Dublin Array offshore wind farm

Methodologies used in the preparation of viewsheds and photomontages

Macro Works Ltd was commissioned by Saorgus Energy Ltd in 2004 to carry out visual analysis of their proposed wind farm on the Kish/Bray Bank and prepare a series of photomontages to simulate the look of the proposed turbines from a number of selected viewpoints along the coast.

In 2012, in light of time passed, with changes to landscape context and updates to best practice and technology, it was deemed necessary to completely update the visibility mapping and photomontages.

Definition of the Study Area:
The study area on which the visibility assessment focuses, extends to a radius of 30km from the proposed development. This distance was selected on the basis of best practice and takes cognisance of the topographical screening to the south of Wicklow Town and the flat screened landscape to the north of Rush in North County Dublin.
Visibility beyond the 30km limit may be possible in exceptional weather circumstances in a northerly direction from an elevated position, however, the study area chosen includes the area within which all significant visual impacts are likely to occur.

Methodology used to prepare ZTV (Theoretical Visibility) mapping:

1. A Geographic Information System (GIS) was prepared in ArcGIS using the Irish National Grid as the standard coordinate system.

2. The locations of the proposed Dublin Array turbines were imported as coordinates direct from MRG Engineers.

3. Digital Terrain Model (DTM) data was procured from Ordnance Survey Ireland (OSi) for the entire study area in question. This is comprised of an array or points at 10m intervals with accurate height values and forms the basis of a Digital Elevation Model (DEM) that is subsequently compiled for viewshed analysis.

4. The ZTVs were prepared using the Viewshed algorithm in ArcGIS's 3D Analyst module. Considering the distance of the proposed wind farm from shore it was decided to calculate the viewshed on the basis of visibility being affirmed if greater than the top half of a blade (30m+, at 12 o'clock) of one or more turbines should be visible to an observer

standing on land. An observer was assumed to have an average eye-level height of 1.7m.
Most importantly for offshore developments - this algorithm accounts for the curvature of the earth and light refraction caused by atmospheric conditions.

5. Once calculated this ZTV of the Dublin Array was reclassified and colour-coded into intervals based on the number of turbines that could potentially be seen from locations on land.

6. With 2 other consented offshore wind energy developments (Codling Wind Park and Arklow Bank Wind Park) falling wholly or partially inside the 30km study area of the Dublin Array, it was necessary to analyse the cumulative combined visual impact that could potentially impact the adjacent coastline. A similar viewshed calculation was carried out for both the Codling Wind Park and the Arklow Bank Wind Park. A cumulative ZTV map was compiled by combining the results of this analysis.
This cumulative viewshed map does not provide a breakdown of the numbers of turbines of the respective developments that could potentially be seen as this would result in a confusing number of visibility classes. This map merely demonstrates whether any portion of a wind farm (all or partial) might be visible i.e. if only one turbine of a particular wind farm is visible - that wind farm is deemed to be visible.

7. This output is indicative only as it assumes that the landscape is devoid of screening (manmade or natural, permanent or temporary). It does, however, provide useful decision support when deciding suitable locations for the preparation of photomontages.

Methodology used to capture and prepare panoramic photography:

The ZTV is an important tool and first step in the identification of potential viewpoints for further analysis through photomontage. As the viewshed is based on screening by landform only, those areas that form part of the ‘not visible’ class will definitely not be visually impacted and will not require further consideration.

Areas that are theoretically impacted, however, require further investigation on the ground to determine whether the potential views of turbines really exist or whether non-landform screening (vegetation, buildings, infrastructure etc) exists to block the view. Local knowledge of the areas in question is particularly useful at this point.

More often than not low-lying areas that do not directly face the sea will be screened and (especially in the case of a city such as Dublin) will have lost their view of the sea a long time ago.

1. Initial desktop analysis identified approximately 35 viewpoints for consideration. Further analysis and deliberation resulted in a final selection of 22, broadly representing all impacted areas along the coastline within the study area.

2. The next stage was to visit all of the potential viewpoints, assess any screening that might be present and adjust their locations where necessary to achieve the clearest possible views. All locations were recorded using a mapping-grade GPS (sub 1-meter xy accuracy) and mapped in the GIS.

3. Panoramic photo series were captured from each of the selected viewpoint locations when the weather was deemed to be most favourable. A professional level digital SLR camera (Canon 5D Mark II with a 24-70mm 2.8 L lens) mounted on a specialist panoramic tripod and head was used to capture all photo series. In adherence with best practice this camera utilises a full-frame sensor and offers the maximum resolution of a camera in its class.

4. All photos were captured at a focal length of 50mm in RAW format, each series comprising at least 11 photos to ensure a full 180^0 angle of view. All sites were visited over a period of 9 separate days, visibility usually being clearest after a rainfall episode, with mid-afternoon offering the best uniform lighting. Most viewpoints were visited multiple times thus ensuring a range of options to choose from during post-processing. A precise GPS location and site specific details were recorded at each incidence of photo capture

5. Once captured each photo series was carefully processed from RAW format and stitched using specialist panoramic software to yield a highly detailed 180^0 panorama. Other post-processing involved image sharpening and minor colour adjustments.
   The GPS data was post-corrected using Rinex data available from the OSi website to yield higher levels of accuracy.

Methodology used in the preparation of photomontages:

1. The DEM created in the GIS for the purpose of visibility analysis was imported into a specialist software package, Topos R2 (by 43D) and used to create a 3-dimensional model of the entire study area to a fine level of detail (accounting for earth-curvature).

2. A generic latest-generation offshore turbine was modeled from scratch using 3D-Studio Max to the correct dimensions using spec-sheets from a small selection of popular models currently and soon-to-be available. This turbine was imported into the 3D environment and positioned multiple times at random rotations into the respective turbine coordinate locations of the Dublin Array. This yielded a fully interactive model of the proposed development in-situ in a replica 3D landscape ready for simulation.

3. The Kish Lighthouse was also modeled according to its exact dimensions and position. In addition to landform such as Bray Head, Killiney Hill and Howth Head the lighthouse was used as an important reference point for correctly positioning the turbines where possible. 18 of the 22 viewpoints actually have a view of the lighthouse.
4. Using the exact dates, times of day, weather conditions and GPS positions recorded at each location, the viewpoints were simulated and output as high-resolution renderings. These turbines and landform were subsequently imported into the panoramic images and scaled by a predetermined percentage and positioned correctly to yield representations of the proposed wind farm.

5. In addition, the same turbines, angles of rotation, site, earth curvature and capture parameters were modeled in 3D-Studio Max. This is a far more complex software package used for renderings of a high photo-realistic quality. A full set of renderings were output from this package and added to the panoramic images using the previous placement models. A final pass of graphics adjustments were made to the turbines to achieve the end result. This second phase of modeling offers a valuable double-checking process for viewpoint and turbine positional and dimensional errors
   This was repeated for each of the consented and proposed wind farms within the study area.

6. The final montages were formatted in Adode Illustrator with titles, maps and all information pertaining. It was decided not to rescale any of the montage images from their original capture size so as to minimize any image deterioration and avoid any impact to the rendered turbines. The

final images are 180^0 measuring 204.64cm (14170 pixels @ 300dpi) x 27^0 measuring 31.7cm (3744 pixels @ 300dpi).
The viewing distances were carefully calibrated and are indicated prominently on each image.

Source documents referred to for pertinent best practice guidance:

- Visual Representation of WindFarms – Good Practice Guidance, *SNH* (2006)
- Visualisation Standards for Wind Energy Developments (amended), *Highland Council* (2010)
- Guide to Best Practice in Seascape Assessment, *Countryside Council for Wales, Brady Shipman Martin, University College Dublin* (2001)
- Studies to inform advice on offshore renewable energy developments: Visual perception versus Photomontage, *Symonds Group Ltd – CCW Contract Science Report No 631*
- Irish Planning Guidelines for Wind Energy, *Department of Environment Heritage and Local Government, 2006*