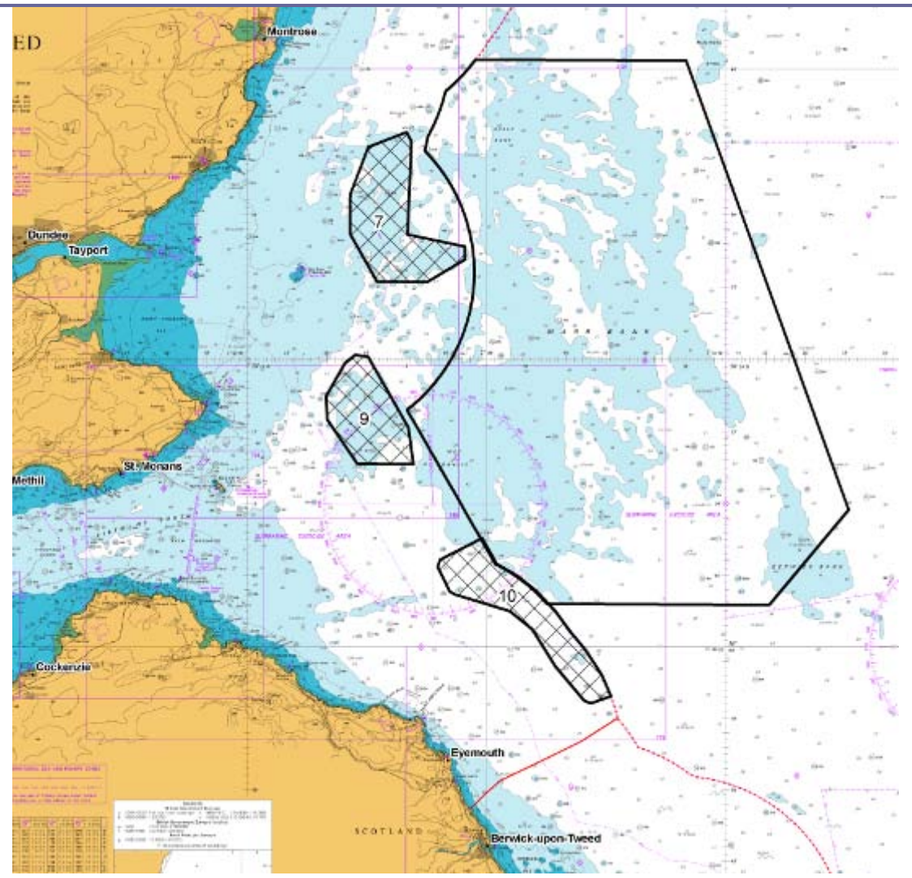


Appendix K1 – Scottish Offshore Wind Farms - East Coast

Discussion Document (3) – Approach to Assessment of Landscape, Seascape and Visual Cumulative Effects

Forth and Tay Offshore Wind Developers Group

March 2011

Document title	Scottish Offshore Wind Farms - East Coast Discussion Document (3) – Approach to Assessment of Landscape, Seascape and Visual Cumulative Effects
Status	Final Report
Date	March 2011
Client	Forth and Tay Offshore Wind Developers Group
Drafted by	Land Use Consultants, SLR Consulting Pegasus Planning Group, Royal Haskoning, RPS Ltd,
Checked by	FTOWDG

1.1 Seascape/Landscape Character, and Visual Amenity

1.1.1 Potential Effects

The Scottish Natural Heritage (SNH) guidance (Cumulative Effect of Windfarms) separates out cumulative **landscape** (can also be taken to include **seascape**) and cumulative **visual** effects. Cumulative effects are described as the **additional** effects of adding a development into a situation where one or more other developments are also proposed.

Three main types of potential cumulative **visual** effects will be described:

- **Simultaneous** (or **combined**) visibility – where two or more wind farms are visible from a fixed viewpoint in the same arc of view;
- **Successive** visibility – where two or more wind farms are visible from a fixed viewpoint, but the observer needs to turn to see the different sites; and,
- **Sequential** visibility – where more than one wind farms will be seen in sequence as the observer moves along a linear route, for example, a road or public right of way.

The potential cumulative effects of the wind farm, in combination with other developments, on **landscape** character and on **seascape** resources and character will be considered. These will include:

- Effects on landscapes (indirect as development is offshore); and
- Effects on seascapes (direct and indirect).

The cumulative effects of the wind farm on **visual** resources will include consideration of potential effects on views and visual amenity as experienced from landscapes and seascapes including representative locations from:

- settlements;
- key tourist destinations;
- other publicly accessible land (including popular beaches/coastal edges);
- promoted routes such as long distance or national trails and cycle routes, or other public rights of way;
- roads including coastal, arterial and minor roads; and
- marine destinations (eg islands reached by tourist boat trips).

Potential direct and indirect effects during construction (short term/temporary effects), operation (permanent or intermittent - such as lighting) and decommissioning (short term/temporary) of the wind farm/s will be considered.

Potential indirect changes to the settings of heritage assets will be considered, along with potential effects on the overall historic landscape, and will be undertaken as part of the assessment of effects upon cultural heritage. ZTVs and visualisations produced as part of the seascape/landscape and visual impact assessment process will be passed across to those assessing effects upon cultural heritage to inform their work.

1.1.2 Consideration of Existing and Proposed Wind Farms in the Cumulative Assessment

The purpose of cumulative assessment is to examine potential interactions with other consented or proposed developments which do not already exist, so that potential effects arising from the presence of two of more developments can be understood. All other proposed offshore wind farms within the study area will be included. All onshore wind farms which are operational, under construction, consented, or the subject of a validated planning application and which lie within the search area will be considered. Projects at scoping stage may need to be included (subject to sufficient detail being available) if they are particularly large or close to the coastline, or if sufficient details are known.

Existing wind farms will be introduced as part of the baseline descriptions. However, for practical and presentation reasons, it is often easier examine and assess all interactions with other developments, both existing and proposed, within the cumulative assessment.

1.1.3 Sizes of Turbines to be Modelled

All of the offshore projects are proceeding on the basis of defining a Rochdale envelope, with two or more development scenarios being set out. Typically if larger turbines are used then a smaller number of turbines will be required. Conversely, if smaller turbines are used then numbers may be in the order of 30% greater. The Environmental Statements will need to assess a reasonable scenario such that the likely maximum effects are given due consideration for all subject areas. However this will be different for different subject areas, and may also vary within discipline areas. In some cases a greater number of smaller turbines may be considered to give rise to more significant effects, even though the highest turbines will always be more widely visible, and so the physical extent of the ZTV would be greatest for the tallest turbines which are likely to be used.

It is not practical to model all scenarios for all visualisations. Therefore, representative scenarios will be used. The ZTVs and wirelines produced for the cumulative assessment will represent the largest turbine which is likely to be used. Illustrative examples will be modelled using smaller turbine options for comparison.

1.1.4 Study Area

Given the probable height of the proposed offshore turbines (in excess of 160m to blade tip), SNH have requested that the study area for the seascape, landscape and visual impact assessment of each individual offshore wind farm should be 50km from the boundary of each proposed offshore wind farm. SNH have also suggested that the search area for cumulative schemes will be 85km. This includes the 50km study area of the offshore wind farm(s), plus an additional 35km beyond this.

Whilst there will be a **core study area** which is common to all (ie where each of the study areas overlap), there will also be areas beyond the common core where there is no overlap. For the purposes of the cumulative work which will be shared by all parties, information will be prepared for the core common area alone.

The landscape architects concerned have mapped study areas of 35km and 50km radius from the outer edge of the three wind farms and would like to agree the core study area for the cumulative assessment as being all land and sea within a 50km radius of the three wind farms.

The cumulative assessment will consider existing and consented wind farms and may include other **major** coastal or significant offshore development proposals. These would only include proposals of comparable or larger size and visual characteristics, within an agreed distance of the boundaries of the proposed site, that have formally entered the planning system through submission of a scoping report and scoping response from the local authority or full planning application. The list of projects to be considered is to be agreed with the relevant authorities, including SNH, and a cut off date for projects to be included to be set 3 months prior to applications being made, enabling data gathering, assessment and modelling to be undertaken.

Projects within the **core study area** will be identified on a map. The list of other projects will be reviewed, and those with which there are likely to be **significant** cumulative effects will be selected for more detailed assessment. Reasons for selection (or not) will be documented in a tabulated form. For those schemes with potential for significant effects, which are likely to include all those within c.35km and a selection of the large schemes up to c.50km away, ZTVs will be generated to an appropriate radius, eg for cumulative onshore schemes with turbines over 100m this will be a 35km radius. Where the ZTV for the cumulative scheme significantly overlaps that of the offshore wind farm, there is the potential for **combined** or **successive** cumulative effects, and therefore the scheme being examined will be included in the detailed cumulative assessment. The visible interaction between the cumulative wind farms will be described, and an assessment made of the level of significance of these types of visual effects.

Sequential visual effects will be described in relation to key routes through the land in the study area. These routes will include: the Fife Coastal Path; A1(M); A198; A917; A92 and Sustrans National Cycle Route 1.

1.1.5 Cumulative viewpoints

A list of preliminary cumulative viewpoints has been generated, and rationalised alongside those viewpoints suggested by SNH (11.02.2011). Viewpoints which are not cumulative, in that they do not lie within the 50km radius ZTV of two or more of the offshore wind farms have not been included. This list is subject to agreement between FTOWDG, relevant local authorities and statutory consultees. The viewpoints are listed in **Table 1** and illustrated on **Figure 1**.

It is proposed that all viewpoint photography will be taken by a single photographer, using the same camera. These photographs will be used by each developer, who will prepare their own visualisations. Standards will be agreed, such as viewing distance, angles of included views, image size, colours, page layout etc, in line with SNH minimum standards for visual representation. It is not considered practical for cumulative visualisations to be prepared collaboratively, due to the changes in baseline scenarios which are likely to occur between successive ES submissions.

Beyond 15km from **any** wind farm, the use of photomontages to illustrate views is considered to be limited, and it will therefore be preferable to use wireframes instead. As a minimum it is agreed that cumulative wireframes will be prepared. Bracketing each wind farm and labelling them clearly (within the sky well above the horizon) will help in understanding which scheme is which. Bracketing may be preferable to the use of different colours for each wind farm due to the number of different schemes which will need to be shown. Colour coding can then be used to reflect status (ie operational/consented/in planning/scoping), and therefore relate to baseline or potential scenarios.

Table 1 Cumulative viewpoints

No	Viewpoint	X	Y	Council Area	Within 50km of:		
					Inch Cape	NnG	Round 3
1	Garron Point	389401	787711	Aberdeenshire	Yes		Yes
2	Johnshaven	379927	767107	Aberdeenshire	Yes		Yes
3	Thorter Hill Viewpoint	365086	780485	Aberdeenshire	Yes		Yes
4	Montrose	372729	758437	Angus	Yes	Yes	Yes
5	White Caterthun Hill Fort	354800	766049	Angus	Yes		Yes
6	Lunan	368666	751738	Angus	Yes	Yes	Yes
7	Arbroath	365763	741411	Angus	Yes	Yes	Yes
8	Carnoustie	356496	734412	Angus	Yes	Yes	Yes
9	Broughty Ferry	347271	730880	Dundee	Yes	Yes	Yes
10	Tentsmuir	349948	724271	Fife	Yes	Yes	Yes
11	Lucklaw Hill Balmullo	341880	721665	Fife	Yes	Yes	Yes
12	St Andrews	350044	717284	Fife	Yes	Yes	Yes
13	Fife Ness Lochaber Rock	363647	709871	Fife	Yes	Yes	Yes
14	Anstruther East	357229	704199	Fife	Yes	Yes	Yes
15	Largo Law	342746	704993	Fife	Yes	Yes	Yes
16	North Berwick	355085	685379	East Lothian		Yes	Yes
17	Dunbar	367134	679355	East Lothian	Yes	Yes	Yes
18	Monynut Edge	370542	667773	East Lothian		Yes	Yes
19	St Abb's Hill	390926	669305	Scottish Borders		Yes	Yes
20	Horsley Hill	383297	662098	Scottish Borders		Yes	Yes

All viewpoint locations will be fine tuned on site on the basis of field work.

1.1.6 Data Gathering

The discipline of seascape/landscape and visual impact assessment (SLVIA) has evolved over a number of years. Current SLVIA methodology in the UK is founded on guidance and techniques published by the Landscape Institute and the Institute of Environmental Management and Assessment, the Countryside Agency and Scottish Natural Heritage and the Countryside Commission for Wales, Brady Shipman Martin and University College Dublin.

The SLVIA will be undertaken with reference to best practice outlined in the following published guidance documents:

- Guidance on the Assessment of the Impact of Offshore Wind Farms: Seascape and Visual Impact Report (November 2005) Enviros, for the DTI;
- Guidelines for Landscape and Visual Impact Assessment, Second Edition (2002) Landscape Institute and the Institute for Environmental Management and Assessment;

- Landscape Character Assessment: Guidance for England and Scotland (2002) Countryside Agency and Scottish Natural Heritage;
- Guide to best Practice in Seascape Assessment (2001) Countryside Council for Wales, Brady Shipman Martin, University College Dublin, Maritime Ireland / Wales INTERREG Report No. 5;
- Landscape Institute Topic Papers and Advice Notes, including relating to the use of photography and photomontages; and
- Scottish Planning Policy (SPP).

There is also a range of published best practice guidance specifically for the assessment of effects of proposed wind farms. Guidance in the following documents (amongst others) may be referred to as appropriate:

- If available, the draft or new seascape character assessment guidance which is being developed by Landscape Design Associates;
- Visual Representation of Windfarms: Good Practice Guidance (dated 2006, published 2007) H+M and Envision. Report for Scottish Natural Heritage, The Scottish Renewables Forum and the Scottish Society of Directors of Planning;
- Scott, K.E, Anderson, C, Dunsford, H, Benson, J.F. and MacFarlane, R, An Assessment of the Sensitivity and Capacity of the Scottish Seascape in Relation to Offshore Wind farms, Scottish Natural Heritage commissioned report 103, 2005;
- Guidance on Cumulative Effect of Windfarms, Version 2 (revised April 2005) Scottish Natural Heritage;
- Countryside Council for Wales (2004). Studies to Inform Advice on Offshore Renewable Energy Developments: Visual Perception versus Photomontage;
- Visual Assessment of Wind Farms – Best Practice (2002) University of Newcastle, Scottish Natural Heritage commissioned report F01AA303A;
- Guidelines on the Environmental; Impacts of Wind Farms and Small Scale Hydroelectric Schemes (2001). Scottish Natural Heritage.

Data which need to be gathered will be as follows:

- Relevant details for wind farms within 50km and other selected major coastal or offshore projects to be included within the study (to a date 3 months prior to submission of each ES);
- Landscape character type (and area) mapping and descriptions;
- Initial seascape unit/area mapping and descriptions (e.g. Scott et al. 2005) (it is expected that further more detailed units will need to be identified and that this should be undertaken and agreed for use for all projects in the area);
- Land and sea use/users through the study area and for each viewpoint;
- Meteorological data for visibility for the past 10 years;
- Locations and descriptions of designated landscapes, including their reasons for designation and special qualities (or equivalent).

Work which will be undertaken **collaboratively** will be as follows:

- Consultation with SNH, the local authorities and other stakeholders (Crown Estate, Marine Scotland) to agree methodology, study area, cumulative baseline and viewpoints;
- Field work to confirm desk-based study and for descriptions of chosen viewpoints (and viewers represented by each) as well as their sensitivity;
- Photography from each viewpoint location;
- Agreement of detailed format for presentation of cumulative graphical materials (example to be prepared and circulated);
- Collation of a list and relevant details for wind farms within 50km of any of the outer edges of the wind farms, and other selected major coastal or offshore projects with similar visual characteristics to be included within the study (to a date 3 months prior to submission of each ES), and in suitable format for inclusion in wirleines;
- Analysis of the projects within the 50km radius to determine if ZTVs and more detailed cumulative assessment will be required (a matter for individual SLVIAs);
- Team workshop, desk study and field work to agree more detailed seascape character areas, their key characteristics and sensitivities for assessment (initial baseline map layers need to be prepared first in order to prepare for this); and
- Digitisation of the agreed seascape character areas, and presentation on maps.

1.1.7 Additional Considerations

Further factors will be considered in determining the likely significant landscape, seascape and visual effects within an established study area. These are:

- Curvature of the earth;
- State of tide;
- Atmospheric visibility;
- Acuity of the eye.

Curvature of the Earth

When the proposed wind farm is viewed from locations near sea level, turbines at distances greater than 50km would disappear over the horizon (see Figure 1). Only the turbine blades would theoretically be visible at distances of between 40 and 45km. These distances could theoretically be exceeded for land based receptors, where the viewing height is above sea level. The presence of hill and upland areas within the study area provides elevated viewing locations for sensitive receptors. The angle of view gained by receptors at greater elevations above sea level would, to some degree, counteract the curvature of the earth, extending the potential availability of views of the wind farms. Modelled ZTVs and photomontages will consequently take account of the curvature of the earth.

State of Tide

As apparent turbine height will vary, albeit slightly, with the state of the tide, it will be beneficial to record approximate tidal ranges within each wind farm area, and to be clear as to stated and modelled heights for ZTVs and photomontages (i.e. AOD, above Mean High Water, above Mean Sea Level etc).

Atmospheric Visibility

It is usual when assessing visibility of turbines to consider atmospheric visibility by examining meteorological data for the area. Such examination can only be approximate, as visibility varies from year to year, according to season, and will vary across the study area, both laterally, and with height above sea level. Available visibility data also does not generally take account of hours of darkness. However ten year averages can be used to indicate approximate

percentages of time within each viewing range (e.g. using a 10 year average for weather data on the east coast of Scotland, percentage of the time, it is not possible to see beyond a certain distance out to sea).

Acuity of the Eye

The Guide to Best Practice in Seascape Assessment (GSA) discusses the limitations of the acuity of the human eye. The guidance states that: "*At a distance of 1 kilometre in conditions of good visibility a pole of 100mm diameter will become difficult to see, and at 2 kilometres a pole of 200mm diameter will similarly be difficult to see. In other words there will be a point where an object, whilst still theoretically visible, will become too small for the human eye to resolve. Mist, haze or other atmospheric conditions may significantly exacerbate that difficulty."* Consequently, when visible in favourable conditions, a slim object approximately 3m in width (such as a wind turbine blade) will be at the limit of perception by the human eye at a distance of 30km.

An object would need to be greater than 5m wide to be visible at or beyond 50km. Only the nacelle and not the blades would be large enough to be visible at this distance, however the nacelle would be below the horizon when viewed from near sea level.

A combination of curvature of the earth and acuity of the eye would limit the potential for seascape, landscape and visual effects especially beyond 50km away.

Analysis of the local landscape and seascape and the identification of visual receptors and preparation of ZTVs, wirelines and photomontages will be undertaken to enable an assessment of the particular effects associated with the proposed development to be established. However, the likelihood of significant effects in the additional zone of the study area (50km rather than 35km) is limited.

1.1.8 Data Analysis

Potential cumulative effects on relevant areas of the landscape and seascape, and their character will be assessed.

The geographical extent of potential visibility will be established for turbine hub and blade-tip heights through the production of a ZTV plan for the wind farms. Potential combined and successive cumulative visual effects of wind farms will be assessed by considering the degree of overlap between the Zone of Theoretical Visibility (ZTV) of the proposed wind farm developments.

Due to the extent of the study area, it would be impossible to assess the visual impact on every individual visual receptor identified within the ZTV, and guidance does not require this. Consequently, a selection of 20 assessment viewpoints looking towards the proposals has been developed, and will be agreed with consultees (see **Table 1** and indicative ZTV in **Figure 1**). The viewpoints will be publically accessible and representative of potentially sensitive receptors situated within the study area, at varying distances and directions from the proposed developments.

Wireline diagrams of the proposals will be produced for each representative viewpoint and set alongside baseline photographs of the landscape/seascape to illustrate the location and potential appearance of the wind turbines from each of the agreed viewpoints. These representative viewpoints will be used to assess the potential visual effects of the proposals on views towards the site. Each ES will include an assessment of the effects on views from the viewpoints relevant to each proposed wind farm.

The significance of cumulative visual effects will be established by making a professional judgement considering both the sensitivity of each viewpoint where more than one site would be visible and the cumulative magnitude of change arising from the addition of the proposed wind farm being considered. See Appendix 1 for detail on these methods of analysis.

Table 2 Summary of seascape/landscape and visual methods and activities

Method/Activity	Status
Data gathering and analysis	Undertaken on behalf of all FTOWDG members. Some aspects can be split between developers (eg gathering data on cumulative schemes). Others are best undertaken by a single organisation (eg photography). Other activities may be best undertaken as a combined team (eg meeting with SNH and local authorities, development of detailed seascape character areas and their sensitivities).
SLVIA for stand alone projects	Commissioned by each developer for their own study area
Cumulative SLVIA	Cumulative data gathering to be commissioned by FTOWDG as above, and to be supplemented by each individual developer to cover additional projects arising up to the relevant cut-off date. Written assessment and cumulative visualisations to be commissioned by each developer for their own study area.

1.1.9 Presentation of Results

The assessment of significance of effects will be based upon guidance from *Guidelines for Landscape and Visual Impact Assessment'*: Second Edition – The Landscape Institute and Institute of Environmental Management and Assessment (2002).

Impact criteria to be used in the cumulative effects assessments are yet to be determined and agreed by developers, as criteria and terminology will need to be consistent with other subject areas within each ES. It will however be helpful if terminology for sensitivity of receptors and magnitude of change (**high, medium, low, negligible/none**), and level of effect (**major, moderate, minor, negligible/none**) and assessment criteria, plus levels of effect to be considered significant, are consistent between developers.

Tables 3-5 provide potential criteria for landscape/seascape and visual effects. Several criteria will be used to evaluate sensitivity of landscape, seascape and visual receptors as well as magnitude of change, as is advised by the based on Guidelines for Landscape and Visual Impact Assessment and drawing on other relevant published sources (e.g. Scott et al). The tables below summarises key considerations. All criteria are subject to the agreement of FTOWDG. It is to be recognised that these are sliding scales and that clear or defined thresholds do not exist between levels.

Each effect will be determined by examining the sensitivity of a receptor and the magnitude of change, applying professional judgement and experience to weigh up the varying contributory factors on a case by case basis.

Table 3 Sensitivity of Receptor

Sensitivity of Receptor	Landscape/Seascape Resource	Visual Resource / Amenity
High	A seascape or landscape of particularly distinctive character, which may be nationally designated for its scenic quality or where its key characteristics have limited resilience to change	Locations frequented by viewers with proprietary interest and prolonged viewing opportunities such as at residential properties or at popular recreational destinations
Medium	A seascape or landscape of notable character or where its key characteristics have some/moderate resilience to change	Locations frequented by viewers with a moderate interest in their environment such as occasional travellers or at recreational facilities when the main focus of activity is not on the surroundings
Low	A seascape or landscape which is of low/poor scenic quality or where its key characteristics are such that they are resilient to change	Locations frequented by viewers with a passing interest in their surroundings and whose interest is not specifically focussed on the scenery, eg at working premises or at locations on roads or railways passed through when travelling

Table 4 Magnitude of Cumulative Change

Magnitude of Change	Landscape/Seascape Resource	Visual Resource / Amenity
High	Considerable additional change in seascape or landscape key characteristics across an extensive part of the horizon	Location affected by substantial additional changes in view, which may be visible for a long duration, facing the change, or which may be in stark contrast with the existing view, or obstruction of a substantial part or important elements of views towards the development area
Medium	Moderate additional changes in seascape or landscape key characteristics across a more limited part of the horizon	Location affected by moderate additional changes in views, or visible for a moderate duration, perhaps at a slight angle, where changes may be in contrast with the existing view, or obstruction of a noticeable part or elements of views towards the development area
Low	A small additional change in key characteristics of the seascape or landscape across a small part of the horizon	Location affected by slight additional changes in views, or visible for a short duration, perhaps at an oblique angle, or which may blend to an extent with the existing view
Negligible/ None	No perceptible additional change in key characteristics of the seascape or landscape	Location affected by an additional change which is barely visible, or visible for a very short duration, perhaps at an oblique angle, or which may blend with the existing view, usually at some distance from the development

Table 5 Assessment of Cumulative Effects

Effect	Landscape/Seascape Resource	Visual Resource / Amenity
Major (Significant)	The proposed additional changes would considerably alter key or defining characteristics/reasons for designation	The proposed additional changes would considerably alter visual amenity as experienced from the location
Moderate (Significant)	The proposed additional changes would noticeably alter key or defining characteristics/reasons for designation	The proposed additional changes would noticeably alter or detract from visual amenity as experienced from the location
Minor	The proposed additional changes would slightly alter key or defining characteristics/reasons for designation	The proposed additional changes would slightly alter visual amenity as experienced from the location
Negligible/ None	The proposed additional changes would have a barely noticeable or indiscernible effect upon key or defining characteristics/reasons for designation	The proposed additional changes would have a barely noticeable or indiscernible effect and would not alter visual amenity as experienced from the location

NB This scale is a continuum and the given grade is based on many variables, weighed up by the application of professional judgement and experience, on a case by case basis.

APPENDIX 1: SLVIA TECHNICAL DATA ANALYSIS METHODS

Zone of Theoretical Visibility

Introduction

Cumulative effects of wind farms are considered where the presence of other wind farms in a given area may have an effect on the perception of the landscape character of that area, or on views from sensitive receptors.

For each wind farm (or group of wind farms) a preliminary Zone of Theoretical Visibility (ZTV) has been produced. A methodology for ZTV production is shown below.

Depending on turbine blade tip height; a study area has been determined for each scheme based on guidance and discussions with SNH. The ZTV is only produced within this study area.

A combined or successive cumulative visual effect will occur when two or more wind farms are visible from the same location within this study area. A figure is produced for each scheme (or group of schemes) to show where the ZTV of the other scheme overlaps the ZTV of the proposed wind farm, thus identifying areas where these types of cumulative visual effect are possible.

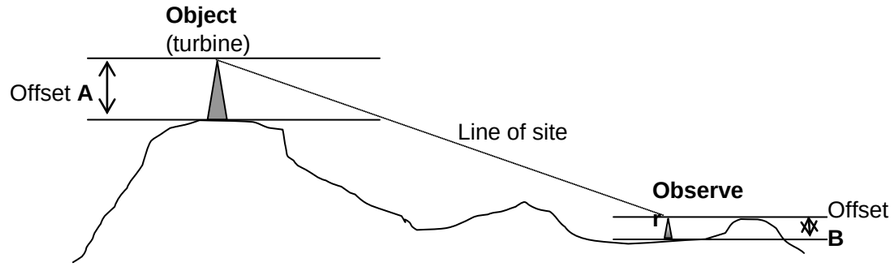
Method for Calculating a Zone of Theoretical Visibility

The ZTV calculation is performed in ArcGIS 9.3 using the Viewshed Analysis tool (part of the 3d Analyst extension) or using other equivalent suitable software, such as Resoft Windfarm. A ZTV indicates the likelihood of a line of sight between an object (e.g. a wind turbine) and an observer location over a digital terrain model (DTM). If the object will be visible a value of one is returned, otherwise the value is zero. If there is more than one object, the results are added together to give an indication of how many objects are visible from that single observer location.

The ZTVs will be calculated with raster height data (the digital terrain model or DTM) interpolated to a 50m grid. The ground is effectively split into individual cells (pixels/squares) of 50m by 50m. Each cell has a single height value representing the average height for the whole cell. When making the calculation the following variables are used.

Offset A = the height of the object.
Offset B = the height of the observer. Assumed to be the eye level of a standing adult and set at 1.5m.

Zone of Theoretical Visibility Methodology



The curvature of the earth is also incorporated.

It should be noted the accuracy of this methodology is entirely dependant on the accuracy and resolution of the underlying DTM. This provides height data at 50m point intervals to an accuracy that is one half the vertical interval of the source data (OS Landranger 1:50,000 contour 10m contour lines), typically ±5m RMSE.

A further caveat is the nature of a DTM, which considers elevation only. Other landscape features such as buildings and vegetation, are not included. Therefore the ZTV will tend to provide a worst-case scenario, as if there were no built features or other obstructions within the landscape to act as visual barriers above the existing relief.

Cumulative ZTVs are generated by overlaying ZTVs for each of the individual wind farms and presenting them both as a series of pairs of ZTVs (the wind farm under consideration and each of the other wind farms which is being considered), as well as an overall ZTV showing the number of wind farms (rather than the number of wind turbines) which will be visible from locations across the study area.

Photography and Wirelines

Methodology for Photography

In order to produce photographs of suitable quality to be used in the photomontages, the following points are adhered to as much as possible:

- Photographs are taken in weather conditions of clear visibility;

- The same exposure is used for all the frames i.e. manual exposure is used to avoid the photographs having different exposures. Alternatively a camera with exposure lock with a carefully set exposure is used especially where wider panoramas are taken where a proportion of the panorama may be taken partially looking towards the sun (which can be a particular problem in early morning/late afternoon/wintertime);

- A 50mm or equivalent lens is usually used in a 35mm format (as recommended in Landscape Institute / IEMA Guidelines, 2002 and Advice Note 01/11), although digital technology means that this is less essential now, so long as the output size is consistent;

- A 30-50% overlap is taken between photos to allow the sides of each photo to be removed when splicing the photos together to minimise distortion;

- Panoramas are produced by splicing standard photographs with recognised software (e.g. Adobe Photoshop) and not by the use of specialist cameras in order to minimise distortion;

- A levelled tripod is used. In addition, the camera is also levelled using a spirit level that sits in the flash socket of an SLR camera. This ensures that the sea horizon is in the centre of the frame;

- A very high quality camera lens is used e.g. Nikon, Canon or Leica;

- When taking the photo the precise location is recorded using a hand held GPS. The orientation to the proposed wind farm development, approximate altitude (ground level), date, time of day and weather conditions are recorded for each viewpoint;

- The height from ground to centre of camera lens is recorded;

- If, when on site, the proposed viewpoint location is screened by trees or minor variations in topography, the viewpoint is relocated and the new location details recorded and submitted to the relevant parties with reasons for relocation. Winter views, if feasible, will ensure maximum visibility through vegetation cover;

- Where possible, the wind farm site is positioned in the middle of the view with frames taken either side to give context;

- Where possible, reference points on the sea horizon are recorded e.g. Met masts, light houses, buoys, anchored ships with GPS locations or compass bearings. If these are visible with binoculars but not the human eye, a surveying rod is placed in the photograph directly below the feature to assist later in the verification of the photomontage. Accuracy can be further improved by liaising with sea vessels within the view (e.g. marine ecologists surveying the site) when an accurate GPS can be given at the time of photographing;

- Where viewpoints are cumulative, a wide enough panorama is taken to cover the locations of all the wind farms to be assessed in the cumulative assessment;

- To ensure all photos align, all shots are taken from the same location/grid co-ordinate by turning the tripod on the same spot; and,

- To enable accurate revisiting of viewpoint locations, a photograph is taken of the tripod as a marker. Additionally, the viewpoint is spray marked (if feasible). This allows professional surveyors to verify GPS records if greater accuracy is required.

Offshore wind farm photomontages have some specific challenges due to their distance from viewpoint locations. The following issues are considered:

- Scale of development. Wind farms can be spread over many kilometres, which makes panoramic photographs a necessary requirement to capture the whole scheme and to avoid criticism of not showing the surrounding context of a proposal. Even when it is possible to keep a development within a small number of photographic frames, the growing obligation to take into account the cumulative effect of developments makes panoramic photography an inevitable requirement;

- Visibility. Off-shore wind farms can be in excess of 20km from land therefore photographs need to be taken on a very clear day to enable visibility. This may mean more than one visit to each viewpoint is required; and,

- Curvature of the earth. Along the horizon view one may be looking at objects over 10km away. The panoramic photograph may start to show a fish eye effect i.e. vertical objects on the edge of the photograph appear to lean over. In addition proposals may start to disappear off the horizon i.e. out of view.

Methodology for the Production of Computer Models

The proposed development is modelled to be superimposed on the photograph to generate the photomontage. Based on the use of Windfarm® by ReSoft (or similar software) to generate the photomontages, the following procedure is used:

- Base mapping and height data of the relevant area are set up to real-world OS co-ordinates;

- The proposed turbines are located according to the scheme design using the correct turbine specification. Additional proposals including metmasts, are modelled in AutoCAD® or similar software to further depict the scheme in 3D. These are positioned to match real-world OS co-ordinates;

- The arrangement and size of the turbines (blade diameter and hub height) are modelled in accordance with the planning application;

- Viewpoint locations are inputted using GPS data collected on site;

- The panoramic photography is then aligned for the relevant viewpoint using GPS data collected on site of existing reference markers visible in the photographs;

- The direction and viewing angle of the perspective is then matched with each photographic frame in the panoramic views;

- Curvature of the earth is calculated using standard settings within the software;

- Photographs are corrected for colour, brightness and contrast to ensure that image quality is optimised. Model lighting is corrected to match photographic conditions;

- The rendered photomontages are generated. The Windfarm software also allows for the generation of wirelines; and,

- Using Adobe PhotoShop imaging software additional features such as metmasts are combined with the generated photomontage.

Note: In “fitting” the computer model for offshore wind farms it is not always possible to have existing features within the application boundary, i.e. on the horizon, at the correct distance. Angles of view and bearings to other objects may be the only feasible way of fitting the proposals to the scheme. This is not ideal and if features on the horizon are added in the future (e.g. met masts), then this information should be used as soon as possible to re-calibrate the photomontages.

Presentation

Photomontages are used as a series of figures within the Environmental Statement. The general format of this document is A3, landscape.

- Each viewpoint is presented on an A3 sheet showing the existing view and the proposed view with specific camera information and distances to the turbines. The A3 format allows for a 75° field of view, which should be viewed at approximately 300mm from the image. If the print is curved around the viewer to give a constant 300mm distance it produces an accurate reproduction of how the viewer would perceive things on site. It is difficult to have an existing view, wireframe and a proposed photomontage view one above another on the same page at A3, as it will not comply with SNH standards especially the heights of the panoramas. In this instance only the existing photograph and the cumulative wireline need to shown, and so the required image height can be met.

- When a 75° field of view is not sufficient the pages can be widened as fold-outs. This is preferable to continuation sheets for ease of understanding;

- Wireline views are shown on an additional sheet if required; and,

- Views are annotated to aid interpretation.

Forth and Tay Offshore Wind Farms

Cumulative Zone of Theoretical Visibility (ZTV) to tip height of Forth and Tay Offshore Wind Farms, showing the potential number of wind farms visible

Neart na Gaoithe turbine locations and site boundary - 75 Turbines (190m to tip)

Inch Cape turbine locations and site boundary - 174 Turbines (195m to tip)

Firth of Forth Round 3 estimated turbine locations at corners of site boundary (195m to tip)

35km Buffers around Outer Turbines

50km Buffers around Outer Turbines

Potential wind farm visibility:

1 windfarm visible

2 windfarms visible

3 windfarms visible

Viewpoints

1 - Garron Point
2 - Johnshaven
3 - Thorter Hill Viewpoint
4 - Montrose
5 - White Caterthun Hill Fort
6 - Lunan
7 - Arbroath
8 - Carnoustie
9 - Broughty Ferry
10 - Tentsmuir
11 - Lucklaw Hill Balmullo
12 - St Andrews
13 - Fife Ness Lochaber Rock
14 - Anstruther East
15 - Largo Law
16 - North Berwick
17 - Dunbar
18 - Monynut Edge
19 - St Abb's Hill
20 - Horsley Hill

Notes:

The ZTV is calculated to turbine tip height from a height of 2m above ground level.

The ZTVs for all cumulative wind farms have been limited to a variable cut off distance of 50km from outer turbines.

The terrain model is bare ground and derived from OS Panorama height data.

The earth curvature and atmospheric refraction have been taken into account.

Map Scale: 1:675,000@ A3

Figure x.x