Photograph

1.6.2 This sheet provides a cumulative wireline image of the Proposed Development including all operational/under construction, consented and in planning wind farms directly beneath an existing 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) [(Ref 1)]. 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.

1.6.3 For the purposes of clarification, the cumulative wireline on this sheet illustrates the Proposed Development and other operational/under construction and consented wind farms/turbines and any schemes in planning.

Sheet B: Wireline of the Proposed Development

1.6.4 This sheet provides an enlarged and cropped wireline image of the Proposed Development. 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) [(Ref 1)].

Sheet C: Photomontage of the Proposed Development

1.6.5 This sheet provides an enlarged and cropped photomontage of the Proposed Development. 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).

1.6.6 For the purposes of clarification this sheet illustrates only the Proposed Development and does not show other consented but as yet unbuilt turbines, or any schemes that are in planning.

Sheet D: Future Baseline Photomontage

1.6.7 This sheet provides an enlarged and cropped photomontage of the Proposed Development added into a 'future baseline' where other under construction and consented schemes have been digitally added into the baseline photograph. 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).

1.6.8 For the purposes of clarification this sheet does not show any schemes in planning or scoping.

1.6.9 For visualisations that also include dark sky views, a further three additional sheets have been included as follows:-

Sheet E: Dark Sky Baseline Photograph (For LVIA Viewpoints 1, 3, 6, 9 only)

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

Sheet F: Wireline of the Proposed Development (For LVIA Viewpoints 1, 3, 6, 9 only)

1.6.11 This sheet provides an enlarged and cropped wireline image of the Proposed Development. 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 A, with the exclusion of other cumulative wind farms, this wireframe is presented in planar projection and identifies the turbines proposed lit turbines. 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) (Ref 1).

Sheet G: Dark Sky Hours Photomontage of the Proposed Development (For LVIA Viewpoints 1, 3, 6, 9 only)

1.6.12 This sheet comprises a photomontage of the Proposed Development showing 200 candela visible aviation lighting on the turbines proposed to be lit, in accordance with NatureScot Guidance on Aviation Lighting Impact Assessment [(Ref 2)]. 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.

1.6.13 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.

1.7 Limitations of the Visualisations

1.7.1 Annex A of 'Visual Representation of Wind Farms', Version 2.2 (SNH, February 2017) [(Ref 1)] sets out a summary of the key limitations of visualisations and recommends that these are set out for each wind farm application. The following text is therefore reproduced from Annex A of the 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;*
- *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*'.

2 References

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

2. NatureScot (November 2024). Guidance on Aviation Lighting Impact Assessment. Available at: https://www.nature.scot/doc/guidance-aviation-lighting-impact-assessment - judging-night-time-sensitivity