# Visualisation Methodology

## Visualisation Production

This appendix sets out the approach to the production of visualisations which accompany the LVIA and CLVIA. The methodology for the production of visualisations was based on current good practice guidance from Scottish Natural Heritage (SNH)[1] and the Landscape Institute[2,3,4].

*Data Used for Terrain Modelling*

1. OS Terrain® 5 mid-resolution height data (digital terrain model (DTM)) (5 m grid spacing, 2.5 m RMSE[5]) for detailed modelling;
2. OS Terrain® 50 height data (DTM) (50 m grid spacing, 4 m RMSE) for draft modelling;
3. Ordnance Survey 1:50,000 raster data;
4. Ordnance Survey 1:250,000 raster data.

*Zone of Theoretical Visibility (ZTV) Mapping*

Evaluation of the theoretical extent to which the proposed development will be visible across the study area for the LVIA was undertaken by establishing a ZTV using specific computer software designed to calculate the theoretical visibility of a windfarm within its surroundings. The visibility analysis was performed using Envision's Visibl software, which calculates the visibility of the turbines across a digital terrain model. This is performed on a 'bare ground' computer generated terrain model, which does not take account of potential screening by buildings or vegetation. It should be noted that the software uses raster height data, but while it is defined as continuous data (with each grid square referred to as a 'cell'), it assumes a single height value from the centre of that cell for the whole cell. Therefore any local height variations between centre points of cells will not be recognised.

The DTM used for the analysis is a combinate of the OS terrain 50 and OS terrain 5 height data. The combined datasets are resampled to a resolution of 25m. This means that the software calculates the number of turbines visible from the centre point of each cell, but the visibility is shown over the whole 25 x 25 m cell.

The DTM data has been not been otherwise altered (i.e. by the addition of local surface screening features) for the production of the ZTV. No significant discrepancies have been identified between the DTM used and the actual topography around the study area. The effect of earth curvature and light refraction has been included in the ZTV analysis and a viewer height of 1.5m above ground level has been used. As it uses a 'bare ground' model, it is considered to over emphasise the extent of visibility of the proposed development and therefore represents a 'maximum potential visibility' scenario.

The ZTV was calculated to show the number of turbines visible to blade tip height or hub height. The ZTV calculated to blade tip height is shown in **Figures 6.1** and **Figure 6.2**. The hub height ZTV is shown in **Figures 6.3**. Subsequent figures which include the ZTV make use of the ZTV to blade tip height.

To construct combined ZTVs (CZTVs) to illustrate the combined visibility of the proposed development with other windfarms, the ZTV to tip height of each windfarm was generated (based on the tip height of each turbine to a radius in accordance with the current SNH guidance (SNH, 2014), and then combined with the proposed development ZTV (35km radius). The combined CZTV was set up to show the number of windfarms (rather than the number of turbines) visible (**Figure 6.8**). The combined CZTV is colour coded to distinguish between areas where the proposed development is predicted to be visible (either on its own, or in conjunction with other windfarms), and areas where other windfarms will be visible but the proposed development will not. The combined CZTV does not identify which other windfarms will be visible, but a paired CZTVs are provided to analyse the relationships between key windfarms (**Figure 6.10**).

*Viewpoint Photography*

The methodology for photography is in accordance with guidance from Scottish Natural Heritage (SNH, 2017) [1] and the Landscape Institute [6]. The focal lengths used are in accordance with recommendations contained in guidance, and are stated on the figures. Photography was undertaken by MVGLA between March 2016 and April 2017. The location of each viewpoint and information about the conditions was recorded in the field in accordance with the guidance. The camera used for the photography was a Nikon D610 Full frame sensor digital SLR with a fixed 50mm focal length lens.

A tripod with vertical and horizontal spirit levels was used to provide stability and to ensure a level set of adjoining images. The camera was orientated to take photographs in landscape format. A panoramic head was used to ensure the camera rotated about the no-parallax point of the lens in order to eliminate parallax errors[7] between the successive images and enable accurate stitching of the images. The camera was moved through increments of 24° (degrees) and rotated through a full 360° at each viewpoint. Fifteen photographs were taken for each 360° view.

Weather conditions and visibility were considered an important aspect of the field visits for the photography. Where possible, visits were planned around clear days with good visibility. Viewpoint locations were visited at times of day to ensure, as far as possible, that the sun lit the scene from behind, or to one side of the photographer. South facing viewpoints can present problems particularly in winter when the sun is low in the sky. Photographs facing into the sun were avoided where possible to prevent the wind turbines appearing as silhouettes. Adjustments to lighting of the turbines were made in the rendering software to make the turbines appear realistic in the view under the particular lighting and atmospheric conditions present at that time.

*Visualisations*
*Photographic Stitching, Wirelines and Photomontages*

Photographic stitching software PTGui© and Adobe Photoshop© was used to stitch together the adjoining frames to create panoramic baseline photography.

The same terrain data used for the production of the ZTVs was also used to generate wire-line drawings. The DTM includes the proposed development area, viewpoint locations and all landform visible within the baseline photography. Turbine and viewpoint location coordinates were entered. Photomontages have been constructed to show the candidate turbine with the specified tip height, hub height and rotor diameter. The stitched photographs were matched to the wirelines using Adobe Photoshop. For the majority of viewpoints, wirelines were produced using a viewer height of 1.5m above the terrain height, however on limited occasions this viewer height was increased by a small increment to achieve a closer match between the terrain data and photographic landform content[8].

The panoramic baseline photographic images were imported into the Adobe Photoshop software and from each viewpoint the wireline views of the landform model with proposed turbines were carefully adjusted to obtain a match. Fixed features on the ground, such as buildings and roads, were located in the model and used as markers to help with the alignment process where necessary. Each view was rendered taking account of the sunlight conditions and the position of the sun in the sky at the time the photograph was taken. Blade angle and orientation adjustments were also made to represent a realistic situation.

The next stage uses Povray to render accurately illuminated turbines models, which are subsequently blended into the baseline photograph to create the photomontage. Adobe Photoshop© software was used to combine the images and mask out (remove) turbines or sections of turbines which were located behind foreground elements in the original photograph.

Finally, where applicable the images were converted from Cylindrical Projection to Planar Projection using PTGui© software.

*Figure Layout*

QGIS was used to present the figures. The dimensions for each image (printed height and field of view) are in accordance with SNH requirements [1]. Photography information and viewing instructions are provided on each page where relevant.

The A3 height x A1 length format pages for each viewpoint are set out as follows:

1. The first A3 page contains an OS 1:50,000 scale map showing the viewpoint location, direction of the 90° and 53.5° photomontage view and turbine locations;

[1] Scottish Natural Heritage, (2017). Visual Representation of Windfarms - Version 2.2
[2] Landscape Institute, (2011). Practice Advice Note, Photography and photomontage in landscape and visual impact assessment. Advice Note 01/11
[3] Landscape Institute and the Institute of Environmental Management and Assessment, (2013) *Guidelines for Landscape and Visual Impact Assessment Third Edition*
4 Landscape Institute, (2017). Technical Guidance Note, Visual representation of development proposals. Note 02/17
[5] Root mean square error.
[6] Landscape Institute, (2011). Practice Advice Note, Photography and photomontage in landscape and visual impact assessment. Advice Note 01/11
[7] Parallax is the difference in the position of objects when viewed along two different lines of sight. In the case of a camera this will occur if the rotation point of the lens was not constant and will result in stitching errors in the panorama.
[8] An altered height above ground level was used for mountain summits where local topography did not match the wireframes due to data resolution.

2. The following page contains 90° baseline photography and wireline to illustrate the wider landscape, visual and cumulative context. These are shown in cylindrical projection and presented on an A1 width page. Additional pages in the same format are provided if necessary to illustrate wider cumulative visibility up to 360°;

3. The subsequent pages contain 53.5° wireline and photomontage of the view towards the Development. These images are shown in planar projection and presented on an A1 width page.

*Visualisations for Viewpoint in Areas of Steep Topography*

Given the topography of the landscape around the study area, some viewpoints within valleys close to the Development Area look upwards to the horizon, and will have views of turbines above. For certain views, therefore, the horizontal is lowered on the printed page in order to allow the turbines above to be visible within the vertical field of view recommended by SNH.

For one viewpoint, VP7 within the Mennock Water Valley, turbines are located above the vertical field of view allowed by SNH guidance for printed images, such that visualisations produced to meet guidance would only show the hillsides. For VP7, the photography was taken with the camera tilted upwards slightly to extend the vertical field of view high enough to include the horizon above the viewer, above which the turbines will be visible. For this viewpoint, visualisations (**Figures 6.16a** to **6.16d**) are set out and printed on A1 size paper (landscape orientation and full height), in order to include the vertical field of view necessary to show the turbines. These figures do not therefore match SNH guidance standards, but have been adjusted to allow the Development to be shown.