Offshore Wind Power Limited

West of Orkney Windfarm EIA Report

Volume 2, Supporting Study 17: Zone of Theoretical Visibility and Visualisation Methodologies.

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West of Orkney Windfarm

CONTENTS

1 INTRODUCTION

Zones of Theoretical Visibility (ZTVs) and visualisations (including photopanoramas, wirelines and photomontages) are graphical images produced to support, assist and illustrate the SLVIA (including cumulative assessment) of the offshore Project.

2 ZONE OF THEORETICAL VISIBILITY (ZTV) PRODUCTION AND LIMITATIONS

ZTV studies are prepared using the ESRI ArcGIS Viewshed routine. This creates a raster image that indicates the visibility (or not) of the points (blade tip, hub height) modelled for each turbine location. The 60 km radius ZTV was produced using Geographic Information System (GIS) computer software and using a combined 5 m and 50 m resolution Digital Terrain Model (DTM), with the 5 m DTM majorly around the coastal areas to provide greater accuracy of Visibility Analysis. Curvature of the earth has been taken into consideration and an assumed observer height of 2 m.

The resulting ZTV map does not take account of visually significant structures and vegetation and settlements, which may screen or partially obscure the offshore Project, and therefore it represents the worse-case scenario visibility. As a result, there may be roads, tracks, and footpaths in the wider setting which, although shown as falling within the ZTV, have restricted viewing opportunities since they are heavily screened or filtered by banks, walls, and vegetation. The ZTVs, therefore, provide a starting point in the assessment process and accordingly tend to over-estimate the potential visibility of the proposed turbines. While the ZTV provides a useful indication from where visibility of the turbines might be experienced, it should be noted that just a fraction of the modelled turbine used in the ZTV generation may give rise to the wide colour band indicating visibility. Therefore, the blade tip ZTV (Figure 18.9.1) could at the same time indicate the visibility of the whole turbine or only a blade tip.

In order to obtain further intelligence as to which areas of visibility are caused by different heights of the scheme, the Blade Tip ZTV (Figure 18.9.1) has been overlaid by the Hub height ZTV (Figure 18.8.1), produced for 200m hub height, as presented in Figure 18.8.1. The purpose of the Comparative Blade Tip / Hub Height ZTV (Figure 18.9.2) is to identify areas where only the nacelle with blades would be visible. The light blue colour band indicates potential visibility of nacelle and blades above the hub, which would have the potential to appear in the view above an intervening topographical or man-made feature.

As the ZTV takes account of the earth's curvature, the Hub height ZTV (Figure 18.8.1) with 200 m high tower structure, shows a clear cut off of visibility at a distance of around 57 km on the sea, whereas onshore the ZTV draws on topography. NatureScot requested additional ZTVs from Half Hub Height (Figure 18.8.2) and Quarter Hub Height (Figure 18.8.3). These ZTVs illustrate how the Earth's Curvature affects visibility, obstructing visibility of 100 m high structures beyond 42 km and visibility of 50 m high structures beyond 32 km.

It should be noted that these ZTVs do not identify how many turbines or to what extent the offshore Project would be theoretically visible.

In addition, what adds to the limitations of the ZTV is that the viewer's height in a ZTV map is generally set at 2 m above ground level. This is higher than the camera height recommended for photographic visualisations (1.5 m), to compensate for potential inaccuracies in digital terrain data and to ensure that the 'worst case' is represented. However, this is also higher than the average eye level height of a viewer (visual receptor) and therefore potentially increases theoretical visibility/ the ZTV pattern.

These ZTV exercises are only meaningful if they take into account the limitations of the ZTV production. It should be considered that the main factor to the magnitude of scale, is the distance and this cannot be modelled in the ZTV and as a result, the extent of actual visibility experienced on-the-ground from onshore locations would be considerably less than is suggested by the ZTV pattern.

Table 2-1 below lists the utilised ground model products and their specifications / accuracy.

Table 2-1 Ground model products and their accuracy

PRODUCT	DISTANCE BETWEEN POINTS	VERTICAL RMSE ERROR
Ordnance Survey OS terrain 5	5 m	up to +/- 1.5 m
Ordnance Survey OS Terrain 50	50 m	+/- 4 m

The ZTVs do not take account of atmospheric conditions which would obscure the wind farm sites for periods of time, from within areas shown as having potential visibility.

In light of these limitations, whilst ZTVs are used as a starting point to inform the assessment, providing an indication of where the offshore Project will theoretically be visible, the information drawn from the ZTV was verified with reference computer-generated wireline images of the offshore Project in the field, to ensure that the assessment conclusions represent the visibility of the offshore Project reasonably accurately.

3 VISUALISATION PRODUCTION

3.1 Background

The assessment is supported by wirelines and photomontages (daytime) of the 'worst case' layout for all representative viewpoints, along with night-time photomontages from five viewpoints. The wirelines and photomontages are presented in Figures 18.VP1 to 18.VP28 (Supporting Study 20 (SS20): SLVIA visualisations. Each viewpoint has been illustrated with a photograph, a wireline and/or a photomontage indicating the offshore Project. Definitions of each of these are described as follows:

- Baseline photograph: A photograph of the existing view recorded in fair weather conditions and usually presented as a panorama as required by the relevant Scottish Natural Heritage (SNH, now NatureScot) or The Highland Council (THC) guidance:
  - Visual Representation of Wind Farms Version 2.2 (SNH, 2017); and
  - Visualisation Standards for Wind Energy Developments (THC, 2016).
- Wireline or Wireframe: A computer generated model of the landscape and the offshore Project.
- Photomontage is a visualisation which superimposes an image of the offshore Project (in this case the wireline or wireframe) upon the baseline photograph, which is then rendered by computer software to produce a visual image of the offshore Project from the specific viewpoint. Photomontage is a widespread and popular visualisation technique, which generally allows changes in views and visual amenity to be illustrated and assessed.

The completed panoramas, wirelines, photomontages and accompanying data are then presented as figures using Adobe InDesign software.

3.2 Baseline photography

Once a view has been selected, the location is visited, confirmed, and assessed with the aid of a wireline or similar visualisation in the field. The viewpoint location is micro-sited to avoid as far as reasonable foreground clutter and photographed during fair weather and light conditions. A photographic record is taken to record the view and the details of the viewpoint location and associated data are recorded to assist in the production of visualisations and to validate their accuracy.

The following photographic information is recorded:

- Date, time, weather conditions and visual range;
- GPS recorded 12 figure grid reference accurate to ~5-10 m;
- GPS recorded Above Ordnance Datum (AOD) height data;
- The focal length of lens is confirmed;
- Horizontal field of view (in degrees); and
- Bearing to Target Site (offshore Project).

Photographs are then taken using a digital full frame SLR camera with a fixed 50mm or 75mm focal length lens as required. Camera is mounted on the panoramic head equipped tripod. Detailed information is then recorded on site

to enable the accurate alignment of the photographs with the wireline model (data such as: GPS grid co-ordinates; ground level information; compass bearings; and any other known references and viewpoint information).

To create the baseline panorama, the photographs from the viewpoint are then digitally joined using Adobe Photoshop or PTGui software to form a planar or cylindrical projection image or panorama using computer software to remove 'barrel distortion' caused by the camera lens. Colour correction and blending may differ between the SNH and THC panoramas due to differing stitching algorithms and the number of frames stitched.

There are practical limitations to shooting viewpoint photographs only in very good or excellent visibility and at particular times of day or from a location that avoids foreground clutter or other vertical features such as telegraph poles, particularly where this is a true representation of the view from that viewpoint area. With regard to the photography which is orientated to the offshore Project it is difficult to judge the distance of an object when it is out at sea, where there is no scale indicator giving a familiar, comparative size. The SNH guidance (para 207) advises that in this case, it is essential to include local landmarks or familiar features, such as oil platforms, existing turbines, or lighthouses within a photograph where at all possible. Therefore, more than one 90-degree panorama has been produced and included for each viewpoint.

3.3 Wireline production

Wireline images of the offshore Project, both 90 and 53.5 degree field of views have been generated for each representative viewpoint. The wirelines are produced using Resoft Wind Farm© software to generate a perspective view of the offshore Project. This software creates a 3D computer model of the existing landscape and the offshore Project using digital terrain data and models representing the specified geometry and position of the proposed turbines. The computer model includes the terrain of the entire SLVIA Study Area and takes into account the Earth's curvature. however it does not take account of the screening effects provided by any intervening objects and vegetation.

3.4 Photomontage production

Photomontages have been produced for all the agreed viewpoints in order to provide a 'photorealistic image' of the offshore Project. Only Viewpoint 11 is illustrated by wireline only views.

Photomontages that illustrate the offshore Project are produced using Resoft WindFarm, which takes account of the effects caused by atmospheric refraction. The photomontage is produced by digitally combining or superimposing the wireline / computer-generated 3D model of the landscape and the offshore Project onto the baseline photograph and rendering this in order to add colour, texture and lighting effects and weather conditions occurring on the day.

There is no visualisation guidance available for offshore developments at considerable distance from the coast, where variations in light and atmospheric conditions influence the appearance and visibility of elements within the images.

The Resoft WindFarm takes account of the effects caused by atmospheric refraction, and to a certain extent the distance of WTGs from the viewpoint. However, the sharpness of the WTGs is reduced as the image is represented by fewer pixels resulting in the WTGs not appearing clearly when printed. The SNH guidance provides that photomontages production will usually be of most value for views within 20 km of a windfarm site, for WTGs up to

150 m to blade tip. "*At distances greater than this it can be difficult to represent the WTGs well on a photomontage. However, this will depend on issues such as the specific windfarm design and environmental conditions, so this parameter, and which viewpoints require photomontage, should be discussed and agreed with the determining authority and consultees*".

Through the consultations, NatureScot requested that the proposed WTGs should be rendered with 'sufficient contrast' on the background. In order for the WTGs to appear clearly visible when printed, all WTGs have been enhanced evenly through the rendering process. These images illustrated the closest and furthest WTGs (turbines are rendered in between 24km and 60km) at the same intensity as those further away which results in a loss of perspective, and there is no distinction between foreground or background turbines. In reality, WTGs at differing distances would appear in varying degrees of sharpness.

NatureScot also requested that turbines have to be shown grey from several selected viewpoints. This selection of viewpoints with grey turbines is somewhat arbitrary as the photography was taken within a few consecutive days under similar weather conditions. In order to achieve 'sufficient contrast' the grey turbines were provided in viewpoints where otherwise the white turbines would have been absorbed by the sky. In reality, with the turbines being within such a large site, some of them would appear grey and some of them white, dependent on the movement of light.

As noted above, in reality, WTGs at differing distances would appear in varying degrees of sharpness. Therefore, in addition, an alternative photomontage (SS20: Visualisation, Figure 18.29) is included, which illustrates how turbines fade away over distance. The rendering of this photomontage considers the effects caused by atmospheric refraction. The closest WTGs to the viewpoint were enhanced to create perspective. Perspective creates a realistic impression of depth, or of distance. THC acknowledged that this fading of turbines was realistic in certain cases and recommended including examples to provide context. However, the sharpness of the WTGs beyond the first row on the photomontage reduces as the WTGs are rendered without enhancement resulting in the WTGs not appearing clearly when printed. Therefore, this image should be preferably viewed on screen which provides better resolution than does the printed image.

3.5 Limitations of visualisations

The photomontage visualisations used in the SLVIA are for illustrative purposes only and, whilst useful tools in the assessment, are not considered to be completely representative of what will be apparent to the human eye. The assessments are carried out from observations in the field and therefore may include elements that are not visible in the photographs.

The photomontage visualisations of the offshore Project have a number of limitations when using them to form a judgement on visual effect. These include:

- 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;
- 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 visualisation can never show exactly what the offshore Project 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;

- When assessing the magnitude of change it should also be considered that visual simulation significantly crops the foreground provided by the landform and sky, both elements of which particularly contribute to the perception of these Sutherland, Caithness and Orkney's seascape and landscape character;
- The WTGs' yellow steel jacket bases of the WTGs located over 24 km offshore would be below the horizon for observers at sea level. Therefore, the WTGs' yellow steel jackets have not been depicted on photomontages;
- The 2D images do not give the scale and the distance to the offshore Project. In reality, WTGs at different distances would appear in varying degrees of sharpness;
- A 2D static image cannot convey movement such as WTG blade rotation or other features such as the movement of water or the reflection from the sun. The assessment however will take account of WTG movement by examining animated versions of the photomontages on screen and/or other examples of existing wind farm development on site;
- To form the best impression of the scale of the proposed WTGs, the A3 27-degree images are best viewed at the viewpoint location; and
- Images should be held flat at a comfortable arm's length. If viewing these images on a wall or board at an exhibition, stand at arm's length from the image presented to gain the best impression.

3.5.1 Printing of maps and visualisations

All electronic visualisations and maps should be printed out and viewed at the correct scale as noted on the document. If viewed on screen, then the PDF should be enlarged to 100% in order to see the correct scale of the wireline and / or photomontage.

3.6 Figure layout

Adobe InDesign© software has been used to present the figures. The dimensions for each image (printed height and field of view) are detailed below and each viewpoint visualisation has been presented as follows:

1. A3 Viewpoint location map;
2. 90˚ Baseline photograph (cylindrical projection) and 90˚ Wireline image (cylindrical projection) below. Wireline image shows the offshore Project and cumulative developments (up to four x 90˚ sections presented in this format)
3. 53.5˚ Wireline image (planar projection);
4. 50mm single frame Photomontage (THC guidance); and
5. 75mm single frame Photomontage (THC guidance).

4 REFERENCES

Scottish Natural Heritage (2017) 'Visual representation of wind farms'. Available at: https://www.nature.scot/doc/visual-representation-wind-farms-guidance [Accessed: 15/01/2023].

The Highland Council (2016b) 'Visualisation Standards for Wind Energy Developments'. Available at: https://www.highland.gov.uk/downloads/file/12880/visualisation_standards_for_wind_energy_developments [Accessed: 13/01/2023].