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Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Seascape, Landscape and Visual Impact Assessment: Adjustment of the Proposed Rochdale Envelope Assessment
21 June 2012

A Worton Rectory Park
Oxford OX29 4SX
United Kingdom
T +44 (0) 1865 887050
F +44 (0) 1865 887055
W www.lda-design.co.uk

LDA Design Consulting LLP
Registered No: OC307725
17 Minster Precincts, Peterborough PE1 1XX

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Contents

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21 June 2012

Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Preface to this Environmental Statement Addendum (June 2012)

Addenda are commonly submitted as a project evolves through time to clarify issues, or to provide additional baseline data and updated environmental assessment information. This report, the *Seascape, Landscape and Visual Impact Assessment: Adjustment of the Proposed Rochdale Envelope Assessment*, forms part of the ES Addendum.

The June 2012 Addendum contains the following information:

- Additional bird and marine mammal baseline data.
- An additional visualisation from Girdleness lighthouse.
- Results of a geo-locational study into golf courses and Round 1 offshore wind farms.
- Requested minor adjustments to turbine dimensions which form a part of the project description information, known as the 'Rochdale Envelope'.
- Preliminary landscape and visual design principles for the scheme (addressed in this report).
- Supporting statement and representative viewpoints of landscape and visual effects taking account of the adjustments to the Rochdale Envelope and preliminary design principles (addressed in this report).
- Updated ornithological collision risk modelling resulting from the updated Rochdale Envelope, updated ornithological impact assessment, and updated Habitats Regulations Assessment.

21 June 2012

Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Where to View the Consent Application

The ES addendum submission may be viewed at the following locations during normal office hours:

Vattenfall Wind Power Ltd 3rd Floor The Tun Holyrood Edinburgh EH8 8AE	Balmedie Library Eigie Rd Balmedie AB23 8YF
Aberdeen Central Library Rosemount Viaduct Aberdeen AB25 1GW	Peterhead Library 51 St Peter Street Peterhead AB42 1QD
Ellon Library Station Road Ellon AB41 9AE	Bridge Of Don Library Scotstown Road Bridge Of Don Aberdeen AB22 8HH

The ES addendum can also be viewed at the Scottish Government Library at Victoria Quay, Edinburgh, EH6 6QQ.

Obtaining Your Own Copy of the Planning Application Addendum

The ES addendum is available on the Vattenfall website:
http://www.vattenfall.co.uk/en/aberdeen-bay.htm

21 June 2012

Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

1.0 Introduction

An application for the European Offshore Wind Deployment Centre (EOWDC) was submitted in August 2011 in accordance with the Rochdale envelope principle that allows for the identification of an agreed realistic worst case scenario option for assessment. For the purposes of the Seascape, Landscape and Visual Impact Assessment (SLVIA), the dimensions of the turbines were agreed with the consultees to be assessed at the worst case scenario, which was 11 turbines of 10 MW with a hub height of 120 m and blade tip height of 195 m above Lowest Astronomical Tide (LAT). The SLVIA is contained in ES Chapter 19 and Appendices 19.1 and 19.2 of the August 2011 submission.

At the time of defining the Rochdale envelope (as submitted August 2011) the applicant undertook consultation with the supply chain to understand manufacturers' ambitions and likely specifications of wind turbines at an early stage of development. This initial consultation reflected the supply chain and ambitions of manufacturers at the time. Consequently a Rochdale envelope allowing for turbine tip heights of up to 195 m, rotor radius of up to 75 m and hub heights of up to 120 m informed the project description (as submitted).

The overarching objective of the EU grant associated with the EOWDC is to deploy new equipment, systems, processes and initiate research and development to improve the competitiveness of offshore wind energy production, whilst generating environmentally sound marketable electricity and to increase the supply chain capabilities in Scotland, the wider UK, and Europe.

Since the submission of the application in August 2011, commercial re-evaluation of prospective turbine suppliers who can meet the EU requirements has revealed that a number of manufacturers' turbines marginally exceed the Rochdale envelope parameters (as submitted). These turbines would require an adjustment to the tip height of up to 198.5 m, and rotor radius of up to 86 m as summarised in the table below.

Table 1: Rochdale envelope: As submitted and proposed adjusted

Parameter	Rochdale envelope (as submitted)	Rochdale envelope (proposed adjusted)	Differential
Tip Height (above LAT)	Up to 195 m	Up to 198.5 m	3.5 m
Hub Height (above LAT)	Up to 120 m	Up to 120 m	Nil (likely reduction)
Rotor radius (diameter)	Up to 75 m (150 m)	Up to 86m (172 m)	11 m (22 m)

Please note that the maximum dimensions are likely only to be applicable to specific wind turbine locations and are unlikely to be relevant to all 11 turbine locations. Please also note that a minimum clearance of 22 m above Mean High Water Springs (MHWS) will be maintained for marine navigation.

21 June 2012

Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Worst-Case Scenario

At the scoping stage for the August 2011 application, examples of wireframes showing different turbine sizes were prepared. Within the application, six wireframes showing different wind turbines heights within the array were submitted (Figures TH1-3). Appendix 19.1: Section 1.1 stated the following:

"The scheme has undergone numerous iterations since 2005 in terms of location and number of turbines which are discussed in the Environmental Statement (ES). The nature of the deployment centre is that it will comprise first of run turbines which may result in turbines of different heights. For the purposes of the SLVIA (e.g. ZTV, photomontages) the dimensions of the turbines have been agreed with the consultees to be assessed at the worst case scenario which is eleven 10 MW turbines with a hub height of 120 m and blade tip height of 195 m above lowest astronomical tide (LAT). As with all developments, there will need to be an allowance for micro-siting which in this case may be up to 100 m for each turbine. It is not envisaged that the final mix of turbine heights will result in a height difference that is greater than 20-35 m between turbines. Any differences may be noticeable at closer distances and the assessment will take this into consideration. Please see Volume 3 of the ES for a figure showing a detailed layout."

Further explanation on turbine height differences and interpretation of the wireframes showing different turbine heights is included in Appendix 19.2: Section 5.1. The conclusion of this section is that "the potential height variations would not increase the significance of impacts already identified in the assessment of the worst case scenario."

The August 2011 ES submission also examined whether the inclusion of turbines of two contrasting hub and blade tip heights would meaningfully alter the findings of the SLVIA and the results were outlined in Appendix 19.2: Section 5.1. As noted in that appendix, *"potential height variations would not increase the significance of impacts already identified in the assessment of the worst case scenario."* Experience indicates that changes in height of 20 to 35 m between turbines rarely translate into a meaningful or demonstrably noticeable difference in terms of magnitude or significance of effect.

This report provides an evidence base and explores whether the above changes in the Rochdale envelope parameters would be satisfactorily covered by the existing SLVIA within the submitted ES. This paper focuses on the proposed adjusted Rochdale envelope and seeks to establish whether the changes amount to a significant and material variation in seascape, landscape and visual impacts, such that the new proposals would constitute a new realistic worst case scenario from that previously identified.

This report focuses on changes to the worst-case scenario, or Rochdale envelope, as summarised in Table 1. Zoning scenarios relating to landscape and visual considerations are summarised in Appendix C.

1.1. Zone of Theoretical Visibility Plans and Wireframes

For the purposes of this study a selection of Zone of Theoretical Visibility (ZTV) plans and wireframes for both scheme options (195 m and 198.5 m blade tip height) have been prepared in accordance with current best practice guidance as set out within *Visual Representation of Windfarms: Good Practice Guidance* (Scottish Natural Heritage, 2007).

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

For the wireframes, initial visualisations of the proposed adjusted Rochdale compared to the submitted Rochdale indicated that perceptible differences would best be tested from the viewpoints nearest to the Proposal. Preliminary visualisations were made of viewpoints 1, 2 and 4 from the original August 2011 submission. The scale of difference perceptible in these visualisations indicated that it would not be useful to prepare comparative visualisations from more distant viewpoints. However, for thorough examination of the materiality of any differences between the Rochdale envelopes (submitted and proposed adjusted), additional visualisations were prepared for three additional coastal viewpoints at Royal Aberdeen Golf Course (viewpoint 30), Murcar Links Golf Course (viewpoint 23) and the Trump International Golf Links (viewpoint 28).

Appendix A of this paper includes a brief summary on key aspects of the guidance whilst Appendix B includes LDA Design's method statement on the preparation of ZTVs, wireframes and photomontages.

1.2. Figures

The following figures have been produced to accompany this report:

- 3336/101 – Comparative ZTV of Blade Tips on Bareground
- 3336/102 – Comparative ZTV of Blade Tips with Obstructions
- 3336/103 – Comparative ZTV of Blade Tips with Obstructions (Aberdeen City)
- 3336/104 – Visualisations: Height Study
- 3336/105 – Visualisations: Zoning Scenarios

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

2.0 Analysis of Submitted and Proposed Adjusted Rochdale Envelopes

2.1. Zone of Theoretical Visibility

The bareground ZTVs (Figures 3336/101 to 103) illustrate the contrasting extent of theoretical visibility of the original scheme (195 m blade tip height submitted August 2011) and the proposed uplifted scheme (198.5 m blade tip height).

There is minimal discernible difference in the extent and distribution of areas of theoretical visibility when comparing the 195 m and 198.5 m maximum blade tip heights.

There is a very minor increase in the extent of theoretical visibility in the western onshore part of the study area. This is manifested primarily in relation to more elevated areas, where theoretical visibility of blade tips would occur from marginally lower down hillsides. This pattern is very minor and is discernible as a pink fringe (showing theoretical visibility of 198.5 m blade tip) around the purple areas (showing theoretical visibility of 195 m blade tip). For example this occurs on hills to the north-west of Inverurie near Chapel of Garioch at roughly 25 km distance from the turbines (Figure 3336/101). This difference would be barely perceptible on the ground.

Figure 3336/103 shows a comparison of the ZTVs within the Aberdeen area. There is little discernible difference between the 195 m and 198.5 m blade tips. Again, a narrow pink fringe (198.5 m) surrounds some of the purple areas (195 m), which indicates that areas on the margin of the ZTV would have views of the higher blade tips. In the interpretation of the ZTVs, it is worth bearing in mind that, especially in a landscape where visibility is primarily driven by topography, the margins of areas shown as theoretically visible are generally more likely only to have views of the turbine blade tips, rather than the whole structure. It is also these areas of theoretical visibility which in practice would be more likely to be excluded from views by local features such as field boundaries or roadside vegetation, which are not modelled in the ZTVs.

There is a minor increase, of approximately 3 km, in the extent of theoretical visibility from offshore locations for the 198.5 m blade tip height turbines. The ZTVs indicate that this increased extent of visibility occurs at between 50 and 60 km from the nearest turbine at which distances the turbines will be barely noticeable and then only in conditions of very clear atmospheric visibility.

The following tables quantify differences in the ZTVs:

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Table 2: Differences between ZTVs for Rochdale submitted and proposed adjusted (bare ground ZTVs – Figure 101)

Distance Range (km)	Total Area (ha)	Submitted Rochdale		Proposed Adjusted Rochdale		Difference in areas between submitted and proposed (Ha)	Difference between submitted and proposed (%)
		Visible Area Blade Tip 195 m (Ha)	Visible Area Blade Tip 195 m (%)	Visible Area Blade Tip 198.5 m (Ha)	Visible Area Blade Tip 198.5 m (%)		
0 - 10	3297.0	3050.0	92.5	3057.4	92.7	7.4	0.2
10 - 20	8331.3	6157.4	73.9	6191.0	74.3	33.6	0.4
20 - 30	13398.3	7927.5	59.2	7999.1	59.7	71.6	0.5
30 - 40	18465.3	10058.0	54.5	10145.9	54.9	87.9	0.5

Table 3: Differences between ZTVs for Rochdale submitted and proposed adjusted (ZTVs with obstructions – Figures 102 and 103)

Distance Range (km)	Total Area (ha)	Submitted Rochdale		Proposed Adjusted Rochdale		Difference in areas between submitted and proposed (Ha)	Difference between submitted and proposed (%)
		Visible Area Blade Tip 195 m (Ha)	Visible Area Blade Tip 195 m (%)	Visible Area Blade Tip 198.5 m (Ha)	Visible Area Blade Tip 198.5 m (%)		
0 - 10	3297.0	2821.2	85.6	2841.5	86.2	20.3	0.6
10 - 20	8331.3	5374.2	64.5	5436.7	65.3	62.5	0.8
20 - 30	13398.3	7306.8	54.5	7372.4	55.0	65.6	0.5
30 - 40	18465.3	9505.2	51.5	9571.1	51.8	65.9	0.4

From a review of the ZTVs it is clear that the desired uplift to a 198.5 m blade tip height turbine for the proposed wind farm development would bring about very minor increases in the extent of theoretical visibility. The magnitude of the increase is very limited and would not represent a material change in the extent of significant potential effects on seascape or landscape character or on visual receptors beyond those already covered within the submitted SLVIA.

2.2. Review of Sample Representative Viewpoints

Figure 3336/104 comprises a set of photomontages from a selection of the closest viewpoints submitted with the SLVIA in August 2011 and from a number of locations on coastal golf courses on the stretch of coast to the north of Aberdeen. The latter viewpoints were not used in the SLVIA but were produced at the request of Marine Scotland during April and May

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

2012, to respond to representations made by third parties in relation to the August 2011 submission.

- Viewpoints 1, 2 and 4 were assessed in the August 2011 submission.
- Viewpoints 23, 28 and 30 are new additional coastal viewpoints to test the proposed adjusted Rochdale envelope (see section 1.1).

The visualisations show three scenarios:

- Scenario A: 195 m blade tip / 120 m hub (the worst case-scenario assessed and submitted August 2011)
- Scenario B: 198.5 m blade tip/120 m hub
- Scenario C: 198.5m blade tip/112m hub

Scenarios B and C together represent the proposed adjusted Rochdale envelope (Table 1) and were selected to show the upper and lower ranges of hub and blade diameter combinations (scenario B represents the highest hub and therefore the lowest blade diameter; scenario C represents the lowest hub and highest blade diameter).

In the visualisations three scenarios are precisely sized and located over the panoramic view from the agreed viewpoint locations and use either the panoramas included within the August 2011 application, or produced from the locations on coastal golf courses during April and May 2012.

Viewpoint 1: Balmedie Beach

This viewpoint (see Figure 3336/103) is located at Balmedie Beach 3.51 km to the north-west of the nearest turbine. All 11 turbines are visible in all three scenarios. The turbines would occupy 51 degrees of the view (roughly 28 per cent of the 180 degree seaward horizon).

The August 2011 SLVIA determined that the turbines would be prominent features in the view and would bring about high magnitude visual effects, which would be significant in EIA terms.

The visualisation indicates that there would be a barely perceptible difference between scenarios A and B in terms of the prominence of the turbines. There would be no difference between the attributed magnitude and significance of visual effects that would be identified for either of these scenarios. It is clear that there would be no meaningful difference between the effects arising from these two alternative scenarios.

The difference between scenario A and C (a 7.5 m lower hub) is perceptible with the two scenarios overlaid on the same photomontage. For scenario C, the difference with scenario A in terms of blade tip height would be barely perceptible. The difference in terms of hub height (7.5 m lower) and the bottom of the rotor sweep (18.5 m lower) would be perceptible but would not give rise to different levels of magnitude and significance of visual effects. There would be no meaningful difference between the effects arising from the two alternative scenarios.

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Viewpoint 2: A90 Harehill Turn-Off

This viewpoint (see Figure 3336/103) is located on the A90 4.44 km to the west of the nearest turbine. All 11 turbines would be visible and the regular nature of the array would be evident from this viewpoint.

The array would extend across approximately 30 degrees (or 20 per cent) of the available 180 degree seaward-facing view.

The August 2011 SLVIA determined that the turbines would be prominent and would bring about high magnitude visual effects, which would be significant in EIA terms. The turbines would appear as visually prominent vertical elements in an otherwise simple and expansive seaward horizon.

There would be a barely perceptible difference between scenarios A and B. No differences in magnitude or significance of visual effects would arise.

The difference between scenarios A and C is perceptible with the two options overlaid on the same visualisation (Figure 3336/104). The difference in blade tip would be barely perceptible. The difference in hub height (7.5 m lower) and the bottom of the rotor sweep (18.5 m lower) is slightly more noticeable but would not give rise to a different magnitude or significance of visual effect.

Differences between the three scenarios would be negligible.

Viewpoint 4: Whitecairns (B999)

This viewpoint (see Figure 3336/103) is located near the B999 and 8.10 km to the west of the nearest turbine. The turbines would sit partially behind the raised landform that lies between the viewpoint and the site. The turbines would occupy 26 degrees of the illustrated 60 degree view and would appear in five groups. The hubs of four groups would be visible.

The August 2011 SLVIA determined that a medium magnitude of visual effect would arise at this location. For local residents, these effects were determined to be significant in EIA terms.

For scenarios A and B, the difference would be imperceptible at this distance. The magnitude and significance of visual effect would be the same for both scenarios.

For scenarios A and C, the difference would be barely perceptible and would not relate to the 3.5 m difference in blade tip height, but to the 7.5 m lower hub and 18.5 m lower bottom of rotor sweep for scenario C. This marginal difference would not give rise to visual effects of different magnitude or significance.

Differences between the three scenarios would be negligible.

Viewpoint 23: Murcar 8th Tee

This viewpoint (see Figure 3336/103) is located on the 8th tee of the Murcar Links Golf Course and is 3.22 km to the west of the nearest turbine. The turbines would occupy 37 degrees of the view.

This viewpoint was not assessed in the August 2011 SLVIA. This viewpoint is located a similar distance from the proposal to viewpoints 1 and 2 and has a similar level of visual

exposure to the proposed development. Many of the golfing fairways at Murcar, particularly on the seaward edge of the dune system, contain near views of the foreshore and uninterrupted views over the area of sea in which the Proposal would be located. Therefore, corresponding to viewpoints 1 and 2, a high magnitude of visual effect would arise at this location and effects would be significant in EIA terms.

The difference between A and B would be barely perceptible in terms of the prominence of the turbines (Figure 3336/104). The magnitude and significance of visual effect would be the same for both scenarios.

The difference between scenarios A and C would be barely perceptible in terms of blade tip height, but the difference between hub heights (scenario C would be 7.5 m lower) and the bottom of the rotor sweep (scenario C would be 18.5 m lower) would be perceptible with the scenarios superimposed on the same visualisation. This difference would be marginal and would not give rise to visual effects of different magnitude or significance.

There would be no meaningful difference between the three scenarios in terms of the magnitude and significance of visual effects.

Viewpoint 28: Menie Estate (back nine)

This viewpoint is located 5.26 km to the north-west of the nearest turbine on the back nine of the Trump International Golf Links. The array would occupy 26 degrees of the view from this location. All 11 turbines would be visible from this viewpoint, with the four columns of the array forming a regular pattern in the view.

This viewpoint was not assessed in the August 2011 SLVIA. The viewpoint has an open coastal view similar to viewpoint 1 (Balmedie Beach) assessed in the original submission. The coastal location on the edge of the dune system gives the viewpoint a high level of visual exposure to the proposed development. Uninterrupted views would be possible and high magnitude visual effects would arise, corresponding to the nearby coastal viewpoints assessed in the original submission (viewpoints 1 and 2). These effects would be significant in EIA terms.

At this distance, there would be a barely perceptible difference between scenarios A and B. No differences in magnitude or significance of visual effects would arise.

The difference between scenarios A and C is perceptible in terms of the difference in hub height and the bottom of the rotor sweep (and barely perceptible in terms of blade tip height) with the two scenarios superimposed on the same visualisation. The difference between scenarios A and C would not give rise to any difference in magnitude or significance of visual effects.

Viewpoint 30: Royal Aberdeen (Clubhouse)

This viewpoint is adjacent to the clubhouse, first tee and 18th green at Royal Aberdeen Golf Course. The viewpoint is 5.53 km to the south-west of the nearest proposed turbine. The three rows of the array would form a regular pattern in the view. The turbines would occupy 15 degrees of the view.

21 June 2012

Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

This viewpoint was not assessed in the August 2011 SLVIA. Similar to the other assessed coastal viewpoints, the open coastal views mean that the viewpoint would have a high degree of visual exposure to the proposed development. High magnitude visual effects would arise in line with the other assessed coastal viewpoints (viewpoints 1 and 2). These effects would be significant in EIA terms.

From this location, the difference between scenarios A and B would be barely perceptible. No differences in magnitude or significance of visual effects would arise.

The difference between scenarios A and C is barely perceptible in terms of blade tip height and marginally more perceptible in terms of the 7.5 m difference in hub height and 18.5 m difference in the bottom of the rotor sweep. Nevertheless, no difference in the magnitude or significance of visual effects would arise between scenarios A and C.

3.0 Conclusion

The August 2011 SLVIA assessed the proposed EOWDC based on a worst-case scenario of 11 turbines with maximum hub height of 120 m and maximum blade-tip height of 195 m. For commercial reasons relating to the overarching objectives of the EOWDC project, the applicant is exploring a change to the Rochdale envelope, which would mean a 3.5 m uplift to the maximum blade-tip height.

This report and accompanying ZTVs and visualisations provides an evidence base and examines whether this change to the Rochdale envelope would give rise to any significant variation in seascape, landscape and visual effects.

A comparison of the ZTVs for the two scenarios indicate that the uplift of 3.5 m in maximum blade tip would represent an increase of 0.6 per cent theoretical visibility in the area 0 to 10 km from the proposal and 0.8 per cent in the area at 10 to 20 km distance. Differences of this scale would not be expected to give rise to variations in the significance of seascape or landscape effects. Visual effects would not be significantly more widespread as a result of the uplift in maximum blade-tip height.

A range of representative viewpoints have been considered including viewpoints 1, 2 and 4 from the August 2011 SLVIA, and three viewpoints on the coastal links courses. Visualisations show that the difference between 195 m and 198.5 m blade-tip heights would be barely perceptible from coastal viewpoints which are closest to the proposal. The uplift would not give rise to visual effects of different magnitude or significance. Were the rotor diameter to be increased to 172 m (with the uplifted maximum blade tip height of 198.5 m this corresponds to a lower hub height of 112.5 m), the variation would be marginally more perceptible (the hub height would be 7.5 m lower and the bottom of the rotor sweep 18.5 m lower). While a more noticeable difference, particularly where visualisations are superimposed on the same viewpoint photograph, this variation would nevertheless still not give rise to visual effects of different magnitude or significance.

This report and the accompanying figures demonstrate that the proposed variation to the Rochdale envelope would bring about barely perceptible changes to seascape, landscape and visual effects. The visual difference arising from the variation would be extremely marginal in SLVIA terms and would not constitute a new realistic worst-case scenario. As such the Rochdale envelope as assessed in the August 2011 submission is considered to represent effectively the proposed adjusted worst-case SLVIA scenario.

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Appendix A: SNH's Visual Representation of Windfarms

The SNH best practice guidance was issued in March 2007 and is now widely adhered to for those undertaking visualisations for wind energy development projects throughout the UK. The guidance addresses a number of tasks and deliverables pertinent to SLVIA associated work including the preparation of Zone of Theoretical Visibility (ZTV) plans, photography, viewpoint selection and the production of wireframes and visualisations.

The report summary states (page 2) 'This good Practice Guidance advises on the different purposes, uses and limitations of these and sets down some minimum technical requirements.' and notes that 'Visibility maps and visualisations are tools for VIA [visual impact assessment]' as well as noting that '... there is no 'one size fits all' solution'.

Zone of Theoretical Visibility

This section of the guidance discusses the technical production of ZTV plans. It identifies their uses and their limitations and offers guidance on how ZTVs can be most appropriately produced so as to render them a useful tool to the assessment process. Technical matters such as sampling and sizing are considered and the need to allow for earth's curvature and atmospheric refraction in generating the ZTVs, both of which impact upon reducing more distant visibility, are flagged.

Guidance is also given on the most appropriate production of ZTV figures and their interpretation. Bare ground ZTVs, by their very nature, always give an exaggerated impression of the potential extent of visibility and LDA Design always also opts to include ZTVs where allowance has been made for the screening effects that arise from areas of existing vegetation and settlements.

The ZTVs included as part of this paper have been generated in accordance with SNH guidance.

Viewpoints

This section of the guidance addresses the selection and use of viewpoints and the recording of information. The section flags that:

- Viewpoints should be carefully selected to be representative of the range of views and viewer types
- Specific viewpoints may also be chosen for their importance within the landscape
- Viewpoints are representative of a wider area
- A limitation of viewpoint analysis is noted in that they tend to focus on the particular characteristics of specific viewpoints rather than being seen as being broadly representative of a wider area

The viewpoints selected for the preparation of the wireframes included within this report have remained consistent with those used during the original identification of the realistic worst case scenario option. The viewpoints included within the ES and the technical report were identified and agreed with the consultees. Table 9 (page 66 of the guidance) provides a

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

summary of good practice guidance for the selection and agreement of representative viewpoints.

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Visualisations

This section of the guidance addresses the generation and use of photography, wireframes, photomontages, other techniques and their presentation. It makes a number of key early points that are worthy of highlighting as the use and interpretation of visualisation material is often misunderstood:

- Paragraph 119 stresses the difficulty of making visualisations 'true to life' stating that *'Visualisations, whether they are hand drawn sketches, photographs or photomontages can never exactly match what is experienced in the field.'*
- The same paragraph also notes that *'...visualisations in themselves can never provide the answers, only inform the assessment process by which judgements are made'.*

The key message behind the above quotations is that visualisations are limited in what they can do and they must be utilised and interpreted with caution. They must also be viewed correctly. During the assessment process they are never used by professionals as the sole basis upon which judgements as to the extent of impact and significance of an effect are made. Whilst they assist in the decision making process they are only a tool and remain subject to the limitations that accompanies all photographic based material and the extent to which it can, or can't, replicate what the eye would actually see on the ground. For this reason visualisations can only ever give an impression of the anticipated change, albeit the most accurate one that technology and photographic processes allow us to prepare. They should never be taken as showing precisely the effect that the eye will experience on site and landscape professionals, when undertaking an assessment of impact, will always do so whilst on site and armed with a wireframe, technical data as well as a montage, all of which remain tools to assist the professional with the assessment process.

Table 10 on page 76 of the guidance records the uses and limitations of visualisation material including noting that:

- *'They [visualisations] should never be considered as a substitute to visiting a viewpoint in the field.*
- *Neither photographs nor visualisations can convey a view as seen in reality by the human eye*
- *Visualisations are inherently limited in the field of view and detail that they can represent.'*

The good practice guidance then goes on to identify a variety of ways in which the visualisation material should be presented offering a range of combinations of viewing distances, paper format size and horizontal field of view. These are summarised in Table 15 of the guidance. The guidance also identifies the information that needs to accompany the visualisations to enable their correct viewing and interpretation and this information is always provided on LDA Design's visualisations as a matter of routine.

Table 17 of the guidance provides a good practice summary for the visualisation material identifying minimum and preferred requirements. This highlights, for example, the preferred viewing distance range; the preferred image height range; the extent of the panorama to be presented; the technical requirements to be met such as focal length of

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

camera, use of tripod, frame overlap, camera height and film speed; the preferred lighting conditions; how turbines should be modelled in (facing prevailing wind direction preferred); provision for allowing for the incorporation of earth's curvature; the base data that should be used for generating the wireframes, the utilisation of compass bearings for reference points and many other requirements and parameters.

In summary, the guidance document is a comprehensive reference that embraces all key areas to enable the most accurate representation of visualisation material and LDA Design adheres to it when producing any visualisation material for proposed wind farm developments. As a practice LDA Design also regularly reviews its visualisation production process to take advantage in any technological or software developments and to respond to, if deemed appropriate, any feedback that is received through their exposure to, and close scrutiny at, Public Inquiry.

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Appendix B: LDA Design's Method Statement on the preparation of ZTVs, Wireframes and Photomontages

ZTV Studies

ZTV studies are prepared using the ESRI ArcGIS Viewshed routine. This creates a raster image that indicates the visibility (or not) of the points modelled. Each turbine is analysed at hub and blade tip height. Two studies are carried out, with the first using a topographic model alone, in accordance with SNH guidance. A second study is also prepared including settlements (generally mapped in at an assumed average of 7.5m above ground level) and woodlands (generally mapped in at an assumed average of 15m high above ground level). If significant deviations from these assumed heights are noted during site visits, for example young or felled areas of woodland, or significant areas of single storey development, the features concerned will be adjusted within the model. The areas of settlement and woodlands are based on the Ordnance Survey Vectormap District alpha version dataset (this equates to urban areas on a 1:25,000 Ordnance Survey plan and woodlands from the Ordnance Survey streetview 1:10,000 product).

The visibility is modelled taking into account both the curvature of the earth and light refraction, and an observer height of 2m, in accordance with SNH guidance. The ZTV also begins at 1m from the observation feature (for example the wind turbine) and will work outwards in a grid of the set resolution (generally 12.4 sq. m for Ordnance Survey Opendata Landform Panorama) until it reaches the end of the terrain map for the project.

For all plan production LDA Design will produce a ZTV that has a base and overlay of the 1:50,000 Ordnance Survey Raster mapping. The ZTV will be reproduced at a suitable recommended scale on an A1 template to encompass the study area. For printing purposes all A1 figures will be produced at 600 dpi to allow interpretation of the base map.

Ground model accuracy

Depending on the project and level of detail required, different height datasets may be used. Ordnance Survey Landform Profile (roughly linked to quality of 10K mapping) and Ordnance Survey Opendata Landform Panorama (roughly linked to the quality of 50K mapping) are supplied as raster dataset. Below is listed the different data products and their specifications:

Product	Distance Between Points	Vertical Error	Horizontal Error
LiDAR	50cm – 2m	up to +/- 10cm	up to +/- 1cm
Derived Aerial Photography Heights	1m – 5m	up to +/- 25cm	up to +/-15cm
Ordnance Survey Landform Profile	10m	+/- 1.8m	+/- 1m
Ordnance Survey Opendata Landform Panorama	49.6m	+/- 5m	+/- 3m

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

For most purposes, the Ordnance Survey Opendata Landform Panorama data will be used, but on certain occasions more detailed analysis of areas close to the site may be required, in which case, ZTVs based on Ordnance Survey Landform Profile data with areas of vegetation and building footprints taken from the Ordnance Survey 1:10,000 mapping may be used. Similarly, where actual heights from obstructions and hedgerows might need to be assessed more detailed surface mapping products such as Derived Aerial Photography Heights (from Infoterra or Bluesky) or LiDAR can be used.

Wireframes

Wireframes are produced in 6 key stages:

1) Photography is undertaken by a professional photographer using a digital SLR camera and 50mm equivalent lens. A tripod (usually 1.6m high) is used to take overlapping (50%) landscape format photographs which are joined together using Adobe Photoshop software to create a single panoramic image for each viewpoint. These are then saved at a fixed height and resolution to enable correct sizing when reproduced in the final images. The photographer also notes the GPS location of the viewpoint and takes bearings to visible landmarks whilst at the viewpoint.

2) Creation of a ground model and 3D Mesh to illustrate that model - This is created using OS landform panorama point data and KEY Terrafirma ground modelling software.

3) The addition of the turbine wireframes to the 3D model using AutoCAD- The turbines are correctly proportioned to match the nacelle height and blade lengths proposed for the development. They are also modelled to closely resemble the turbines proposed. The turbines are then inserted into the 3D model at the proposed locations, facing into the prevailing wind direction.

4) Wireframe generation – The viewpoints are added within the 3D AutoCAD model with each observer point being inserted at 2m above the modelled ground plane. The location of the landmarks identified by the photographer may also be included in the model. The view from the viewpoint is then generated using the AutoCAD camera function, creating a number of single frame images, which also include bearing markers. For cumulative wireframes, each wind farm will be shown in a different colour. As with the photographs, these single frame images are joined together using Adobe Photoshop software to create a single panoramic image for each viewpoint. These are then saved at a fixed height and resolution to ensure that they are the same size as the photographs.

5) Wireframe matching – The wireframes are matched to the photographs using a combination of the visible topography; bearings taken on site and the bearing markers; and the landmarks which have been included in the 3D model.

6) Reproduction – the wireframe images are presented on sheets which are 297mm high and the length needed to show the view. The photographs are shown at 140mm high (a viewing distance of 300mm) with the wireframes below. Data required by the SNH guidance and a location plan is also included on each sheet. Where very wide panoramas (more than 180 degrees) are required to show all of the schemes within a cumulative study, the view will be split across two sheets.

21 June 2012

Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Photomontages

Photomontages are produced in 4 key stages:

1) Wireframe preparation, up to stage 5 above.

2) 3D Studio Max is used to produce a rendered 3D view of the turbines from the viewpoint. The rendering uses a pale grey colour (similar to that used for many turbines) and lighting conditions according to the time of day for the viewpoint photograph. These images are then saved at a fixed height and resolution to ensure that they are the same size as the photographs.

3) The rendered turbines are then added to the photographs in the positions identified by the wireframe (using Adobe Photoshop to overlay the photograph with both the wireframe and rendered turbines to ensure accuracy). The images are then layered to ensure that the turbines appear in front of and behind the correct elements visible within the photograph.

4) Reproduction – the photomontage images are presented on sheets which are 297mm high and the length needed to show the view which is usually cropped to 90 degrees of the wireframe view, focussed on the wind farm location. The photographs are shown at 200mm high (a viewing distance of 435mm). Data required by the SNH guidance and a location plan is also included on each sheet. Where very wide panoramas (more than 135 degrees) are required to show all of the schemes within a cumulative study, the view will be split across two or more sheets.

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Appendix C: Height Corrections for Earth Curvature and Refraction

The following table is taken from Scottish Natural Heritage's 'Visual Representation of Windfarms: Good Practice Guidance' (March 2006).

Table 4: Height corrections for earth curvature and refraction	
Distance	**Vertical correction for earth curvature and atmospheric refraction**
5km	1.7m
10km	6.7m
15km	15.0m
20km	26.7m
25km	41.7m
30km	60.1m
35km	81.8m
40km	106.8m
45km	135.2m
50km	166.9m
55km	201.9m
60km	240.3m

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Appendix D: EOWDC Zoning Scenarios

Following a comprehensive review of consultation responses, and as requested by Marine Scotland, SNH and Aberdeenshire Council we have given substantial consideration to landscape and visual design principles in addition to the work carried out in earlier phases. We have translated and refined these principles further into 3 Zoning Scenarios. Specifically, SNH's list of 'proposed conditions' included a request for a design statement to form any condition of grant of consent, and consequently we have undertaken a 'look ahead' review of all potential turbines under consideration to understand the implications of SNH's proposed condition of consent.

In defining these principles we have attempted to maintain a good visual balance and cohesiveness of views of the wind farm from the closest receptors. It should be noted that the final scheme design is constrained by the following key factors:

- Wind resource and spacing constraints within and between turbine rows. These constraints are particularly important for a demonstration site due to the need for 'clean' wind to demonstrate generation capacities.
- A preference to site the same type of turbine on the same cable 'string' due to electrical grid connection constraints.
- Maximum of 4 export cables from the wind farm.
- Practicalities associated with different types of installation vessel and installation methods for different foundations.
- Practicalities associated with crane lifting capacities for turbine towers and rotors which impact on vessel types and availabilities.

The Zoning Scenarios aim to meet the following objectives:

- Objective 1: The closest shoreward array (Turbines 1-3) should be relatively consistent in tip height to maintain design integrity in views from the immediate coastline
- Objective 2: The closest shoreward array (Turbines 1-3) should be populated with the smallest tip heights and rotor diameter. The variation in turbine heights will aim to work with perspective, rather than against, with the tallest turbines located further out to sea and a gradation to the lowest turbines located closest to the coastline.
- Objective 3; The largest turbines should be placed on locations 7, 8, 9, 10 or 11
- Objective 4: Turbines 3, 6, 9. and 11 should increase in size from shoreward to seaward with the smallest being at turbine no 3, and largest at location 11.
- Objective 5: Minimum heights are as important as maximum heights when considering design principles

In defining these objectives we have taken account of recognised aesthetic design principles. These include a commitment to having a clear and legible arrangement that works with the gentle sweep and alignment of the coastline. The detailed design considerations will also be mindful of a range of broader aesthetic considerations such as scale, proportion, visual balance and harmony, the effects of perspective and the perception of distance, visual framing, changing visual context and visual contrasts.

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Many of these considerations are either directly mentioned or implied within SNH's 2009 publication *'Siting and Designing windfarms in the landscape'*. Whilst this design document is focused upon onshore development it does include a brief section on the coast (para 4.50 – 4.54) and some of the design principles contained within this document can, and will be, usefully applied to the detailed design stage for the EOWDC. None of these generally subtle design refinements outweigh though the principal source of effects which essentially arise from the number and size of the turbines as already set out within the ES.

In assessing an adjustment to the turbine parameters, we have strived to maintain a balance of adjustment relative to the original scheme and the identified classification of environmental visual effects. That is to say that we have identified design principles which would result in no material increase in environmental effects over and above those already outlined in the August 2011 Environmental Statement submission.

We have translated the objectives/principles into zoning of turbine dimensions by row location, and can confirm that none of the larger turbines would be located on the shoreward array of turbines (locations1-6). The largest turbines would be located in locations 7, 8, 9,10 or 11 (known as Row C in Scenario 3). The smallest turbines would be located on turbines 1, 2, 3 and potentially turbine 6 (Row A). The mid row B would contain turbines between the smallest and largest turbines.

As we cannot prejudge the outcome of commercial negotiations and our assessment of innovative content (the latter being a requirement of the EU grant) at this stage we are unable to confirm the relative proportion of larger/mid range/smallest turbines as to do so would restrict commercial negotiations. Consequently we have assessed the likely maximum versus minimum number of the larger turbines which could be present in the final scheme proposal. Whilst we cannot confirm that larger turbines will definitively be present on the scheme, we have to allow for all size ranges to be present, without limiting those size ranges to one supplier.

It should be noted that from an engineering perspective, hub heights are the most uncertain relative to the site metocean characteristics (and impact on transition piece dimensions and thus tower heights) as well as wind resource. Whilst we have relative certainty on potential rotor diameter size ranges available, there is less certainty at this stage on tip heights and hub heights.

Taking all considerations into account, we believe that the following design proposals meet the Marine Scotland request for 'zoning' of turbines, and provide the project with some flexibility in regard to supplier selection and engineering considerations.

Table 5: Zoning Scenarios

Parameter	Tip height range	Maximum Hub ht (provisional)	Rotor diameter range
Row A	158 -180.5m	90 - 110m	128 - 135m
Row B	181 -190.5m	90 - 115m	150 - 165m
Row C	191 -198.5 m	90 - 120m	165 - 172m

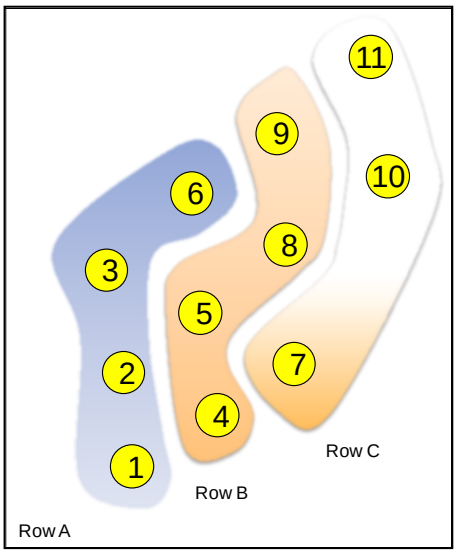
21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

The zoning is represented diagrammatically below. These scenarios are not definitive but we believe represent a Rochdale envelope in terms of landscape and visual effects, which includes the maximum and minimum likely scenarios with respect to the balance of the larger/mid range and smaller turbines. These scenarios are consistent with the adjusted proposed worst-case scenario examined in the ZTVs and wireframes in this report.

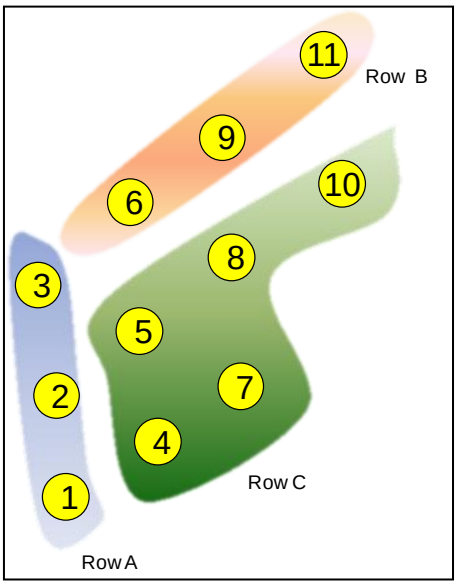
21 June 2012

Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Zoning scenario 1:



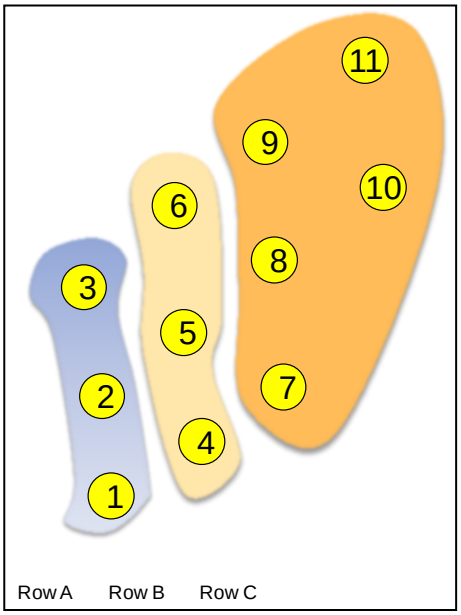
Zoning scenario 2:



21 June 2012

Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Zoning scenario 3:



Appraisal of the Zoning Scenarios

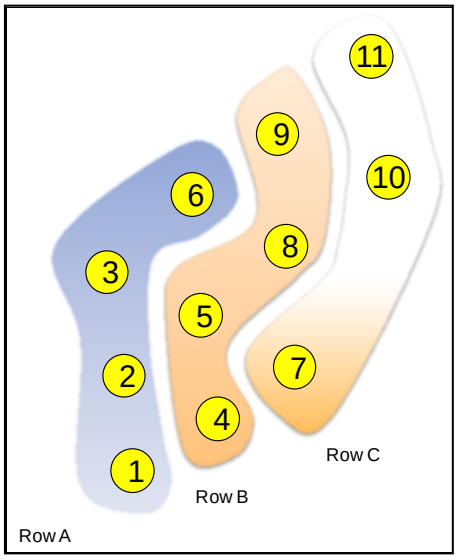
Photomontages have been produced illustrating the above Zoning Scenarios. The following table contains the turbine hub and tip heights used in these visualisations (Figure 105).

Table 6: Zoning Scenarios – Assumed Tip and Hub Heights for the Visualisations

Parameter	Tip height	Hub height	Rotor diameter
Row A	158m	90m	136m
Row B	185.25m	102.5m	165.5m
Row C	198.5m	120m	157m

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Zoning Scenario 1



Viewpoint 1: Balmedie Beach

This viewpoint is located to the north-west of the proposal and 3.5km from the nearest turbine. Differences between rows A (158m blade tip), B (185.25m blade tip) and C (198.5m blade tip) are barely perceptible as the effect of perspective in the view reduces the visible difference between the rows.

Viewpoint 2: A90 (Harehill turn-off)

This viewpoint is located to the west/south-west of the proposal and 4.4km from the nearest turbine. The lowest turbines occupy the positions nearest to the viewpoint (row A at 158m to blade tip). There is no perceptible step up in hub height or blade tip height from row A to row B (despite the 27.25m blade tip increase). The increased distance from the viewer to row B appears to offset the increased turbine height. There is, however, a perceptible step from row B to C (13.25m increase in blade tip height), which relates primarily to the hub height (17.5m increase) rather than blade tip height. Despite these differences between rows B and C being perceptible, the layout of the array remains regular and legible. This difference does not have an adverse visual effect on the legibility of the design.

Viewpoint 23: Murcar 8th Tee

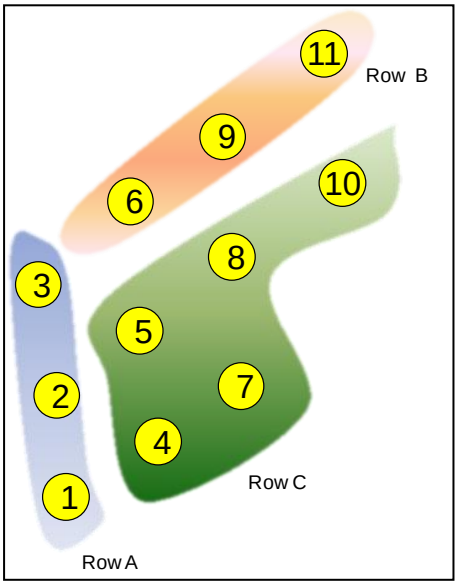
The Murcar viewpoint is located to the west/south-west of the array and is 3.2km from the nearest turbine. The position of the viewpoint gives a clear view of the three columns of the array. Again, there is no perceptible difference between rows A and B. Despite the real 27.25m blade tip increase, the increased distance from the viewer to row B offsets the increased height. The 17.5m increase in hub height from row B to C is more noticeable, although there is no perceptible difference in blade tip height (despite the 13.25m increase).

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

This slight step up in hub height, although perceptible, does not materially affect the appearance of the array. From this viewpoint, the nearest appraised in this review, zoning scenario 1 represents a legible and regular design.

Viewpoint 28: Menie Estate back nine

This viewpoint is 5.2km to the north of the array. The turbines stand in four columns. The columns in the right and left-hand side of the view contain uniform turbine sizes. The central two columns contain a mixture of rows A and B or B and C. Within the second column from the right, there is no perceptible difference between the turbines from rows A and B. Within the second column from the left, however, the difference between turbines B and C is more noticeable. This relates to the hub height rather than the blade tip height. This pattern is reflected when comparing turbines 9 and 11. There is a noticeable step up in the hub height between these turbines, while there is no appreciable difference between turbines 6 and 9. Of the viewpoints assessed for this zoning scenario, it is this viewpoint which reveals the largest perceptible difference between the different rows. The effect of this difference on the legibility of the design of the array is nevertheless very slight.



Zoning Scenario 2

Viewpoint 1: Balmedie Beach

This viewpoint is located to the north-west of the proposal and 3.5km from the nearest turbine. In the right-hand side of the view, the turbines appear more closely and regularly spaced. To the left hand side of the view, the distances between the turbines increase and appear less regular. Differences between the turbine heights are more perceptible in the left-hand side of the view. Here, turbines from rows B and C are seen alternately, which emphasizes the difference in hub heights very slightly. The difference in blade tip heights is

less perceptible. Despite these subtle differences between rows, the array still has a cohesive appearance.

Viewpoint 2: A90 (Harehill turn-off)

This viewpoint is located to the west/south-west of the proposal and 4.4km from the nearest turbine. Row A occupies the positions nearest to the viewpoint. Row B stands behind the left-hand turbine of row A. There is no perceptible difference between rows A and B. The turbines from row C stand behind the central and right-hand turbines from row A. This difference is slightly more marked. The increase in hub height from row A to C is 30m and this increase is perceptible. Nevertheless, the differences between rows A and C do not mean that the layout of the array is dischordant from this viewpoint.

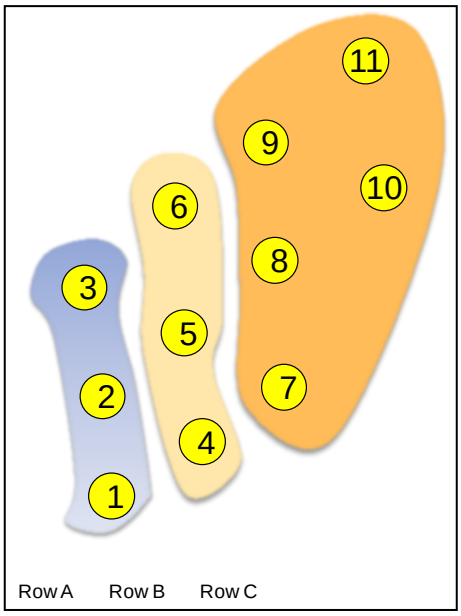
Viewpoint 23: Murcar 8th Tee

The Murcar viewpoint is located to the west/south-west of the array and is 3.2km from the nearest turbine. The position of the viewpoint gives a clear view of the three columns of the array. As with viewpoint 2, for zoning scenario 2, there is no appreciable difference between rows A and B, as illustrated by the left-hand column of the photomontage. The difference between rows A and C (the central and right-hand columns in view) is more perceptible. This is perhaps particularly the case with the right-hand column in view where the 30m increase in hub height (and, to a lesser extent, the 39.5m increase in blade tip height) is noticeable. Nevertheless, from this viewpoint, which is the nearest considered in this review of zoning scenarios, the array maintains a regular and legible layout.

Viewpoint 28: Menie Estate back nine

This viewpoint is 5.2km to the north of the array. The turbines stand in four columns. The right-hand column contains all of the turbines from row A. The other columns are comprised of turbines from row B in the nearest position to the viewer and turbines from row C in more distant positions. There is a marginally perceptible step-up from row A to the turbines of row B or C. There is also a smaller step-up from row B to row C in the left two columns in view. These differences are subtle and do not have an adverse effect on the regular appearance of the array.

21 June 2012
Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre



Zoning Scenario 3

Viewpoint 1: Balmedie Beach

This viewpoint is located to the north-west of the proposal and 3.5km from the nearest turbine. The left-hand side of the view is comprised of turbines from row C (198.5m blade tip). The right-hand side of the view is comprised of rows A (158m blade tip) and B (185.25m blade tip). The column nearest to the viewer contains turbines 11, 9, 6 and 3 (left to right). The decrease in turbine height from 11 and 9 to 3 is only just perceptible and could be interpreted as the effect of perspective.

Viewpoint 2: A90 (Harehill turn-off)

This viewpoint is located to the west/south-west of the proposal and 4.4km from the nearest turbine. The lowest turbines occupy the positions nearest to the viewpoint (row A at 158m to blade tip). There is no perceptible increase in turbine blade tip or hub height from rows A to B. The increase from row B to C is slightly more marked, particularly in the right-hand column of the array. The increase between B and C seems to be more noticeable in relation to the increase in hub height (30m) than the increase in blade tip height (39.5m).

Viewpoint 23: Murcar 8th Tee

The Murcar viewpoint is located to the west/south-west of the array and is 3.2km from the nearest turbine. The lowest turbines occupy the positions nearest to the viewpoint. The more distant turbines are higher. The effect of placing taller turbines at the back of the array is to flatten perspective slightly. The increase in hub height from row A to B is not noticeable. The increase from row B to C is more marked but subtle and is manifested more in a flattening of perspective (i.e. turbines don't decrease in height with distance as might be expected) than as a defined step. This viewpoint is the nearest considered in this review and the array maintains a legible layout with this zoning scenario.

21 June 2012

Aberdeen Offshore Wind Farm, also known as the European Offshore Wind Deployment Centre

Viewpoint 28: Menie Estate back nine

This viewpoint is 5.2km to the north of the array. The turbines stand in four columns, which from this viewpoint are equivalent to the zoning rows (i.e. each column only contains turbines of one size). The two right-hand rows are noticeably slightly lower than the two left-hand rows. This has the effect of making rows A and B appear slightly more distant than they are when compared to row C. This zoning scenario presents the most regular and legible of the three scenarios reviewed at this viewpoint.

Conclusion

The appraisal has determined the following patterns:

- Overall differences between rows A, B and C are subtle for all three zoning scenarios.
- Changes are most marked where A and C are directly next to each other. Where this happens, the difference in hub height is more noticeable than the difference in blade tip height. Zoning scenario 2 is disadvantageous in this respect. This disadvantage is, however, subtle and should not preclude the use of zoning scenario 2 compared to scenarios 1 or 3.
- In visual design terms, the mixing of rows and columns (i.e. zoning scenarios 1 and 2) would create more opportunities for the increases in hub or blade tip height between rows to be noticed. Zoning scenario 3 is advantageous in this respect. Despite this, even when the rows and columns are mixed (i.e. zoning scenarios 1 and 2) changes are not marked and would easily go unnoticed.
- The perceptible differences between rows in any of the three zoning scenarios reviewed are subtle. Adhering to any one of the zoning scenarios would not represent a material difference in visual effects when compared to the other zoning scenarios.
- No differences between zoning scenarios identified in this review would have an adverse visual effect on the layout. Differences are subtle and all three zoning scenarios would create an array which is legible, cohesive and feasible in visual design terms.