Visual Assessment of Windfarms: Best Practice

Report No. F01AA303A

For further information on this report please contact:

Nigel Buchan
Scottish Natural Heritage
2 Anderson Place, Edinburgh EH6 5NP
NIGEL.BUCHAN@snh.gov.uk

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COMMISSIONED REPORT

Summary

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BACKGROUND

The development process for many windfarms requires formal environmental impact assessment (EIA) and the incorporation of the results into an environmental statement (ES). SNH's experience is that there can be a great deal of variation in the way that visual impact assessment (VIA) is dealt with in EIA. This project involved: a review of relevant guidance, research and development work on visibility, visual impact and significance; an investigation of the visibility of eight existing Scottish windfarms; a comparison between as-built visibility and estimates of visibility in the ESs; evaluation of Zone of Visual Influence (ZVI) and other assessment tools; and generation of Best Practice Guidelines for VIA of windfarms.

MAIN FINDINGS

- Many guidelines on windfarm development appear to be based on first generation windfarms and need to be revised for second and third generation turbines.
- There is some research and a wide and diverse range of guidance and opinion on the detailed issues of ZVI, distance, visibility and significance for windfarms, explained by the complexity and the subjectivity of the issues, the desire of one set of windfarm interests to minimise the political, professional and public perception of the visual (and landscape) effects of windfarms and an opposing desire by another set of interests to maximise these perceptions.
- The magnitude or size of windfarm elements, and the distance between them and the viewer, are basic physical measures that affect visibility, but the key issue is human perception of visual effects, and that is not simply a function of size and distance.
- The influences on apparent magnitude are reviewed, including factors that tend to increase it and factors that tend to reduce it. A new conceptual model and schema for assessing visual effects is provided.
- Based on survey work at eight sites - Beinn An Tuirc, Beinn Ghlas, Deucheran Hill, Dun Law, Hagshaw Hill, Hare Hill, Novar and Windy Standard - an overall analysis is provided of the effects on visibility of the Size and Scale of the Development, Proportional Visibility, Lighting, Movement and Orientation, Distance, Colour and Contrast, Contrast, Skylining and Backclothing, Elevation of Windfarm and Human Receptor and Colour and Design.
- Zones of Visual Influence (ZVI) are never wholly accurate and other tools such as photomontage are never wholly realistic. Suggestions are made of ways to address these issues.

For further information on this project contact :
Nigel Buchan, Scottish Natural Heritage, 2 Anderson Place, Edinburgh EH6 5NP.
For further information on the SNH Research & Technical Support Programme contact ascg@snh.gov.uk

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1 INTRODUCTION

1.1 Concern for the landscape, visual and other environmental effects of tall, industrial or technological structures in the landscape is not new (e.g. Goulty, 1990). In the case of windfarms, however, there is universal acknowledgement that the potential landscape and visual effects are among the most important and to some extent the most intractable issues for obvious and well-rehearsed reasons (e.g. Coles & Taylor, 1993; Lindley, 1994).

1.2 Strategic approaches to the siting of windfarms are advocated through the use of tools such as Geographical Information Systems (GIS) (e.g. Sparkes & Kidner, 1996) and there are commercial software packages such as WindFarmer (Garrad Hassan, no date), WindPRO (EMD, no date) and WindFarm (ReSoft, no date) that combine GIS with procedures for calculating Zones of Visual Influence (ZVI) and producing photomontages. It is not clear if such software is in widespread use in the UK. Ultimately, however, the assessment of all but the smallest individual development project for a windfarm requires formal environmental impact assessment (EIA) and the incorporation of the results of that assessment into an environmental statement (ES).

1.3 Under the EIA Regulations, effects on landscape must be assessed. Established guidance (LI-IEA, 1995 and LI-IEMA, 2002) makes a distinction between landscape effects and visual effects, the latter being considered a specific subset of the former. *"Landscape effects derive from changes in the physical landscape which may give rise to changes in its character and how this is experienced. This may in turn affect the perceived value ascribed to the landscape. … Visual effects relate to the changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity"* (LI-IEMA, 2002). In this report the focus is mainly on the visual effects for the reasons discussed below.

1.4 Scottish Natural Heritage's (SNH) experience is that there can be a great deal of variation in the way that assessment of both visual impact and the significance of visual impact are dealt with in EIA documents, including the appropriate distance for Zone of Visual Influence (ZVI) surveys. The latter attracts a degree of contention amongst some developers and landscape professionals. There is therefore a need for some independent opinion on all these aspects.

1.5 The brief for the current study (Appendix 4) therefore required that it address the following aims:

- to identify any relevant work on visibility, visual impact and significance
- to investigate visibility of existing windfarms
- to compare as-built visibility with estimates of visibility in ESs
- to draw conclusions about appropriate distances for ZVI in different circumstances

1.6 A series of research questions has therefore been posed in order to address these aims:

- What research, policy, guidance and opinions exist on issues related to the assessment of the magnitude and significance of the visual effects of windfarms?
- Is this literature consistent, and if not, what are the sources of and details of any differences?
- What are the key factors that affect visual effects and the assessment of those effects?
- What is the visibility of existing windfarms, and is this real-life visibility as predicted by the literature and as predicted in EIA? If not, why not?

- Based on the answers to those questions, can recommendations be made for best practice with regard to visual impact assessment within EIA?

1.7 This report is divided into six main sections as follows:

- The methodology and approach used for the study are described in section 2.
- Background research is described in section 3.
- Survey and analysis of eight case-study sites are described and analysed in section 4.
- An analysis of the overall survey is described in section 5.
- Discussion of the overall findings of the study appears in section 6.
- Recommendations for Best Practice Guidelines are summarised in section 7.

Table 1: Case Study Windfarms

Windfarm *	Local Planning Authority	SNH Office	OS Sheet/ Grid Reference	Location
(1) Beinn an Tuirc, Kintyre (2001)	Argyll & Bute Council	Argyll & Stirling	68/NR 753361	Centre/East of Kintyre
(2) Beinn Ghlas, Oban (1999)	Argyll & Bute Council	Argyll & Stirling	49/NM 980257	5km south of Taynuilt, 10 km east of Oban
(3) Deucheran Hill, Kintyre (2001)	Argyll & Bute Council	Argyll & Stirling	62/NR 760440	Centre/East of Kintyre
(4) Dun Law (Soutra Hill), Borders (2000)	Scottish Borders Council	Forth & Borders	66/NT 465575	South of Soutra and north west of Lauder
(5) Hagshaw Hill, Douglas (1995)	South Lanarkshire Council	Strathclyde & Ayrshire	71/NS 790307	4km west of Douglas
(6) Hare Hill, Ayrshire (2000)	East Ayrshire Council	Strathclyde & Ayrshire	71/NS 655098	Near New Cumnock
(7) Novar, Dingwall (1997)	The Highland Council	East Highland	20/21/NH 555715	6km north west of Evanton
(8) Windy Standard, Galloway (1996)	Dumfries & Galloway Council	Dumfries & Galloway	77/NS 615015	9km north east of Carsphairn and east of Loch Doon

* The date given is when the windfarm was built and/or commissioned.

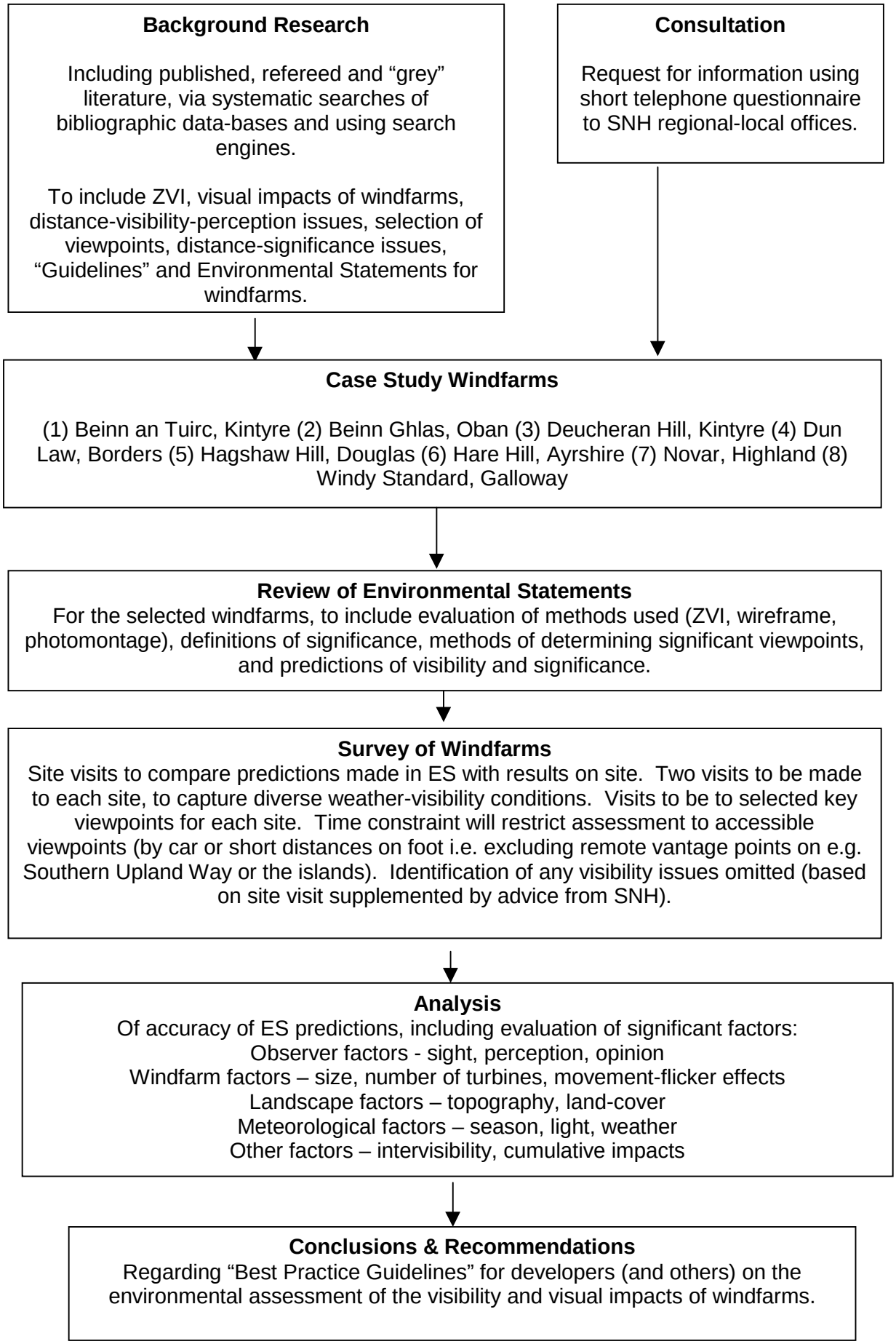
2 METHODOLOGY

2.1.1 The project has followed the requirements and guidance of the brief in all key respects and proceeded as follows (Figure 1).

2.2 Background Research

2.2.1 Both published and grey literature[1] on relevant topics was reviewed. The World Wide Web was searched for access to a wide range of unpublished guidance, opinion and comment. Although the primary focus was on Visual Impact Assessment (VIA), there are many other sources concerning renewable energy or wind energy that refer indirectly to technical detail concerning VIA and these have been included wherever relevant.

Figure 1: Project Methodology



2.3 Case Study Sites

2.3.1 The character of the landscape, weather and other environmental effects are important and so the study was required to focus mainly on Scotland. Selection of case study sites was iterative. A first short list was compiled from those windfarms built and operating in Scotland (Appendix to Brief), concentrating on the larger windfarms (in terms of numbers of turbines). Next, the age of the windfarms, the landscape character and the availability of Environmental Statements were examined. A final selection of eight sites was chosen, all in Scotland (Table 1). The ES for each windfarm was obtained through SNH[2] (Appendix 1).

2.4 Case Study Survey and Analysis

2.4.1 An identical survey and analytical procedure has been used at each case study site. First, the Environmental Statement and related or supplementary documents (Appendix 1) were analysed to extract basic information (if present) on the ZVI, viewpoints, visualisations (including photomontages) and terms used to define visual significance. The main focus was on the key elements of the Visual Impact Assessment (VIA) and not on the broader Landscape (including landscape character) Assessment.

2.4.2 Next, a contact within SNH (including some advisors who have since left the organisation) was telephoned to ask about the process of environmental assessment for each case study and to discover information not available from the ES, such as whether a public inquiry was held. Although we began asking for detailed recollection from each contact (for example: Did SNH advise on the precise radius of the ZVI? Were all viewpoints identified by SNH included or were any excluded?), this proved an unrealistic expectation. Contacts quite reasonably could not recall case details from several years previous and were only able to give general comments and recollections. Whilst case details could be extracted from archived SNH files, we did not pursue this due to time constraints. The contacts were able to comment on changes made between the windfarm *"as assessed"* and *"as built"*, but again could not provide site-specific details on turbine re-locations and similar adjustments. In some cases there are significant differences between *"as assessed"* and *"as built"* that have affected our ability to test the accuracy or otherwise of the ES.

2.4.3 Finally, site visits were made during which as many viewpoints as practicable were visited and a comparison made between the appearance of the windfarm on site and the verbal description and photomontage (if any) presented in the ES. Records of the weather, time of day, light levels, visibility etc were made. The site survey protocol was devised and field tested at Dun Law windfarm by all three surveyors, and then revised and refined before being applied at the remaining seven sites. Each site was visited by one of the professional landscape surveyors accompanied by an assistant. The numbers of visits to each viewpoint are noted in Section 4.

2.5 Timetable

2.5.1 Site visits to the case study sites were made on the dates shown in Table 2. Two visits were made to each windfarm, except at Novar where one visit was made.

2.6 Limitations

2.6.1 The study was constrained by time, and by time of year, and these factors must be borne in mind in the interpretation of the results. The whole project was executed over a short period of approximately 8 weeks. Field work was completed during January and February 2002 and so was not able to compare visibility or visual effects over four seasons

and during a wide range of light and weather conditions. Although most sites were seen in contrasting weather conditions, it was not possible to ensure that every viewpoint at every case study site was observed in contrasting conditions (for example, overcast and clear skies).

Table 2: Fieldwork Timetable

DATE	DAY	KES	SPJ	JFB
30 Jan	Wednesday	Dun Law	Dun Law	Dun Law
3 Feb	Sunday	Beinn Ghlas		
4 Feb	Monday	Deucheran Hill Beinn An Tuirc		
6 Feb	Wednesday		Hare Hill Hagshaw Hill	
7 Feb	Thursday		Windy Standard	
9 Feb	Saturday			Novar
13 Feb	Wednesday		Windy Standard	
14 Feb	Thursday		Hare Hill Hagshaw Hill	Dun Law
17 Feb	Sunday	Deucheran Hill Beinn An Tuirc		
18 Feb	Monday	Beinn Ghlas		

2.6.2 It was not practical to visit every viewpoint in every ES; inaccessible or remote viewpoints (such as on islands, at the tops of mountains or hills or in remote walking terrain) were in general omitted from the study. Particular case study site limitations are mentioned in section 4 and may affect the comprehensiveness of the diagnosis for individual windfarms. Adverse weather conditions were a significant constraint in Kintyre. However, overall the study team assessed 70 viewpoints and made 113 individual viewpoint assessments; the more generalised diagnoses and conclusions from these pooled results are therefore more robust, limited only by the seasonal constraints.

3 BACKGROUND RESEARCH

3.1 Guidelines on Windfarm Development

3.1.1 We have reviewed a range of guidelines on windfarm development. There is universal acknowledgement that visual effects are important, that they depend on distance, size, visibility and other factors, and on both landscape and visual receptors. Whilst there is some evidence to suggest a degree of professional landscape consensus on VIA and significance, there is extremely diverse and subjective opinion among other stakeholder groups. Some guidelines quote specific distances for recommended ZVI or for the relative impacts (and by implication significance) of visual effects in relation to distance. Some guidance appears to be re-cycling guidance from other sources and justification for any specific distances quoted in these documents is rare. In most cases any distance-effect guidance is not related directly to or varied with the size or height of turbine towers, but appears to be based on first-generation windfarms with tower heights (to hub/nacelle) of 25-30 m approximately (40 – 55 m overall).

3.1.2 The latest version of National Planning Policy Guidance 6: Renewable Energy Development (Scottish Executive, 2001) sets out broad policy but contains no detailed technical advice concerning the assessment of landscape or visual effects (but see below). Similarly, Department of the Environment (1993)(Planning Policy Guidance 23) is generic but non-specific, although it does recommend light grey/white colours as most suitable for towers, nacelles and blades in Northern Europe. Department of the Environment (1995) quotes as an example that the zone of visual influence for a particular windfarm development in Britain has been calculated to be approximately 10 miles (16 km), but without any detail. Scottish Executive (2002)(Planning Advice Note 45) offers the following general guide (Table 3) to the effect that distance has on the perception of a windfarm development in an open landscape (without relating this to tower height, but having earlier referred to turbines of tower height >70m and rotor diameters of >80m):

Table 3: General Perception of a Wind Farm in an Open Landscape

	Perception
Up to 2 kms	Likely to be a prominent feature
2-5 kms	Relatively prominent
5-15 kms	Only prominent in clear visibility – seen as part of the wider landscape
15-30 kms	Only seen in very clear visibility – a minor element in the landscape

Source: PAN 45 (revised 2002): Renewable Energy Technologies.

3.1.3 A similar table appeared in the Draft NPPG6 Consultation Document (2000), and the comments made on that Draft are of interest. For example, the British Wind Energy Association (BWEA) asked for the term *"impact"* to be replaced by *"effect";* argued that the table of perceptions of impact was prejudicial and asked for its removal; and offered that *"significant visual effects of wind turbines are only experienced within 5 km; beyond 15 km wind turbines can generally only be seen in very clear visibility and even when visible are likely to be a minor element in the landscape"* (Powergen Renewables made essentially the same argument).

3.1.4 Other consultees referred to the fact that turbines are increasing in size; that the Novar windfarm is clearly visible at 30 km; preferred a recommendation of semi-matt to matt surfacing for towers; and raised the issue of cumulative effects. Several consultees referred to the Sinclair-Thomas Matrix (see section 3.7 and Table 4) without identifying its source, pedigree or publication. As a result of these consultations, almost all reference to particulars was removed from the final version of NPPG6. Some details do however reappear in PAN45, but the word *"dominant"* which appeared in the table in NPPG6 Consultation Draft is changed to *"prominent"* in the table in PAN45 (above).

3.1.5 Scottish Natural Heritage (2001) is the most detailed of any statutory agency guidance available or published. Whilst it contains detailed information on issues of siting and design, and the processes of site planning, it also contains a specific recommendation that a ZVI should usually extend to at least 25 km. The Countryside Council for Wales (1999) specifies a ZVI of at least 10 km from the site (for wind turbine proposals) and up to 20 km on the fringes of National Parks and Areas of Outstanding Natural Beauty (AoNB) and in areas likely to be seen from such distances. Countryside Commission (1991) suggests an outer limit of 10 – 15 km for ZVI. There is no up-to-date Countryside Agency guidance in existence but we understand it is in preparation.

3.1.6 It is likely that much local government guidance exists, but a comprehensive review would have required letters or questionnaires to each organisation; a small selection available on the www is noted here. Cornwall County Council (no date) is general development guidance and is based on Landscape Institute - Institute of Environmental Assessment (LI-IEA)(1995). It combines the concepts of impact magnitude and receptor sensitivity (both *"landscape"* and *"viewer"* for landscape and visual respectively) and then offers two matrix tables for evaluating landscape and visual significance.

3.1.7 Specifically for windfarms, Moray Council (2001) recommends the use in EIA of a ZVI map and viewpoint analysis based on wireline diagrams and photomontage without specifying any distance or technical detail for these. Cornwall County Council (1996) (Appendix A: Visual Impact Assessment of Delabole Wind Farm) describes how this project (which began operation in December 1991, comprising 10 No 400 kW turbines, each 40.4 m high inclusive), was assessed using a ZVI of 7.5 km and based on the nacelle height only (32 m).

3.1.8 South Norfolk District Council (2000) (Supplementary Planning Guidance) is more explicit, and contains the following specific guidance (extract)(although the South Norfolk topography and landscape character are very different to much of Scotland): *"The following seven general principles … should be met if the visual impact of any proposal is to be minimised: … ii) Where a proposal lies within 5km of the Broads Authority Executive Area boundary, it would only be acceptable if it was demonstrably capable of locating without visual intrusion to the Broads; … vi) Proposals should be spaced at not less than 5km intervals from each other in order to prevent substantial adverse cumulative impacts which might exceed the capacity of the landscape to accommodate wind developments; …".* The SPG also recommends that any visual assessment is made on a 20km radius of the proposed large turbines in its zone of visual influence.

3.1.9 Cumbria County Council (1999) is the most detailed local government guidance we have identified. It is based on turbine heights to a maximum of 60 m and recommends a basic ZVI of 20 km and the visualisation of key viewpoints within 10 km. It also addresses cumulative effects, recommending such assessment for windfarms within 20 km of each other, and contains a range of further detailed guidance on both landscape and visual impact assessment.

3.1.10 The British Wind Energy Association (1994) suggests that the ZVI should be defined within a radius agreed with the local planning authority but contains no specifics concerning ZVI or other visual assessment tools.

3.1.11 The Campaign for the Protection of Rural Wales (CPRW)(1999) draws attention to the progressive increase in installed capacity and size of individual towers between 1991 to 1998 of from around 300 kW (41.5 m) to 600 kW (60 m) and notes that future increases will come from higher capacity machines of 1.5 MW (c 95 m) or more and that due to their extended threshold of visual intrusion, their impact would not be correspondingly diminished

and would be considerably intensified at closer range. CPRW has argued that 95 m turbines could be visually intrusive at a 12 km radius and readily discernible at 22 km (Sinclair, 2001, discussed further at sections 3.7 and 6.2) so that CPRW recommend a *"radius of visual impact analysis of 30 km compared with 20 km for the current typical 55 m turbines".* They note the potential siting of turbines offshore and call for this to be at non-intrusive distances from the coast (more than 10 km and preferably 15 km). CPRW state that 60 m turbines can be visually significant within a 15 km radius and forecast 20 km for 95 m turbines. Thomas (1996) argues for 20 km or more (ZVI) for large-scale developments and the landscape terrain of the Mid Wales upland plateaux.

3.1.12 Although the project has not been able to review international guidance, we did note that guidance from New Zealand (EECA, 1995) explicitly omits detailed recommendations for assessing visual effects and argues that *"each development will need to be considered on its merits in terms of site and locality-specific considerations such as distance, back-drop, landscape scale and number of potential viewers".*

3.2 Research and Development Studies

3.2.1 Reference to ZVI and visual significance is contained in several national, supra-national and international research and development reports, some focused on wind power and some considering renewables in general.

3.2.2 AEA Technology plc (AEAT)(1998) is part of a study attempting to produce an overall valuation (or cost-benefit analysis) for the whole wind fuel cycle, including monetary estimates of the aggregate visual amenity damage of windfarms. It offers an *"Impact Pathway for Visual Intrusion"* and refers to the *"visual burden"* and the *"objective impact*" of that burden, and then contrasts this with the *"perceived impact"* which is influenced by attitudes and the existing land form and scenery. It refers to ZVI as zones of visual intrusion and notes that *"It can be concluded that there is unlikely to be any significant visual impact at a range of greater than 6 km",* although this conclusion is not justified.

3.2.3 The International Energy Agency (IEA)(1998) uses similar language to AEAT (1998), emphasising the difference between the visual burden (comprised of the height, shape, form, colour and number of turbines themselves) and human responses to it. It goes on to state that beyond 20 km the turbines will not be visible to the human eye (apparently based on towers of *"40 m height with the blades adding another 20 m*") and that in practice there are very small or negligible effects on visual amenity beyond 12 km*. "Between 6-12 km, the towers are indistinct and the rotor movement will be visible only in good conditions. Therefore, the visual amenity effects are generally concentrated within 6 km of the wind farm"* (the latter conclusions appear to be based on Eyre, 1995).

3.2.4 The European Commission (EC)(1997) (also based extensively on Eyre, 1995) states that *"a 1.5 MW turbine looks little different from a 500 kW machine, so the continuing trend towards larger wind turbines may, paradoxically, reduce the subjective visual effect of a given installed capacity".* Although not explained, this may be a reference to the suggestion that any enlargement is very difficult to perceive if there are few comparable scale indicators in the landscape, although this ignores the effect of height on the visibility distance and also ignores the effects of magnitude near to a tower. It notes that *"two bladed rotors appear to tilt with respect to the horizon whereas three bladed rotors appear to revolve and are therefore more calm and pleasant to view"* but it makes no reference to distance effects.

3.2.5 Soerensen & Hansen (2001) focus on offshore windfarms and note that it is assumed that the visual impact to viewers at sea level is negligible when the farms are located more than 8 km from shore. With distances larger than 45 km, the visibility will be almost zero due

to the curvature of the earth's surface. These distances will be greater where there are elevated viewpoints but may also be severely reduced depending on the atmospheric clarity. They quote a study in Germany where visual impact would not be regarded as a problem at all if the farms were placed 15 km from shore. CADDET (2001) reports briefly on studies for two offshore windfarms in Denmark. The Horns Rev windfarm (eighty 2 MW turbines in a grid pattern 14-20 km offshore) *"will be visible from shore on a very clear day"* but *"the dominance of the windfarm in the landscape as viewed from the shore will be so modest that the impact is likely to be minimal".*

3.2.6 Quantitative research on ZVI, distance and visual impacts appears less common. Hull & Bishop (1988) examined the effects of electricity pylons on the landscape and in particular the relationship between distance and scenic impact. Based on the use of photographs and a rating of *"scenic beauty"* on a ten-point scale, they found that the visual impact decreases rapidly as distance increases. Most of the impact occurred in the 100 m to 1 km range, and the impact at 500 m was about 25% of the maximum, whilst at 1km it was 10%. The tower's scenic impact was also influenced by the landscape surrounding the tower. It appeared that towers had less impact in more complex scenes, especially at larger distances, presumably because the tower becomes less of a focal point and the observer's attention is diverted by the complexity of the scene.

3.2.7 Recent research by Bishop (in press) used animated computer simulations in paired comparisons of scenes, with and without a wind turbine, to test the ability of respondents (students) to first detect, then recognize, and then judge the impact of the turbine in relation to distance, contrast and atmospheric conditions (drawing on detailed equations from Shang & Bishop, 2000). The test turbine was 63 m in height (to rotor tip). His key conclusions (drawn from a Draft report by the Windfarm Steering Committee, Victoria, Australia, supplied by Nigel Buchan) are that:

- Recognition was only made by 5% of respondents at 30 km distance
- Recognition was only made by 10% of respondents at 20 km distance
- The most significant drop in recognition rates occurred at 8-12 km in clear air
- The most significant drop in recognition rates occurred at 7-9 km in light haze
- Visual impact drops rapidly at approximately 4 km and is <10% at 6 km in clear air
- Visual impact in light haze is not greatly different. A rapid decrease in visual impact begins at under 4 km and is <10% at 5 km
- Low contrast in light haze reduces the distance thresholds by 20%
- High contrast can dramatically increase the potential impact of white towers
- Ratings are highly sensitive to changing atmospheric conditions.

Given the size of the test turbine, these controlled and simulated findings are not dissimilar to the empirical results reported in Stevenson & Griffiths (1994) and Turnbull Jeffrey Partnership (1997)(Appendix 5), discussed below.

3.2.8 Research has been carried out, mainly in the USA and Denmark, into observer attitudes to the symbolism and meaning of wind energy (e.g. Thayer & Freeman, 1987; Wolsink, 1989, 1990), and into design issues such as scale, visibility, dominance, coherence, diversity, and the effects of site layouts (e.g. Bergsjo et al, 1982), but this research does not contain details that would inform the present study. For example, in some research smaller turbines appeared to have a lower effect than larger turbines, but this was a small preference compared to the effect of the number of units, so that people preferred fewer larger turbines. One potentially contradictory piece of research evidence is that on the one hand people find moving rotors more attractive than static ones, so that motion has been equated with lower perceived visual impact by some commentators, whilst elsewhere

there appears to be agreement that movement makes the turbines more conspicuous than they would otherwise be.

3.2.9 Atkins Planning (1986) carried out a scoping study for the Energy Technology Support Unit on the visual impact of large wind turbines (up to 50 m high), which contains a range of sound, general observations and conclusions, although the penetration of such commissioned reports into wider circulation and practice is less clear. For example, we found no reference to that report, or Stevenson & Griffiths (1994), discussed below, in any of the ESs examined for the current study (except for an indirect reference to Stevenson & Griffiths in the Dun Law ES).

3.2.10 Stevenson & Griffiths (1994) carried out a comprehensive post-development audit of eight windfarms in England and Wales, visiting each windfarm on up to four occasions throughout the year. Six viewpoints were analysed at each site at distances up to 20 km, although in practice topography and visibility restricted views from 10 km and prevented views beyond 16 km for all sites. Photographs used a medium format camera (image area 4.5 x 6 cm) and a 80 mm focal length lens *"to provide an image closest to that of the human eye"*. The case study sites included turbines ranging in maximum height from 40.0 to 61.5 (but six were within the range 40.0 – 43.5 m) and in a variety of landscape settings.

3.2.11 Drawing on previous literature, and their own judgements, they devised an impact-zoning schema as follows:

> *"i) Visually dominant – the turbines dominate the field of view and appear large scale. The character of the immediate area is substantially altered and the movement of the rotor blades is obvious.*
>
> *ii) Visually Intrusive – The turbines appear fairly large in scale, and an important element in the landscape. However, they do not necessarily dominate the field of view. Blade movements are clearly visible and can attract the eye.*
>
> *iii) Noticeable – The turbines are clearly visible but not intrusive. The windfarm is noticeable as an element in the landscape. Movement is visible in good visibility but the turbines appear small in the overall view. Some change to the landscape setting is likely.*
>
> *iv) Element within Distant Landscape – Turbines are indistinct and form minor insignificant elements within a broader landscape. Movement of blades is generally indiscernible. The apparent size of the turbines is very small".*

3.2.12 Their main conclusions are that

- *In most situations turbines dominated the view up to a distance of 2 km (zone (i)).*
- *Turbines appear visually instrusive at distances between 1 and 4.5 km in average to good visibility (zone (ii)).*
- *Turbines are noticeable, but not intrusive, at distances between 2 and 8 km, depending on atmospheric conditions and other factors (zone (iii)).*
- *Turbines can be seen as indistinct elements within the distant landscapes at distances of over 7 km (zone (iv)).*

3.2.13 They also include further analysis and discussion concerning the effects of atmospheric conditions and seasonal variations, before analysing a number of VIA techniques. For ZVI, they recommend 10 km as suitable in most conditions. For photomontages, they make a number of straightforward recommendations, but in particular

note that the size of the original photograph will affect the apparent size of the turbine image, stating that *"where photographs smaller than A3 are used, the turbines on the photomontage appear smaller than in reality"* and *"An A3 size print viewed from approximately 8 " [20 cm] gives an accurate rendition of scale".*

3.2.14 A recent study on ZVI, distance and visibility has been carried out at Hagshaw Hill windfarm for Scottish Power plc, as part of the preparation of the Beinn an Tuirc ES (Turnbull Jeffrey Partnership, 1997). Although we have not been able to examine the full report, we have reproduced a summary of it in Appendix 5 (from Scottish Power, 1997) because it covers similar issues to the present study.

3.2.15 It is evident that there is some research and a wide range of guidance and opinion on the detailed issues of ZVI, distance, visibility and significance for windfarms. Some of the differences identified might be explained by much of the early work having been based on first generation windfarms of a maximum height of from 40 to 55 m. Other differences can be attributed to both the complexity and the subjectivity of the issues, especially concerning visibility, perception and significance. A final influence is probably the desire of one group of windfarm interests to seek to minimise the political, professional and public perception of the potential visual (and landscape) effects of windfarms, and an opposing desire by another group of interests to maximise these perceptions. In practice, those differences must be resolved and decisions made.

3.3 Visual Effects and Design Issues

3.3.1 IEA (1998) notes that stroboscopic effects are minimised by keeping rotation rates below 50 rpm for three-bladed machines (75 rpm for two-bladed machines). The flicker effect (from the effect of sunlight streaming past the rotating turbine blades) has only a short potential duration each day and depends on a number of other criteria. In any event, effects should be minimal at distances greater than 300 m. It also states that *"Visual impacts are only normally important for residents and tourists up to a distance of about 10 km, with the main effects on amenity being concentrated within a few kilometres of the wind farm".*

3.3.2 The Danish Wind Industry Association (2000) offers some simple suggestions regarding design issues, similar to but much less comprehensive than SNH (2001). SNH (no date) remarks that *"experiments in blade colour have shown that pale blue, brown and grey rather than white appear to be more recessive, whilst a matt surface reduces the amount of glint"*, whilst Stanton (1996) argues that the colour used should be white rather than off-white or grey, arguing that this (white) represents a forthright design statement, rather than off-white or grey which may be seen as a form of deception. Stanton argues that white is associated with purity and neutrality, whilst grey appears technically primitive, linked with other industrial elements. Gipe (1995) reviews public opinion surveys and a range of design guidance, based on North American and European experience, to arrive at conclusions not dissimilar to the guidance contained in SNH (2001).

3.3.3 A recent study (European Wind Energy Association, 2000) has examined the colour issue afresh and has explored a wide range of colours, combinations and design approaches – including camouflage, blending and articulation – but the work was restricted to explorations using photomontage and we are not aware of any field testing of different colour combinations. *"The overall conclusion was that graduated colour schemes worked well in all situations, especially helping to "root" the turbines in their setting. In terms of actual colours, "earthy" colour schemes - browns, greens and oranges – were found to tie the turbines to their surroundings more effectively than "airy" blues and greys. Schemes using a range of different grey shades on different turbines in a group, and an idea for "false shadows" – three or four shades of grey in vertical irregular stripes up the tower - were both*

considered visually confusing". It is not clear from this report whether the issue of visibility and perception in relation to distance was included in this study of colour.

3.4 Visibility and Perception

3.4.1 Viewed by the human eye 1.8 m from the ground across a *"flat"* surface such as the sea, the horizon will be of the order of 6 km distant, due to the curvature of the earth. Viewed at an elevation of 60 m, the horizon will be of the order of 32 km distant and from the top of a 1000 m mountain the horizon will be at a distance of approximately 113 km. A tall structure standing above the horizon would of course increase these distances significantly; for example, for an observer at 1.8 m who is viewing a man-made structure 50 m tall, the effective distance to the horizon is 34 km and for a 100 m structure the distance is 46 km (Miller & Morrice, no date).

3.4.2 However, actual human perception is affected by the acuity of the human eye. In good visibility (visibility is meteorologically defined as the greatest distance at which an object in daylight can be seen and recognised), a pole of 100 mm diameter will become difficult to see at 1 km and a pole of 200 mm diameter will be difficult to see at 2 km. In addition, mist, haze or other atmospheric conditions may significantly affect visibility (Hill et al, 2001). Assuming this relationship is linear, and assuming absolute clarity of view, this suggests that the outer limit of human visibility in clear conditions of a pole (e.g. a notionally cylindrical wind turbine tower) 5000 mm (5 m) in diameter (a representative figure for a 60+ m high tower) will be of the order of 50 km; and the absolute limit of visibility imposed by the limit of the horizon viewed across a flat plane is similar at approximately 46 km.

3.4.3 Although there is frequent reference in ESs to the effect of reduced visibility caused by atmospheric or weather effects, data is rarely used to quantify this effect (the Hare Hill ES is an exception among the case study sites, and Stevenson & Griffiths (1994) also use such data). Such data is available from the Meteorological Office.

3.4.4 Physical visibility is not, of course, the only issue. Human perception is equally important in considerations of if and how a windfarm will be seen. Whole branches of medicine, ophthalmology, psychology and many applied sciences are concerned with perception. Numerous text books provide illustrations of the complexity of perception, including many familiar optical illusions. These issues are critically important in areas such as the design of roads and signage, in the training of airline pilots, the analysis of accidents and the design of machinery. Whilst the thrust of much research is concerned with how people can be deceived or make perceptual misjudgements, there are several key points that we believe may be material to VIA for windfarms.

3.4.5 People perceive size, shape, depth and distance by using many cues, so that context is critically important. When people see partial or incomplete objects, they may mentally *"fill in"* the missing information, so that partial views of turbines may have less effect than imagined. Although people may be able to physically *"see"* an object, inattentional *"blindness"* caused by sensory overload, or a lack of contrast or conspicuousness, can mean they fail to *"perceive"* the object. In a contrary way, large size, movement, brightness and contrast, as well as new, unusual or unexpected features, can draw attention to an object. In all these effects, issues such as experience, familiarity and memory may have an important role to play. Therefore, perception depends on experience, the visual field, attention, background, contrast and expectation, and may be enhanced or suppressed.

3.4.6 Two important issues, depth perception and size constancy, deserve further discussion. At least six monocular cues (cues dependant on one eye only, compared to binocular cues that require both eyes) are recognized as being used in the perception of

depth and relative distance. These include (i) interposition (one object partially obscuring another appears nearer), (ii) the relative size of the retinal image (an object of known size is perceived to be further away if the image is smaller), (iii) the height of an object relative to other objects (an object at a lower level is perceived to be nearer), (iv) objects that appear clearly visible are judged to be nearer than others which are less clear, (v) linear perspective (converging lines in the landscape can create this effect), and (vi) movement cues (fast movement is judged nearer than slow movement by a stationary observer). We can therefore surmise that these phenomena will act to increase or decrease the apparent distance of a windfarm from the observer in the landscape.

3.4.7 Constancy is the phenomenon in which the properties of familiar or well-known objects appear to be constant and stable irrespective of the circumstances in which they are viewed. In size constancy, objects are perceived as the same size even when viewed from different distances. This is often illustrated using photographs containing people, but applies with any familiar object – the perception of the size of the people is quite different to their actual size on the photograph. This effect appears to be based on factors such as the relative size of other objects, textures and familiarity (the phenomena of shape, colour and brightness constancy are also well-recognised). We can therefore surmise that on viewing a windfarm in the landscape, a human observer could perceive the turbines to be the same size over a potentially long distance range as their familiarity increases, even if the image sizes (on either the retina or a photographic film) are very different.

3.4.8 The general conclusions to be drawn are that the magnitude or size of windfarm elements, and the distance between them and the viewer, are basic physical measures that affect visibility, but the real issue is human perception of visual effects, and that is not simply a function of size or distance. We say more on factors that we believe increase perception of *"apparent size",* and factors that decrease it, in sections 5 and 6.2.

3.5 Zone of Visual Influence[3] (ZVI)

3.5.1 The visibility of a windfarm is of course also affected by topography. The concept of the ZVI[4] in professional landscape work originated in the 1970s. Typically, topographic sections would be plotted and sight lines analysed at, say 10^0, intervals. This manual process was and is crude, slow and laborious. Faster and more refined manual techniques were developed using contour maps and templates or overlays. By the mid-1980s, Jarvis (1985) is describing the use of custom-written computer programs to produce ZVI and related visual assessment tools, but one is a program that takes six hours to execute 100,000 sections checking intervisibility; he gives an example of a ZVI covering 20 km^2 based on a 150 m grid.

3.5.2 The rapid development of computing power and capacity, and a parallel decline in relative costs, is of course familiar, so that a typical desk-top personal computer today might have many times the power of the Jarvis machine. However, the programs needed for calculating visual or landscape impacts over large areas have fallen into a no-man's land between Computer Aided Design (CAD) and GIS so that some companies such as TJP Envision (Turnbull Jeffrey Partnership, 1995; McAulay, 1997) have invested much in-house research and development effort in this area. The results are that today such ZVI calculations can be executed rapidly and relatively cheaply in terms of program costs and computing time (although it should be noted that program running times for ZVI calculations are counted in hours, not minutes, and these times increase linearly with the number of turbines and by the square (or worse) as the area of the ZVI increases).

3.5.3 The basic modules needed to calculate a ZVI are now an increasingly standard feature of much GIS software and integrated links to programs for producing wireframes and photomontages are commonplace. Use of a 50m grid, producing greater refinement and

resolution, now appears common and standard. However, the rapid changes in the technology and tools that have taken place during the last 10 years inevitably means that some of the early ZVI in windfarm assessment (including the case study sites) are not as sophisticated or extensive as those appearing in current assessments, and this needs to be borne in mind in assessing aspects of the case study sites analysed later.

3.5.4 Hankinson (1999) describes three possible stages or components of a ZVI. First, a desktop study during which an experienced assessor can usually read the local contours from a 1:25,000 or 1:50,000 plan and gain a good idea of the likely extent of visibility. Next, an analysis (computer based) using a digital terrain model (DTM), cross-sections etc is carried out. Finally, site evaluation. She emphasises the distinction to be made between the ZVI (from the desk study and site evaluation) and what she terms the Zone of Theoretical Visibility (ZTV) derived from computer modelling (Hankinson, Box 16.7, page 367). There are two main sources of error in any ZTV.

3.5.5 First, data errors built into the computer program used include the contour intervals in the baseline data, which affect the degree of interpolation used in the program; and the accuracy and reliability of that data (other error refinements include whether the program takes account of the curvature of the earth etc)(Hankinson, Box 16.8, page 369). For example, a ZTV derived from a DTM based on 1:50,000 contour information (10 m contour interval) may be interpolated and rounded to the nearest metre in the program. The *"1 m interpolation"* assumes a straight-line slope between two contours and cannot take account of rocky terrain that can vary by up to 9.9 m without appearing on the 10 m contour base. Purchased data (from Ordnance Survey) and data digitised in-house also all contain inaccuracies or errors.

3.5.6 The second source of error arises because the ZTV is theoretical, that is it usually assumes a perfectly bare and smooth terrain unencumbered by houses, buildings or other structures, vegetation, hedges, woodland and forests. The site evaluation is the opportunity to take account of landform features that do not appear on the ZTV and landscape features that affect visibility such as trees, hedgerows, fences and buildings. Some programs are being developed that allow the introduction of surface features such as tree cover into the computation of ZVI (e.g. Turnbull Jeffrey Partnership, 1995 and illustrated in the Beinn An Tuirc ES). The key conclusion offered by Hankinson is that users and readers of ZTV/ZVI in environmental statements need to be alert to and explicit about the inherent sources of error, assumptions and limitations of the tools.

3.5.7 Current EIA DTM and ZVI calculations appear to be based on the use of Ordnance Survey (OS) topographic information, which is available for commercial and business use as Land-Form PROFILE (from 1:10,000 scale) or Land-Form PANORAMA (from 1:50,000 scale). The degree of detail, error and cost (at February 2002) of these products are significantly different. PANORAMA is available as 20 km x 20 km tiles (812 tiles cover Great Britain) that cost £10 each. Hence the digital or contour data for a windfarm in the centre of a tile might cost only £10 (to produce a 20 x 20 km ZVI), or £40 in the event that the proposed site fell at the corner of a tile. However, it should be noted that contour intervals are at 10 m and the error is ± 3 m, with a 50 m cell size. When details are stated in the case study ESs, the data set most commonly used is 1:50,000.

3.5.8 PROFILE has contour intervals at 5 m (±1 m) or 10 m (±1.8 m)(cell size 5 m) but each tile only covers 5 x 5 km and more than 10,000 tiles cover Great Britain. The cost per tile varies depending on quantity (e.g. decreasing from £100 - £70 - £42 - £25 per tile). The result is that 9 tiles cover an area 15 x 15 km, 16 tiles cover 20 x 20 km, 25 tiles cover 25 x 25 km and 36 tiles cover 30 x 30 km. The raw data costs are then, respectively, £900 - £1120 - £1750 - £2520. The practical result of this is that we are not aware that PROFILE data is used in ZVI for windfarms.

3.6 The Accuracy of ZVI Predictions

3.6.1 Fisher (1995) has analysed the effects of data errors on viewsheds calculated by GIS programs and shown that the calculations are extremely sensitive to small errors in the data, and to the resolution of the data and errors in viewer location and elevation. Other studies have shown that a viewshed calculated using the same data but with eight different GIS programs can produce eight different results. The direction of such errors – to either over or underestimate the ZVI – is unclear and is not obviously unidirectional. Such errors and effects are well researched and familiar in the detailed GIS technical literature but may not be highlighted in commercial programs or reported in practice reports, which reinforces the conclusion that the ZVI reported in most studies should be described as the Zone of Theoretical Visibility or the *"probable viewshed"*[5], and be subject to subsequent field testing and verification.

3.6.2 Prediction is at the heart of EIA and the general scarcity of detailed post-development audits by which the accuracy of impact predictions might be judged is surprising and regrettable, although some studies are now appearing. A general study by Wood et al (2000) across a range of project types and all (EU Directive) impact categories found that for landscape and visual effects, 40% of predictions were accurate, almost 40% were nearly accurate and approximately 20% were inaccurate.

3.6.3 Wood (1999) has made a detailed audit of the accuracy of a number of EIA predictions, including a ZVI for a clinical waste incinerator in Leeds. He discovered that for the incinerator stack, the ZVI overestimated the spatial extent of project visibility, due mainly to the use of a worst-case and simple topographic model that took no account of the heterogeneous and complex natural and man-made elements in the surrounding landscape.

3.6.4 In a further study (Wood, 2000) he audited the ZVI for four developed projects, including the Ovenden Moor windfarm near Halifax (ES dated 1991) in which the ZVI was determined by desk-study and not by the use of a topographic model or DTM. Overall he found a relatively close match between the predicted and actual ZVI, but including many errors of detail (large discrepancies were revealed for the other projects he analysed). He attributes the detailed errors in part to the fact that the ZVI was based on the tower height excluding the rotors, so that there was systematic under-prediction of visibility at the fringes of the ZVI; however, the general accuracy achieved using a coarse technique based on terrain only is probably due to the homogeneous landscape of the windfarm, dominated by open moorland with virtually no screening vegetation or buildings.

3.7 Visual Effect, Distance and Impacts

3.7.1 The most explicit and structured recommendations on the specific issue of the potential visual impact of wind turbines in relation to distance appears to be the self-styled Sinclair-Thomas Matrix (CPRW, 1999; Sinclair, 2001). This has its origins in a table produced in 1996 by a planning officer of Powys County Council (Thomas) and since revised and updated by a consultant (Sinclair). Assuming unimpeded, good visibility, Thomas defined 9 distance bands (A-I) and classified these with a visual impact rating from *"dominant"* (A) to *"negligible"* (I). This initial table was devised based on the 25 and 31 m hub machines built at Cemaes and Llandinam (Wales) in 1992. At that time, Thomas concluded that *"15 km is considered to be the appropriate radius distance for study"* and according to Sinclair, this became recognised as the norm for ZVI in EIA (apparently irrespective of turbine size).

3.7.2 Sinclair repeated the analysis, concluded that the Thomas distance bands were *"rather conservative",* and revised them upwards. Sinclair then extended the approach to

viewpoints around other windfarms, including larger (72 m) turbines at Great Eppleton (Durham), and also projected or extrapolated the recommendations to encompass 90-100 m turbines. Both authors acknowledge that the Matrix is a general guide, especially at the margins of each band, and recognise the important influences of local conditions, viewing direction, turbine angle and the scale and nature of the landscape context. The resulting Sinclair-Thomas Matrix is reproduced in Table 4 (from Sinclair, 2001)(it is repeated in slightly different form in CPRW, 1999).

3.7.3 We have not been able to determine if this Matrix is in widespread use, or if it has been accepted, challenged or revised at public inquiries (although we are aware that it has been presented and used at public inquiries). It is not referred to in any ES we have examined (although many of these pre-date production of the Matrix) and it is not referred to in any of the literature we have examined, barring its citation in CPRW (1999) and Sinclair (2001) and mention in the consultation responses to Draft NPPG6.

3.7.4 Our initial diagnosis is that the Matrix raises several issues and difficulties of interpretation, including the fact that it is based on the professional (if experienced) opinion of two people, and that it sometimes conflates two separate points – magnitude and significance – for example in using the value-laden word *"intrusive"* in Band C. Such

Table 4: The Thomas and Sinclair-Thomas Matrices

THE THOMAS AND SINCLAIR-THOMAS MATRICES (section A) to estimate the potential visual impact of different sizes of wind turbines					
Overall height of turbines (m) >>>		41-45	41-48	53-57	72-74
Descriptors	Band	Thomas Matrix		Sinclair-Thomas Matrix	
		Original	Revised		
		Approximate distance range (km)			
Dominant impact due to large scale, movement, proximity and number	A	0-2	0-2	0-2.5	0-3
Major impact due to proximity: capable of dominating landscape	B	2-3	2-4	2.5-5	3-6
Clearly visible with moderate impact: potentially intrusive	C	3-4	4-6	5-8	6-10
Clearly visible with moderate impact: becoming less distinct	D	4-6	6-9	8-11	10-14
Less distinct: size much reduced but movement still discernible	E	6-10	9-13	11-15	14-18
Low impact, movement noticeable in good light: becoming components in overall landscape	F	10-12	13-16	15-19	18-23
Becoming indistinct with negligible impact on the wider landscape	G	12-18	16-21	19-25	23-30
Noticeable in good light but negligible impact	H	18-20	21-25	25-30	30-35
Negligible or no impact	I	20	25	30	35
Suggested radius for ZVI analysis		15	At least Junction of Band F and Band G; extended to reflect local circumstances or if cumulative impact may be involved		

THE SINCLAIR-THOMAS MATRICES (section B) Potential visual impact matrix for wind turbines of 72-74m overall height (field observation) and 90-100m (extrapolated). Distances in km					
Band		72-74m	90-100m	Magnitude	Significance
				(subject to other factors)	
A	Dominant impact due to large scale, movement, proximity and number	0 - 3	0 - 4	High	Potential for independent significant impact
B	Major impact due to proximity: capable of dominating landscape	3 - 6	4 - 8	Medium/High	
C	Clearly visible with moderate impact: potentially intrusive	6 - 10	8 - 13	Medium	Potential for contributory significant impact
D	Clearly visible with moderate impact: becoming less distinct	10 – 14	13 - 18		
E	Less distinct: size much reduced but movement still discernible	14 – 18	18 - 23	Low/Medium	Potential for ancillary non-significant impact: only becoming significant if numerous or cumulative with other installations
F	Low impact, movement noticeable in good light: becoming components in overall landscape	18 – 23	23 - 30	Low	
Approximate recommended threshold for ZVI analysis					
G	Becoming indistinct with negligible impact on the wider landscape	23 –30	30 - 38	Negligible	
H	Noticeable in good light but negligible impact	30 -35	38 - 45		
I	Negligible or no impact	35+	45 +		

Source: Sinclair (2001)

confusion persists in the tables because Table section A does not have the same columns as Table section B, where in the latter, magnitude and significance are separated. However, we have attempted to apply the Matrix during the case study visits and this is discussed further at section 6.2.

3.8 Photomontage

3.8.1 The illustration of potential landscape or visual impacts using photographs, wireframes and photomontage is now commonplace and expected in EIA, and videomontage may soon become more widespread. The development of these and related visual or virtual reality techniques is now an area of major research and development interest. The issues are inevitably complex. Perkins (1992), for example, asks what influences *"perceived realism"*? Whilst image quality may be important, he points out that realism may be affected by the context or content of the image portrayed. A technically accurate and precise photomontage that placed Edinburgh Castle on Kintyre will not be perceived as realistic for obvious contextual reasons. Although less extreme, a proposed windfarm placed in a remote landscape may be perceived by a viewer as containing an element of incongruity and inappropriateness that will affect their evaluation of the visualisation.

3.8.2 It should also be obvious that the human eye sees differently than a camera lens, both optically and figuratively. The focusing mechanisms of human eyes and camera lenses are different; human eyes move, and the brain integrates a complex mental image; human vision is binocular and dynamic, compared to a camera that tends to flatten an image. These and related issues of perception have already been referred to in section 3.4.

3.8.3 It therefore follows that when the common recommendation is made that a 50mm standard lens (35mm camera) most closely approximates to the human eye, this *"standard"* or *"normality"* is relative and qualified (and this definition of *"normality*" is challenged in some specialised photographic literature). If a wide-angle lens is used, for example for panoramic effect, the size of the subject in the foreground will increase in relation to the background; in the case of windfarms in a landscape scene, the effect will be to under-represent the relative size of the towers and under-estimate their visual magnitude.

3.8.4 Cornwall County Council (1996) (Appendix A: Visual Impact Assessment of Delabole Wind Farm) notes that *"for photographs taken within 500 m of the site, a standard (75 mm) lens was used on a medium format camera. For all the others, a 200 mm lens was used. The combination of the two sizes of lens seemed to provide the most realistic image of the turbines/wind farm in the landscape".* This is an unusual set of conclusions that we have not been able to verify.

3.8.5 Shuttleworth (1980) is a relatively early example of a continuing body of work using photographs as surrogates for real landscapes, although the work is mainly concerned with landscape character and quality assessment, and not visualisation and realism *per se*. He points out the obvious differences and distortions between the two-dimensional image and the three-dimensional perception of a scene or viewpoint by a human observer. He stresses the need to insert aids in photographs to provide constancy scaling and perspective resolution. Perceptual ambiguity can be reduced if the field of view is as large as possible and if depth cues (paragraph 3.4.6) are deliberately included in the photograph. Interestingly, Shuttleworth found that photographic simulation was most reliable in dealing with the overall perception of the landscape, but less reliable when dealing with perception of detailed elements and characteristics in the landscape.

3.8.6 LI-IEA (1995)(and updated in LI-IEMA, 2002) contains general guidelines on photomontage (and CAD, including ZVI) but contains little technical detail for photographs or

ZVI. Sparkes & Kidner (1996) remark that photomontages are not cheap to produce, are fundamentally inflexible and of course cannot depict movement. They also suggest they can give a pessimistic impression of a development because for the turbines to be visible on the photograph, they tend to be painted in white or given a black outline, resulting in them having a high degree of contrast compared to expectations in reality. This was not our experience during the case-study research (paragraphs 6.1.16-6.1.21).

3.9 Significance

3.9.1 Prediction and then evaluation of significance are at the heart of EIA. All developments produce effects, which may be positive or negative. All developments produce effects which vary in size or magnitude and such variation may be spatial or temporal or both. It may or may not be feasible, technically or economically, to reduce or mitigate such effects. After mitigation, an effect may still be significant because of size, location, type, risk or related factors. Such significance may be temporary or permanent, reversible or irreversible. Significance is therefore always relative and context-specific, which may be local, regional, national, supra-national or international.

3.9.2 Ultimately, significant is whatever individuals, people, organisations, institutions, society and/or policy say is significant – it is a human evaluative and subjective judgement on which there may or may not be consensus. It is therefore important that two separate but critical characteristics of all effects – magnitude and significance – are clearly distinguished.

3.9.3 The wide diversity of opinion evident on the merits or otherwise of windfarms, including their visual effects, and the implicit expression of opinion on significance within that diversity of opinion, should not be surprising. It is therefore also important that in any ES, the foundations and assumptions on which significance is based must be clear and explicit.

3.9.4 Remarkably, perhaps, significance is little researched in relation to visual impacts. Exceptions are Bishop (in press), referred to at paragraph 3.2.7, and Stamps (1997), who offers a detailed review of the issue (including the related issues of design guidance and design review) and a theoretical and methodological model for assessment based on a statistical analysis of human preference ratings for before and after scenes. However, his focus, and his case-studies, are based on urban design issues in California.

3.9.5 The legal and regulatory starting points in Scotland are the Environmental Impact Assessment (Scotland) Regulations 1999 (Circular 15/1999) which require that *"the aspects of the environment likely to be significantly affected by the development"* are included in the ES, but offer no specific guidance on definitions of significant. The guidance states that impacts are more likely to be significant in sensitive locations, examples of which are listed. In the case of windfarms, the *"likelihood of significant effects will generally depend upon the scale of the development, and its visual impact … EIA is more likely to be required for commercial developments of five or more turbines, or more than five MW of new generating capacity".* The complementary PAN58 (Environmental Impact Assessment)(Scottish Executive, 1999) does not offer specific guidance on definitions of significance.

3.9.6 Specifically for landscape and visual effects, the LI-IEA Guidelines (LI-IEA, 1995) are widely referred to and appear to have achieved status as a de-facto national standard. However, the Landscape Institute has produced an advice note[6] that emphasises that the Guidelines are general, non-prescriptive, and were not intended to offer a preferred methodology. In particular the note is at pains to point out that the examples given (Figure 3.1 [classification of sensitive landscape/visual receptors and impact magnitude] and 3.2 [the relationship between sensitivity and magnitude in defining significance thresholds]) are illustrative only. *"On no account should they be linked and then applied in the assessment of a proposed development. As paragraph 3.62 states: "… it must be stressed that this is only*

an example. Every project will require its own set of criteria and thresholds, tailored to suit local conditions and circumstances …"".

3.9.7 In the second edition of this guidance (LI-IEMA, 2002), the advice given is less prescriptive and stress is laid on "*informed and well-reasoned judgement supported by thorough justification*" as well as the need to consider issues, including significance, on a case-by-case basis (Box 7.3, LI-IEMA, 2002). Broad professional landscape consensus does exist, as the similarities in the examples given in Appendix 6 of LI-IEMA (2002) show, but detailed differences of interpretation are inevitable. Despite arguments to the contrary that appear in some of the ESs we have examined, there appears to be no statutory guidance on a definition or definitions of significance. Guidance states that potentially significant effects may occur in some sensitive locations (landscapes), with the implication that an effect of a defined magnitude in one location could be significant but that the same effect in another, less sensitive, location would not.

3.9.8 The value judgement of significance is played out through development control and the public inquiry system, in that decisions of re-design, re-siting of turbines, planning conditions and even refusal of permission can be said to be the result of statutory, public and political debate on which visual effects are and are not judged to be significant. It would be an interesting and informative study to test these ideas through a detailed examination of development control and public inquiry case-law, but this was beyond the scope of the current study.

3.9.9 It therefore follows that the definitions and judgements of significance contained within an ES are ultimately those of the developer and/or the consultant, even allowing for the existence of a degree of consensus among landscape professionals who would be expected to share some common standards and norms. Whilst no criticism of the honesty or professional integrity of the parties is intended concerning the case study examples in this project, it is a truism that a developer must want to minimise the number of significant impacts identified, and that a professional is torn between their role as an expert and their role as an advocate. Whilst there are examples in existence of patently biased and promotional Environmental Statements that developers have treated as little more than public relations documents, even in ostensibly fair, balanced and unbiased statements there can exist more subtle and entirely understandable nuances and judgements that can be challenged. Statutory consultees, other professionals and decision-makers are therefore free to accept or reject many definitions and judgements, unless consensus exists.

3.10 Public Attitudes

3.10.1 There is a little research, some survey and much anecdotal evidence that public attitudes to renewable energy, wind energy and windfarms are complex and dynamic. Krohn & Damborg (1998) review a range of international studies and show that (a) there is broad public support for renewable energy in general, (b) there is high (around 80%) public support for wind power, including similar levels of support in the UK based on thirteen surveys conducted between 1990 and 1996, but that (c) there are important and significant differences in attitudes and opinions in the particulars. In other words, there may be a significant difference between attitudes expressed (positively or negatively) in a general way, and actual behaviour in terms of opposition to new developments.

3.10.2 Whether such differences are labelled NIMBYism or invested with more subtle attempts to explain an apparent contradiction is a matter for research and debate (Wolsink, 1994, 2000). At a simplistic level, windfarms are not different from other developments such as hospitals, roads and waste disposal sites, in that the majority of the public accepts the necessity for these but may be vociferous opponents of local developments. Also, studies for windfarms show that human perceptions of potential noise and potential landscape or

visual effects are the key issues. Windfarm interests have been interested to summarise and promote the results of such studies (e.g. BWEA, 1996), although it is worth stressing here that such summaries may show evidence of selectivity in interpretation, and most surveys have been of a type best described as general public attitude and opinion surveys that have not focused on the more detailed questions being examined in the current study.

3.10.3 Duddleston (2000) reports on a post-development survey (by telephone) of public attitudes and opinions concerning the Beinn Ghlas, Novar, Hagshaw Hill and Windy Standard windfarms. Residents within a 20 km radius of each site were sampled (the study used the following zonal definitions: 0-5 km – high proximity zone; 5-10 km – medium proximity zone; 10-20 km – low proximity zone). Perversely at first sight, perhaps, a slightly higher proportion of respondents in the medium and low proximity zones (11% and 12% respectively) said that they disliked the windfarm because it was unsightly or spoiled the view compared to those (8%) in the high proximity zone, but this bald result ignores detailed local visibility issues (for example, the Novar site is essentially invisible in the high proximity zone, except for specific and limited localised viewpoints, but more visible beyond this zone). This point is elaborated by Duddleston (Table 4, page 12), where she shows that a higher proportion of respondents in the medium proximity zone see the windfarm from their home or garden or when travelling on local roads compared to those in other zones, and they also see the windfarm more frequently (every day or most days). The survey then asked people to compare their anticipated and actual problems. For all effects including *"look of the landscape being spoilt",* the results show actual effects to be around 15-20% of anticipated effects.

3.10.4 Whilst windfarm interests are keen to offer these (and other) results from public attitude surveys as evidence that public reaction and opposition to windfarms is exaggerated, it could equally be interpreted as evidence that detailed attention to the planning, impact assessment, siting and design processes is successful in minimising effects or mitigating potentially significant impacts. The Duddleston survey did not address specific visual questions, such as whether the windfarm as built appeared more or less prominent than they (the public) had expected or had judged from inspection of pre-project visualisations (the main sources for pre-project information were local newspapers, other media and word of mouth, with some consultation by developers in the high and medium proximity zones). It therefore offers no results to inform the detailed questions being asked by the current project.

3.10.5 We have not discovered any public attitude or opinion surveys that address the specific issue of the relationships between turbine size, distance, visibility and impacts.

3.11 Cumulative Effects

3.11.1 This general phenomenon is flagged or raised in many discussions and policy documents as an important issue. A relatively recent report is Energy Technology Support Unit (2000). This is generic guidance on principles and processes but contains little specification or technical detail on issues of magnitude, distance and significance.

3.11.2 Piper (2001) has analysed three cases of the cumulative effects of two or more projects, including windfarms in Holderness (Yorkshire) and Kintyre. In Holderness (study for East Riding of Yorkshire Council), the boundary of the study area was seen as the maximum distance (about 20 km) from which the windfarms might be seen (in a coastal region of very flat topography). The basic approach involved defining landscape character and determining the sensitivity of the landscape (based on potential change, intrinsic character and potential visibility). The study defined several visibility thresholds as follows: 0-2 km: turbines a prominent element in the local landscape – high visual impact; 2-5 km: turbines would appear as clearly visible element in landscape – high-medium or medium

visual impact. In terms of best practice for cumulative effects assessment, Piper rates the Holderness study as limited and partial; for example, no cumulative zone of visual influence map was produced to show overlapping affected areas within different dominance thresholds. For the Kintyre project (study for Scottish Natural Heritage) the study area was defined as a radius up to 30 km, assuming turbine heights to blade tip of up to 68 m, and based on five projects or potential projects at various stages of resolution. As for Holderness and in terms of best practice for cumulative effects assessment, Piper also rates the Kintyre study as limited and partial; for example, landscape character assessment was not used and no explicit assessment of significance in relation to distance is made.

3.11.3 MosArt Associates (2000) have prepared an analysis of landscape character and sensitivity to windfarm development for Cork County Council, but this was an area based study akin to the similar capacity studies being carried out in Scotland and elsewhere, and contains few detailed technical recommendations on aspects of VIA. With regard to cumulative effects, however, it recommends the use of overlapping ZVI and, pending a further study, that the outer limit of cumulative effect is set at 10 km separation, with any larger separation not considered as having a cumulative effect. For individual applications, it recommends a basic ZVI of 20 x 20 km and, for large turbines (a height of more than 60 m), a ZVI of 30 x 30 km.

3.11.4 Information on a current research study on cumulative impact of wind turbines, commissioned by the Countryside Council for Wales, is at Macaulay Land Use Research Institute (2002). At present the material available here is largely literature review, much of which is general and non-specific for windfarms. For example, it reviews controversies over the differences between professional and lay public preferences for landscape and scenic quality; it reviews several studies (largely drawn from the USA and the Netherlands and much from the late 1980s) on perceptual studies of windfarms (but much of this is focused on attitudes and symbolism, and general design issues) and it reviews a familiar range of tools for VIA, including ZVI and viewpoint analysis.

4 CASE STUDY SITES

4.1 Introduction

4.1.1 The following sections provide a short description of each windfarm, followed by a condensed analysis of each Environmental Statement (Appendix 1), concentrating on key aspects of the VIA [7]. For each viewpoint visited we provide a brief summary of the prediction or judgement made in the ES, and then a brief comment based on our site appraisal. An overview of the site appraisals is then presented, followed by some brief conclusions.

4.2 Beinn An Tuirc

The Windfarm

4.2.1 The windfarm was constructed in 2001. The original proposal was for 50 turbines with a hub height of 40.5 m and a total height of 62.5 m. As built the windfarm consists of 46 turbines with height to hub of 40.5 m and total height of 62.5 m. Viewpoints were selected by negotiation with the local planning authority and SNH. The site moved south during negotiations because of ornithological interests and the layout also changed for this and visual reasons. There are significant locational differences between as assessed and as built.

The Environmental Statement

4.2.2 The ES material available to us was varied and complex and it proved difficult to cross-match, collate and test the documentation. The main statement (no date) is based on layout G (layouts D, E, F and G are referred to). The ZVI radius (study area) is declared as 15km, but is actually 16.6 km to accommodate the spread of the windfarm layout of 3.3 km. Chapter 9 in the ES includes a detailed discussion of the basis for the selection of 15 km. The basic ZVI is a zone of theoretical visibility (bare-ground or worst-case scenario). Computer calculations are also made of the zone of actual visibility taking account of trees rendered in the program as standardised forestry blocks. Relative visibility in the ZVI is based on a hub height of 40.5 m, not the maximum height, but this decision is not explained.

4.2.3 Eighteen viewpoints were selected based on site survey and consultation with SNH, Argyll & Bute Council and North Ayrshire Council (Arran). Site assessments were made based on visualisations (photographs and wireframes), not photomontages. The effects on both stationary viewers and moving viewers are distinguished and analysed and a long list of factors considered in assessment is provided. Orientation of the turbines in relation to the prevailing winds is considered. Separate reports exist containing *"Wireframe Overlay Illustrations"* (May 1998)(viewpoints 1, 2, 5, 11, 12, 13 and 15 only) and *"Photomontages"* (no date)(prepared for viewpoints 2, 5, 11, 12, 13 and 15 only). The recommended viewing distance for visualisations is 24 cm. It is not clear if these separate reports refer to the 18 viewpoints in the main ES.

4.2.4 At the end of each viewpoint assessment (descriptive), a statement is made as to the anticipated effect (e.g. *"moderate adverse effect on visual amenity*") and the significance (e.g. *"significant*"). The ES makes reference to the Environmental Assessment Regulations and concludes that minor effects are not significant, but moderate and major effects are significant. The basis for the assessment of significance does not appear in the main ES (layout G), but is described and discussed in detail in a supplementary report, *"Assessment of Landscape and Visual Effect Layout F, Draft 2"* (1997), as is the technical detail of the ZVI, DTM etc. We also obtained a packet of visual material (ZVI, site layout, wireframes)

dated 1999 that in one case referred to layout H. We assume that layout H is close to the as built windfarm.

4.2.5 Although based ultimately on professional judgements by more than one assessor, this ES is explicit in listing and discussing the factors taken into account in judging very significant, significant and not significant or no effect. The details in the ES are long and relatively complex and are not repeated here for that reason. The supplementary report (1997) is effectively a second version of the ES, based on Layout F, but concerned only with the landscape and visual effects. A full set of ZVI, visualisation, photomontage and related materials is presented.

Site Survey

4.2.6 There are 19 viewpoints in the ES. Seven are on the islands of Gigha or Arran and 2 are in the sea; these were not visited during this study. Of the 10 remaining, 5 were not visited due to their remoteness. To assess them would have involved some hill walking which may have been feasible in better weather but was not practical due to the time constraints of the project and the poor weather conditions. Therefore only five out of 19 viewpoints were assessed.

4.2.7 We made a total of 9 visits to the 5 viewpoints (viewpoint 6 involved walking 2 miles so we visited it only once when the weather was good) but were only able to make 5 useful assessments of 4 viewpoints due to the weather.

Table 5: Viewpoint Analysis for Beinn an Tuirc

VP	Distance (km)	No of Visits	ES Description (main ES)	Site assessment	Photomontage/wireframes (main ES)	Wireframes (supplementary)
1	5.85	2	States 11 turbines visible.	None visible. This may be due to layout changes.	Totally inaccurate, looks like layout change.	
2	4.35	2	States 35 turbines visible over 2 hills. States 'moderate adverse impact'.	23 then 11 visible over 1 hill. Although the number and layout were not accurate, 'moderate adverse impact' is correct.	Inaccurate in number and position. Turbines looked bigger in reality than in photomontage.	Called viewpoint 1. Wireframe shows 23 turbines with extreme tips of three more (which were obscured by vegetation in reality). The individual positions are reasonably accurate. The overall position and size of the farm is accurate.
3	7.8	2	States 30 turbines visible. States 'new visual focus' and 'moderate adverse impact'.	15 visible. "Moderate adverse impact' may be too strong as there are already many manmade elements in this landscape.	Not accurate in position or number. Size looked bigger in reality.	Called viewpoint 2. Two wireframes, one without vegetation and one with blocks of trees. The former shows 15 turbines with the tip of one more. The overall position and size is accurate. The latter wireframe shows only 11 turbines and the tip of one. As we saw more it would appear that the screening effect of the trees has been overestimated.
6	6.6	1	ES states 21 turbines visible and 'low adverse impact'.	7 visible (although light conditions poor). 'Low adverse impact' is correct.	Not accurate in number or position.	Called viewpoint 5. Shows 8 turbines.

4.2.8 There were substantial changes in layout between the ES and construction, accounting for the major discrepancies we found. We do know that the number of turbines was reduced by 4 and the whole position was shifted south because of ornithological interests. Apart from the numbers and positions, we generally agreed with the assessments of impact and significance and there was only one disagreement where we felt that the impact had been slightly overstated, but again layout change may have affected this assessment.

Conclusions

4.2.9 Full technical details of the VIA are provided and justified in the ES and potential errors are acknowledged. Magnitude, sensitivity and significance are separated, justified and discussed in detail and in a balanced way. Major changes between assessment and construction mean that this ES is not strictly accurate. The turbines look bigger in reality than in the photomontages. The newer wireframes to accommodate the layout changes are generally accurate regarding the positioning and overall impact of the windfarm with minor inaccuracies regarding individual positions of turbines and screening effects of trees.

4.3 Beinn Ghlas

The Windfarm:

4.3.1 The windfarm was constructed in 1999. The original proposal was for 16 turbines with a hub height of 40 m and a total height of 61.5 m. A total height of 65m was used in the ES landscape assessment for reasons that are not explained, which might have resulted in over-prediction of the ZVI. As built the windfarm consists of 14 turbines with a height to hub of 35 m and a total height of 57 m. SNH judge that all the main or significant viewpoints were covered, although views from roads to the west (leading to Loch Awe) were ignored or underestimated, and emphasis was perhaps not placed on views by walkers on nearby hills. Although 2 turbines were removed, we understand that the other 14 locations were not changed.

The Environmental Statement

4.3.2 The ZVI is shown for an area of 30 x 30 km, distinguishing the differing numbers of turbines to be seen. However, the resolution is crude and it is not overlain onto an OS map, making locational referencing difficult. This was produced using a DTM (worst-case conditions, ignoring structures, forests etc) of the 1:25,000 OS map, but no details of potential errors are given. The VIA then uses photographs for 17 viewpoints using a wide panoramic format camera and wireline visualisations. Five views are illustrated using photomontage.

4.3.3 Significance (Volume 1) is based on LI-IEA (1995). First, magnitude was defined as:

> *High – Notable change in landscape characteristics over an extensive area ranging to intensive change over a more limited area.*
> *Medium – moderate changes in local area*
> *Low – virtually imperceptible changes in any components*

4.3.4 And then sensitivity was defined as:

> *High – important components or landscape of particular distinctive character susceptible to relatively small changes*
> *Medium – landscape of moderately valued characteristics reasonably tolerant of changes*
> *Low – a relatively unimportant landscape. The nature of which is potentially tolerant of substantial change*

4.3.5 These were then combined into a classification as:

> *Significance Substantial – the product of high sensitivity and high magnitude, or medium sensitivity with high magnitude*
> *Significance Moderate - the product of medium sensitivity and medium magnitude, or low sensitivity with high magnitude*
> *Significance Slight - the product of low sensitivity or low magnitude*

4.3.6 This schema is essentially similar to LI-IEA (1995), but in this case it is logically flawed and incomplete, in that in a 3 x 3 matrix (magnitude versus sensitivity) there must be 9 classes, but only 6 are referred to in the ES (and only 6 examples are illustrated in the detailed technical appendix (Volume 3)). No distinctions are made between magnitude, sensitivity and significance for landscape impacts as opposed to visual impacts. For each viewpoint, a description leads to categorisation of significance, although the authors then introduce terms such as very slight (presumably lower than slight). The significance

terminology then changes in a later summary table to minor-moderate-significant. Although not explained, the implication is that only substantial impacts are judged to be significant. Four additional viewpoints (using a Linhof panoramic format camera giving 90^0 field of view) were produced to give further wirelines and photomontages. This supplementary report to the ES does explain sources of discrepancy between the ZVI predictions and on-site evaluation (including data interpolation errors).

Table 6: Viewpoint Analysis for Beinn Ghlas

VP	Distance (km)	No of Visits	ES Description	Site assessment	Photomontage
4	9	2	ES states 13 turbines visible and that "they would not be conspicuous in most lighting conditions".	Only 4 visible but weather conditions poor. We could still distinguish them clearly and they stood out more than was suggested in the ES.	The turbines seemed about twice the size in reality. There were fewer visible but these stood out more on the skyline.
5	13	2	ES states 10 visible and described as minute elements in the landscape and impact 'slight'.	10 visible. Assessment correct.	The turbines look much taller in reality and more spread out than in the photomontage.
6	10	1	ES states that no turbines would be visible from the road.	None visible.	N/A
7	-	1	This was a viewpoint chosen to evaluate the access track and substation.	We could not make out any track or locate the substation.	N/A
10	8	2	States 10 turbines would be visible and would be inconspicuous in most lighting conditions and impact 'slight'.	10 visible on each visit. Description incorrect. Underestimates appearance and impact.	N/A
11	11	2	States that towers of 10 and rotors of a further 4 would be visible. States "barely discernible in most lighting conditions" and "slight impact".	We saw only 3 but the cloud was low. Assessment correct but in better weather conditions this could be an underestimate.	N/A
13	13	2	States all turbines visible and "barely discernible in most lighting conditions" and "slight significance".	All turbines visible. Incorrect that turbines would be "barely discernible in most lighting conditions" as we saw them clearly in poor light. "Slight significance" correct.	N/A
B	14	2	States all (14) turbines visible and "barely discernible in most lighting conditions" and "significance slight".	13 visible but weather poor. Incorrect that "barely discernible in most lighting conditions" as we saw them very clearly in poor light. "Significance slight" correct.	Turbines seem much more noticeable and distinct than on PM. They seem bigger and more spread out.

Site Survey

4.3.7 There are 17 viewpoints in the ES. Three were not visited because they were remote. Out of 26 visits to 14 viewpoints we were only able to make 9 useful assessments of 8 viewpoints due to weather conditions.

4.3.8 Although we generally thought that the number of turbines and the impact/significance ratings were accurate (bar one underestimate), we thought that the descriptions of visibility were on the whole an underestimate. The photomontages also appeared to underestimate size and the positions seemed inaccurate.

Conclusions

4.3.9 The technical details of the VIA in the ES are not provided in full, nor are they justified, and potential errors are not always acknowledged. There is no explanation given on the potential accuracy (or otherwise) of the photomontages. Magnitude, sensitivity and significance are separated, justified (very succinctly) and discussed, but not separately for landscape and visual effects, and there is some inconsistency of terminology.

4.4 Deucheran Hill

The Windfarm:

4.4.1 The windfarm was constructed in 2001. The first proposal that was given the name Deucheran Hill was for 12 turbines with the height to hub not stated but a total height of 76 m. As built the windfarm consists of 9 turbines with height to hub of 46 or 60 m and total height of 62.5 or 76.5 m. Viewpoints were selected after consultation.

The Environmental Statement

4.4.2 There is some complexity and lack of clarity within this ES because a separate ES (not examined in this study) was prepared for an earlier proposal (named Cruach nan Gabhar) with 24 (and then 15) turbines. The proposal was later modified, the turbines reduced to 12 (and then 9) and the name was changed to Deucheran Hill. In the Deucheran Hill ES, visual re-assessments are restricted to those 3 viewpoints (from an original 14) where an increase over the Cruach nan Gabhar proposal(s) is expected. For other viewpoints, the (now pessimistic) assessments based on Cruach nan Gabhar are used in the Deucheran Hill ES. A table (Table 5.1) compares the number of turbines visible for each windfarm, distinguishing between (rotor) tips and hubs. Towers are to be coloured off-white/ pale grey with a semi-matt surface.

4.4.3 The ZVI is a worst-case survey (bare ground), but the screening effect of conifer plantations is noted. The data used and resolution are not stated. The distance used is 15 km (overlain on 1:50,000 OS map (reduced)) but this distance is not justified. A revised ZVI is then produced (supplementary drawings) for 7 x 79 m and 2 x 93 m turbines (as built).

4.4.4 Visualisations use wireframes and it is emphasised that these are not photomontages. The camera was at a height of 1.8 m using a 50 mm focal length lens and a recommended viewing distance of c23 cm. The ES draws attention to the limitations of the visualisations and stresses that the graphics (dark delineation of towers on a white background) can over-represent the true width and impression of the towers. Accordingly, it is stated that whilst the height representations are correct, at distances beyond 4-6 km the width is over-represented.

4.4.5 This ES adopts a common methodology for assessing significance for each impact category (based on LI-IEA (1995) and Department of the Environment (1995)). The landscape and visual assessment methodology is explained in detail in Appendix E and magnitude (for visual receptors) was defined as shown in Table 7.

Table 7: Magnitude of Impact – Visual Receptors (Table F3 from Deucheran Hill ES)

MAGNITUDE OF IMPACT	
HIGH	Major change in view: change very prominent involving total or partial obstruction of existing view or complete change in character and composition of view through loss of key elements or addition of uncharacteristic elements.
MEDIUM	Medium change in view: which may involve partial obstruction of existing view or alteration to character and composition through the introduction of new elements. Change may be prominent but not substantially different in scale and character from the surroundings and the wider setting. Composition of the view will alter. View character may be partially changed through the introduction of features which, though uncharacteristic, may not necessarily be visually discordant.
LOW	Minor change in view: change will be distinguishable from the surroundings whilst composition and character (although altered) will be similar to the pre-change circumstances.
NEGLIGIBLE	Very slight change in view: change barely distinguishable from the surroundings. Composition and character of view substantially unaltered.

4.4.6 Sensitivity was defined as the *"importance of the individual element being assessed e.g. the landscape type or location …",* categorised as Low, Medium or High. The sensitivity of visual receptors is defined and considered in detailed evaluative tables – tourists (high sensitivity), travellers (low), local recreation (high), walkers and climbers (high), estate workers/farmers (medium), residents (high) – with both landscape and visual effects being assessed. These were then combined as shown in Table 8.

Table 8: Impact Matrix (Table 1.2 from Deucheran Hill ES)

MAGNITUDE			
HIGH	Moderate	Moderate/Major	Major
MEDIUM	Low/Moderate	Moderate	Moderate/Major
LOW	Low	Low/Moderate	Moderate
NEGLIGIBLE	Negligible	Negligible/Low	Low
	LOW	MEDIUM	HIGH
		SENSITIVITY	

Note: *"shaded boxes are not considered significant in terms of the Regulations".*

4.4.7 This schema is essentially identical to LI-IEA (1995). Significance is explained and justified. The authors state that only Moderate/Major and Major impacts are judged (by them) to be significant.

4.4.8 There is discussion of cumulative issues in relation to this and other proposals in the area. A cumulative ZVI is included as are 7 wireframes (representing the three windfarms considered) and to justify the conclusion of (cumulative) insignificance.

Site Survey:

4.4.9 There are 14 viewpoints in the ES. Five are on Arran or Gigha and were not visited. Of the 9 on the mainland, 2 were remote. We made a total of 12 visits to 7 viewpoints (2 viewpoints were quite remote so we had time to visit them only once) and were able to make only 6 useful assessments of 5 viewpoints due to weather conditions.

4.4.10 From the few viewpoints we had to go on, we conclude that this ES was quite accurate both in the visualisations and in the descriptions and conclusions. Discrepancies we found were very slight (both in underestimating and overestimating impact) and possibly caused by unavoidable differences in perception between individuals and interpretation of terms such as slight, moderate etc.

Conclusions

4.4.11 The technical details of the VIA in this ES are provided (if not always justified) but potential errors are not acknowledged. Magnitude, sensitivity and significance are separated, justified and discussed. There is much explicit advocacy and argumentation in this ES, in addition to objective impact assessment. Whilst this may appear to run counter to any general best practice guidance that an ES should as far as possible be objective, fair, balanced and not a public relations document, the ES does take space to explain the basis of the arguments. Irrespective of whether one agrees with this argumentation, the separation of objective and subjective assessment, and advocacy, is generally clear.

Table 9: Viewpoint Analysis for Deucheran Hill

VP	Distance (km)	No of Visits	ES description	Site assessment	Photomontage
3	8.9	1	Stated that the tip of 1 turbine would be visible.	Nothing visible but the light was low.	The turbine shown on the visualisation was not visible so cannot comment on the accuracy of positioning
4	16.2	2	States no turbines visible	Accurate, no turbines visible	
5	10.3	2	States no turbines visible	Accurate, no turbines visible	
6	5.4	1	States no turbines visible	Accurate, no turbines visible	
8	13.3	2	ES states 9 hubs visible. States that the scale would remain subordinate to the underlying landform.	1 and 9 were visible on different visits due to varying weather conditions. Correct that the scale would remain subordinate to the underlying landform, but this underestimated the effect of character change in the landscape. Conclusions of impact significance etc correct.	Very accurate in positioning but turbines seem much larger than in the visualisation.

4.5 Dun Law

The Windfarm

4.5.1 The windfarm was constructed in 2000. The original proposal was for 34 turbines with a hub height of 35-46 m (but 45 m is used in the VIA) and a total height of 54.5-68 m (but 66.7 m is used in the VIA). As built the windfarm consists of 26 turbines with height to hub of 40 m and total height of 63.5 m. SNH judge that all potentially significant viewpoints were covered, including some recommended by SNH. There was some adjustment of tower positions between as assessed and as built, partly in response to SNH concerns with the risk of in line views of rows of turbines from key viewpoints, but SNH were not fully involved in these detailed adjustments between an outline permission and construction.

The Environmental Statement

4.5.2 This ES is in parts complex, confused and confusing and it is difficult to tease out the elements of the VIA (for example, pages are not numbered, contradictory but unexplained details appear in different sections, and cross referencing to photomontages is erratic). For the ZVI, radii of 7 and 20 km appear to have been used at one stage (ignoring vegetation, structures etc). One ZVI shows the number of nacelles (hub) visible, but the scale is hard to interpret. Figure 4 in the main report shows a mapped ZVI (called Visual Analysis) of up to 8 km (concentric rings are drawn at 2, 4 and 8 km), overlain on a 1:50,000 map of 14 x 16 km. Figure 5 is a theoretical ZVI of up to 16 km. No technical detail is provided, nor is the varied menu of ZVI explained.

4.5.3 Eight viewpoints are examined, all from publicly accessible locations, chosen after consultation with SNH and Borders Regional Council. There is a wireline for each viewpoint, and a photomontage for seven viewpoints (based on photographs using a 50 mm lens in 35 mm format). In a supplementary report, alternative layout options are examined, and Option E (which appears to be close to the as built windfarm) is analysed using wirelines and additional photomontages for viewpoints 2, 4, 6, and 7.

4.5.4 The evaluation of significance is in part contained within each written viewpoint analysis. The ES states that Energy Technology Support Unit guidelines were used (i.e. Stevenson & Griffiths, 1994) as follows:

Dominant	*< 2 km*
Visually intrusive	*1.0-4.5 km*
Noticeable	*2.0-8.0 km*
Elements in the landscape	*7 km and above*

4.5.5 These guidelines do not actually distinguish magnitude and significance, except implicitly. However, it is hard to determine how these were used, and the ES then proceeds to discuss views and viewpoints in bands of 0-2, 2-4, 4-8, and 8-16 km in order to assess visibility and hint at significance. Words such as dominant, prominent, intrusive, conspicuous are used, but an explicit declaration of significance is not always applied.

Site Survey

4.5.6 There are 12 viewpoints in the ES. One is remote and one is on private land with hostile signage; neither was visited. Of the 10 remaining, we made a total of 19 visits to 10 viewpoints and were able to make 19 useful assessments. This ES makes no explicit prediction of the numbers of turbines visible from each viewpoint and is erratic in offering a judgement of significance.

4.5.7 Assessing the accuracy of the ES is impossible because few exact predictions are made. Allowing for some post-assessment design changes, visualisations were reasonably accurate in positioning but not an accurate representation of the windfarm in reality.

Conclusions

4.5.8 All the key elements of VIA are present in this ES – ZVI, wirelines, photomontage – and some technical detail is provided - but there is a lack of clarity and limited justification for judgements made. Magnitude, sensitivity and significance are not clearly separated, justified and discussed.

Table 10: Viewpoint Analysis for Dun Law

VP	Distance (km)	No of Visits	ES Description	Site assessment	Photomontage
A	0.2 - 0.48	2	States "dominant element in view".	17 turbines visible to W of A68, including overhead power line. Large vertical elements in bare moorland plateau. Constantly changing perspective from fast moving cars. Other turbines largely hidden behind shelter belt to E.	Largely accurate, but wide angle lens used which produces distorting effect.
B	1.2 – 2.4	1	States "dominant and prominent".	26 turbines are visible, context as for viewpoint A.	Same comments as for viewpoint A.
C	1.15	2	States "prominent and intrusive, conspicuous and significant".	26 turbines are visible. At this distance, differences between skylining and backgrounding are irrelevant.	Largely accurate, some small differences probably due to post-ES relocations.
D	1.95	2	States "prominent".	14 turbines are visible. Forestry and other elements in middle and foreground reduce effect of windfarm, and forestry will screen view in time.	PM3 is reasonably accurate, but three turbines at extreme left are missing, whilst PM4 is more accurate.
F	4.2	2	States "prominent on the horizon".	11 turbines are visible but partly screened by foreground hedge.	8 turbines shown on PM but 11 visible on site and PM gives impression much smaller than reality.
H	4.75	2	States visibility "limited to the tips of the blades of 6 turbines". Impact "not significant".	Windfarm is invisible at this point	N/a.
I	9.0	2	States "very small and distant element in view".	13 turbines are visible but are not easy to count with the naked eye and movement not visible. Moving along road ± 0.5 km, turbines much more conspicuous. Effect appears due to complex middle and foreground elements at viewpoint I.	N/a.
J	5.8	2	Impact "slight".	4 turbines just visible above trees, but only with aid of binoculars. Windfarm is effectively invisible. Overhead power line and pylons dominate the view; background tree growth may have screened turbines.	N/a.
K	7.0	1	"Visibility limited to the upper parts of towers and glimpsed views of rotating blades silhouetted above the horizon". Impact "not significant".	23 turbines are visible. Movement clearly visible to naked eye.	Not accurate; the PM mis-labels Dun Law which lies to extreme right of PM.
X	4.3	2	"Prominent on the horizon".	16 turbines visible but movement scarcely visible because of orientation of rotors at 90^0 to viewer.	Largely accurate.

4.6 Hagshaw Hill

The Windfarm

4.6.1 This was Scotland's first windfarm, constructed in 1995. The original proposal was for 30 turbines with a hub height of 35 m and a total height of 55.5 m. As built the windfarm consists of 26 turbines with height to hub of 45 m and total height of 65.5 m. There is therefore a significant difference (in height of the turbines) between as assessed and as built.

The Environmental Statement

4.6.2 The ZVI is a worst case analysis for a radius of 12 km from the centre of the site, shown on a reduced 1:50,000 OS base map, but the choice of distance is not explained. The data used to generate the ZVI are not stated and potential errors are not acknowledged. The ZVI map only shows visibility as present/absent and does not show visibility varying in relation to the numbers of turbines.

4.6.3 There is discussion and argumentation concerning the diversity of opinion concerning the visual and landscape effects of windfarms, drawing from other public opinion surveys. Concerning significance, there is some generalised but inconclusive argumentation to the effect that many factors affect visibility, perception and significance. Within the text, evaluative statements such as marginal significance and relatively insignificant component are used freely. The issue of visibility is introduced by the use of photographs (some panoramic, but by splicing photographs taken with a 50 mm lens) of Delabole and Carland Cross windfarms (of similar height to the Hagshaw Hill proposal), and there is extensive discussion of the relative effects of these at varying distances. Based on this review, the ES states that *"we consider that significant visual impacts, if they exist, will in our opinion only be experienced within a range of up to 1.5 km from the turbines. However, we have allowed a margin of 0.5 km and extended the range to up to 2 km".* The ES then allows that other factors may need to be considered in restricted circumstances, so that *"we do not consider that at a distance greater than 6 km to 6.5 km that the proposal, if seen, would be significantly adverse in views for those who might adopt a negative stance towards them".*

4.6.4 Sixteen visualisations are provided using a mixture of photomontage or photographs with wireline illustrations or wirelines only. Some of these are large panoramas (14 x 96 cm) and all have a recommended viewing distance of 9.5 inches (24 cm). These locations were agreed with SNH, who also represented the interests of Clydesdale District Council. The limitations of these are stressed, including a statement that they (the photomontages) over-represent the appearance of the turbines at distances beyond 4 km to 6 km. Each visualisation is accompanied by discursive text that interprets the view but does not lead to a precise declaration concerning significance. A summary is then provided, leading to a more general appraisal of effects in relation to landscape character (zones).

4.6.5 This detailed Landscape and Visual Assessment (Appendix B, Volume 3) is then translated into the main statement (Volume 1) in a general overview that offers the broad conclusion that *"although the windfarm may be seen over a wide area, there will be few views that will perceptibly change from their present overall character to any significant extent".* It states that the height of the turbines has been reduced from 64 m to 55.5 m (as a result of internal and external consultations). However, the as assessed height (Volume 3) was 55.5 m and the as built height is 65.5 m. We do not understand the reasons for these differences. It might be expected that this discrepancy of 10 m would have introduced error into both the ZVI and the visualisations.

Table 11: Viewpoint Analysis for Hagshaw Hill

VP	Distance (km) - Direction	ES assessment	Site observations	Photomontage
1	3.25	Bare exposed landscape setting above gentler wooded landscape with AGLV to east in view. Conspicuous in certain conditions.	26 turbines visible. Conspicuous in bare landscape. Appears closer because of low light levels and orientation of the development which is in a horizontal plane to the viewer.	Layout of turbines accurate. 30% are lower than on pm.
2	4.5	Waste disposal heaps to W substantially influence view. Substantially screened by topography and development	20 turbines visible. Waste disposal heaps do not substantially influence view as they are below the ridgeline. No topographical screening from the road. Dominant feature as there are minimum number of detractors.	Reasonably accurate. Wider development area than shown.
3	4	Edge of Douglas Conservation Area. Majority of turbines are screened from view. Relatively small and more distant component. Not a significant adverse effect.	11 turbines visible. No towers are visible. Not a dominant feature on the skyline.	Much lower levels of development than shown.
4	4	Influence of the development encroaches into the setting of the AGLV. Will not dominate or significantly affect the quality of the landscape.	22 turbines visible. Does not dominate the scene owing to the landscape character of the valley, but it is a visible feature on the skyline.	Differences in the clustering of the turbines from this viewpoint add to the impact in the centre of the scene. More turbines shown with towers than actually appear on site. Deciduous valley- side trees and conifer blocks limit visibility by acting as detractors.
6	14	Urban environment. Near detractors. Relatively insignificant component with little influence on the urban experience.	24 turbines visible. Strong vertical elements and foreground topography add interest and detract from development. Scale of windfarm small in the scene. Movement only detectable in sunny conditions by glinting off blades.	Individual turbines on pm appear smaller than on site
7	8	Substantially screened by topography. Not a significant change	5 turbines visible. Indistinct over shoulder of hillside. Contrast low.	
8	8	Urban environment seen over conifer plantation and street lights are detractors. Marginal change No real visual significance	24 turbines visible. View of development framed by houses, lines of which lead the eye to Hagshaw Hill, therefore because of this more impact in the view 'No real visual significance' incorrect.	More obvious in view than in wireframe
9	7.75	Fleeting views.	16 turbines visible.	In wireframe the

		Discernible, but not significant adverse effect.	Discernible. Visible but of similar scale to trees and smaller than other more dominant elements closer to the road. Fast speed of travel means windfarm is less obvious. Much more noticeable from junction 12 on M74.	elements appear smaller in scale than in reality
10	8	Turbines are not the highest or most extensive landscape elements in view. Strong horizontal lines.	24 turbines visible. Visual interest in the foreground. Moderately dominant in this sensitive landscape.	Turbines appear taller and more evenly spaced than in pm.
11	2.5	Detractors in view. Will add feature of visual interest	Tip of only 1 turbine blade visible. No significant effect.	N/A
12	12	The nature of the change will not significantly adversely affect either the context of the view or the quality of the wider view.	26 turbines visible. Situated on the highest land in view. Movement attracts attention and increases visibility and intrusion.	
13	12.5	Small and relatively insignificant. Discernible only on clear days. Limited degree of visual influence. No significance. Adverse impact for negative viewers.	26 turbines visible. Clearly visible on skyline to SSW spread across hilltop. Larger in view than any other vertical element in landscape, but not dominant.	Elements appear smaller in wireframe than with naked eye but suspect this is the effect of the moving image.

Site Survey

4.6.6 All viewpoints (listed) were visited twice each except 3, 7 and 12, which were visited once each.

4.6.7 From the site observations the ES is accurate in its predicted assessment in 8 out of 12 of the view points. The photomontages were accurate in 2 out of 11 cases. Of the 9 that were inaccurate, three showed the windfarm larger than it appeared on site and in six of the illustrations the windfarm appears larger as built than in the photomontages. The viewpoint selection provided good coverage of the area with the exception of travel towards the site in a south west direction from Rigside to Douglas on the A70 and particularly around junction 12 on the M74 where the impact was higher and the development has a more significant visual impact than VP 9 (along the northbound carriageway of the M74).

Conclusions

4.6.8 The technical details of the VIA are mostly provided in this ES (if not always justified) but potential errors are not acknowledged. A significant (10 m) discrepancy between the height of the turbines as assessed and as built raises serious doubts about the accuracy of the ZVI and visualisations. The landscape and visual effects are not clearly distinguished, but are interwoven. Magnitude, sensitivity and significance are separated, justified and discussed, but the treatment is extremely discursive so that it is difficult to separate the inherent complexities of the issues. There is also much explicit advocacy and argumentation in this ES, in addition to objective impact assessment.

4.7 Hare Hill

The Windfarm

4.7.1 The windfarm was constructed in 2000. The original proposal was for 20 turbines with a height to hub of 40 m and total height of 60 m. As built the windfarm consists of 20 turbines with height to hub of 62 m and total height of 85.5 m, a dramatic difference that might have resulted in under-prediction in the ZVI. Viewpoints were selected after consultation. This proposal went to a public inquiry through written representation. Although approval was given, the siting of individual towers was a reserved matter that was not followed through fully by further consultation with SNH, and there are significant differences between as assessed and as built.

The Environmental Statement

4.7.2 The ZVI is based on a 20 x 20 km grid centred on the site. The shortest distance from the edge of the site to the limit of the ZVI is 8.5 km and the longest distance is approximately 13 km. The ZVI is the zone of theoretical visibility (worst case scenario). No explicit calculation is made of the zone of actual visibility taking account of ground cover or structures, but it is mapped according to the number of turbines visible (1-7, 8-13 and 14-20). Eight viewpoints were selected based on consultation with Cumnock & Doon Valley DC, SNH and New Cumnock Community Council (shown on Map 14, Main Report), and these are shown as 8 photomontages in the Main Report (prepared using a 50 mm lens and a recommendation that these be viewed from 17 cm).

4.7.3 Impact assessment is based on the number of turbines visible and distance. The ES states that the windfarm would be clearly visible at distances less than 1 km, distinct at 1 – 3 km and less dominant at 3 – 6 km. Beyond 6 km the prediction is that the turbines are increasingly indistinct. The sensitivity of receptors (residents, travellers etc), the degree of screening, visibility effects (eg weather) and field of vision are also considered and discussed. Meteorological data for a distant but comparable weather station is used to estimate and quantify the effects of cloud cover on visibility.

4.7.4 There is a complex but clear and explicit manipulation of several criteria to produce impact rating scales and then an integrated evaluation of both magnitude and significance based on a combination of receptor sensitivity, screening, distance and visibility, with significance classes described as none-minor-moderate-significant. Reference is also made to mitigation by choice of rotor blades (3 not 2) and colour (non-reflective finishes and pale colour).

Site Survey

4.7.5 All viewpoints listed were visited twice.

4.7.6 From the site observations the ES is accurate in its predicted assessment in 5 out of 8 viewpoints. The photomontages showed 50% accuracy in their predicted visual impact (2 out of 4), the inaccuracy representing an under estimate in the visual impact on site. Hare Hill occupies a dominant hill top location visible in particular from directions south clockwise to north east. The siting and topography restricts views from the closest housing at New Cumnock, but views of the windfarm are apparent along the majority of the Glen Afton road, a scenic drive. The ES provides predictions on the anticipated level of impact based on criteria of significance. These criteria were sensitivity of different receptors, extent of screening and or backgrounding of the development by landform or vegetation, distance of the development and the visibility as measured by the field of vision. These were found to be accurate. Visual effects not predicted by the Environmental Statement include: the impact

of the views from the A76 travelling south east from Cumnock to New Cumnock which is increased by intervisibility with Windy Standard (the two windfarms occupy the highest ridges in the view), although at this distance the significance of intervisibility is limited. However, the experience for the driver is of windpower as a noticeable feature in the landscape. The implication of this is for the effects of intervisibility on any future windfarm development.

Table 12: Viewpoint Analysis for Hare Hill

VP	Distance (km) - Direction	ES assessment	Site observations	Photomontage
1	4.5	Significant impact.	5 turbines visible. Vertical interference in view from telegraph poles which are more dominant than the turbines	
2	3.5	9-11 turbines visible. Significant impact increased by the heritage associated with the Glen and the sensitivity of the human receptors.	12 turbines visible. Wind farm covers undulating tops of hills and the variety of heights of the turbines and the variation in topography provides some lessening of effect, but it is the only major development in this area of the attractive valley.	Reasonably accurate. (on 13 Feb Light and contrast in the sun make the turbines more obvious and it appears closer in sunlight.)
3	5.5	Significant impact. Comments as viewpoint 2	16 turbines visible. Bulk of hills and rock faces are greater in scale than the turbines and this lessens the visual intrusion. Moderate element in the landscape made more dominant by movement and skylining	Towers appear taller and less clustered than in p.m
5	6.0	Moderate impact Approximately 8 turbines visible	12 turbines visible. Intricacy of the landscape receptors reduces impact	
6	8.0	Moderate impact. Significance reduced by being greater than 5 km.	14 turbines visible on the skyline. Inter-visibility with Windy Standard increases the perception of the scale of the development.	Reasonable accuracy, but towers do not appear tall enough as the blades in the p.m appear to go down to the ground.
7	4.2	9 turbines on average in view. Farmsteads and dwellings highly sensitive to change and have a wide angle of view, but this would be moderated by distance and screening.	14 turbines occupy a wide angle of view on the hillside in a horizontal plane to the viewer. Screening by topography and the horizontal banding in the view provides an acceptance of the development width.	Reasonable accuracy. Turbines are lower to the E and higher to the W than shown.
8	8.5	Minor impacts. Average of 8 turbines visible, but impacts substantially reduced by distance and effects of atmospheric conditions which would reduce visibility throughout much of the year.	9 turbines visible. Foreground urban and rural detractors reduce the apparent impact of the development.	Pm. Does not link to location plan.

4.7.7 The number of view points chosen was limited and a particular omission was from B741 travelling north east just to the west of Knockburine where 16 turbines at a distance of 10km appear suddenly over the ridgeline and the impact increases as the driver travels towards the windfarm before it becomes obscured by vegetation and topography.

Conclusions

4.7.8 The technical details of the VIA are provided in this ES although potential errors are not acknowledged. The recommended viewing distance for photomontages is extremely short. Magnitude, sensitivity and significance are separated, justified and discussed in an explicit and balanced way.

4.8 Novar

The Windfarm

4.8.1 The windfarm was constructed in 1997. The original proposal was for 34 turbines, but height to hub and total height are not stated in the ES (landscape section), which casts doubt on the accuracy of the VIA. As built the windfarm consists of 34 turbines with height to hub of 35 m and total height of 55.5 m. SNH judge that all the main or significant viewpoints were covered, in consultation with Highland Council, including addition of a viewpoint from Ben Wyvis. There was some (but not major) adjustment of tower positions between as assessed and as built, and there were larger changes regarding ancillary works (access tracks etc) during construction, but these were not considered in the present study.

The Environmental Statement

4.8.2 It is stated that the ZVI was supplied to the landscape consultants by National Wind Power Ltd and no technical detail is provided, nor is the ZVI presented in the ES. The radius used was 10 km *("the turbines would be inconspicuous beyond that distance although they may be visible"*), plus two selected viewpoints beyond 10 km. No explicit calculation is made of the zone of actual visibility taking account of landform, ground cover or structures, and no account is taken of the spatial distribution of individual turbines, which covers approximately 3 km.

4.8.3 Thirteen viewpoints were selected based on site survey and consultation with SNH and Highland Regional Council. Each view was used to assess landscape character, then for impact assessment. Photographs were taken with a wide panoramic format camera. Wirelines are referred to but not shown. Photomontages are shown for 5 viewpoints, but no details of their preparation, limitations or recommended viewing distance are provided (except that they are shown as before and after images, based on the original photographs taken with the wide panoramic format camera). These photomontages are never referred to in the detailed VIA.

4.8.4 The ES refers to the amount of change in assessing impact but there is no reference to character or the concept of capacity. The issues of magnitude and significance are merged and drawn from the Department of Transport Design Manual for Roads and Bridges. Volume 11 – Landscape Assessment as follows:

> *Substantial – where the proposals would cause a significant change in the existing view.*
> *Moderate - where the proposals would cause a noticeable change in the existing view.*
> *Slight - where the proposals would cause a barely perceptible change in the existing view.*
> *No change – where no change would be discernible.*

4.8.5 Only substantial impacts are regarded as significant. This scale is applied at each viewpoint, related to human receptors (e.g. travellers, residents, walkers) and summarised in a table. Reference is also made to mitigation by colour of tower *("a light hue of neutral colour*").

Table 13: Viewpoint Analysis for Novar

VP	Distance (km)	ES Description	Site assessment	Photomontage
1	8.5 – 9.75	Predicts 17 turbines visible and quality "pleasant" and impact "slight to moderate".	23 are visible on site. Turbines are inconspicuous unless you actively search for them. However, 10 were backclothed against snow covered hills giving weak contrast (would be stronger against vegetation).	Difficult to check accuracy of PM at this distance (Ben Wyvis in cloud and so not seen in PM). Panoramic lens completely misrepresents scene.
2	6	Predicts 25 turbines visible and quality "very pleasant" and impact "moderate".	22 are visible on site. Turbines clearly visible in good light.	No PM.
3	5-6	Predicts 24 visible in part and quality "pleasant" and impact "moderate".	22 are visible on site but part-screened by row of trees in middle-foreground.	No PM.
4	4 - 6	Predicts 20 visible in part and quality "pleasant" and impact "substantial".	17 are visible on site.	PM is largely accurate representation of turbines in two groups but wholly underestimates visual effect due to use of panoramic lens.
5	2	Predicts 12 visible in part and quality "pleasant" and impact "substantial".	13 are visible on site.	No PM.
8	6.5	Predicts 13 (part) visible and quality "very pleasant", compromised by overhead power lines directly over viewpoint and impact "slight".	12 visible on site. Overhead power line not strictly "in view". Perception of turbines constantly changing as they are lit-unlit by movement of sun in and out of cloud. In photograph, use of panoramic lens "shrinks" centre hills to give very misleading impression.	No PM.
9	10.5	Predicts all 34 visible in part, and that quality is "pleasant" and impact "slight to moderate".	Fewer visible (13) than predicted but visibility poor. House now constructed in immediate foreground.	No PM.
10	15	Predicts 27 visible in part and quality "very pleasant" and impact "slight".	26 turbines visible, but not clear with naked eye and binoculars needed to check. Movement not detectable at this distance. Those backclothed were clearer but those skylined much less distinct.	Visibility on site much clearer than when PM photograph taken. Hills behind windfarm not an indistinct blur in reality.
11	3	Predicts 10/11 visible and quality "high" and impact "substantial".	11 turbines visible on site.	No PM.

Site Survey

4.8.6 There are 13 viewpoints in the ES. Three were not visited because they were too remote and one because it was on private land. Out of 9 visits to 9 viewpoints we were able to make 9 useful assessments.

4.8.7 The predictions of the numbers of turbines visible were generally very accurate or accurate, and differences may be as much to do with re-siting decisions after assessment as with any errors in the VIA. The photomontages were seriously misleading for two reasons; first, their small size and secondly the use of a panoramic lens camera.

Conclusions

4.8.8 The technical details of the VIA are not provided in full in this ES, nor are they justified, and potential errors are not acknowledged. The ZVI is not provided. There is no explanation given on the potential accuracy (or otherwise) of the photomontages and in fact they are never referred to (we did not have access to the main statement, Volume 1, where such reference may appear). Magnitude, sensitivity and significance are identified but not separated with any clarity, nor are landscape and visual effects clearly distinguished.

4.9 Windy Standard

The Windfarm

4.9.1 The windfarm was constructed in 1996. The original proposal was for 40 turbines with a height to hub of 40 m and total height of 60 m. As built the windfarm consists of 36 turbines with height to hub of 35 m and total height of 53.5 m, which might have resulted in over-prediction in the ZVI. Viewpoints were selected after consultation with SNH and local authorities.

The Environmental Statement

4.9.2 The ES states that a *"computer based study was used to delineate areas of potential visual access within a radius of 16 km*" but such a ZVI does not appear in the ES. Figure 8 shows circles at radii of 5 km and 10 km plus selected viewpoints beyond 10 km drawn on a 1:100,000 scale OS map, but there is no indication of relative visibility in relation to topography and this is not a ZVI. There is a note that *"normally the radius of the search area is 10 km, on the basis that the largest features, the turbines, are generally inconspicuous beyond this distance although they may be visible".* Significance is not treated explicitly. It is stated that *"the assessment of impact is the description of the amount of change within the landscape in conjunction with a consideration of the landscape character"* (sic). Passing reference is made to the Department of Transport Design Manual for Roads and Bridges Volume 11: Landscape Assessment. Elsewhere in the ES, summary tables bring all impacts to a common scale of minor, moderate and significant, although these terms are never explained or justified.

4.9.3 Twenty viewpoints were selected, mostly within 15 km of the centre of the site. A table provides, for each viewpoint, a location, short description, distance, note on predicted visibility (number and effects) and a declaration of significance. Although never justified, the significance terms used are slight, moderate and significant, despite the fact that the DoT Design Manual referred to earlier uses the terms no change, slight, moderate and substantial. Wireline diagrams are referred to but not shown. These viewpoint descriptions are repeated in the text. For six viewpoints, selected after discussion with the Regional Council, photomontages are produced, but these are never referred to in the assessment of viewpoints and no technical details on their production or use are provided. The summary section uses the terms moderate and substantial. There is acknowledgement of the existence of a parallel proposal for a windfarm at Harehill and potential issues of intervisibility and cumulative effect are noted but not analysed.

Site Survey

4.9.4 All the listed viewpoints were visited twice

Table 14: Viewpoint Analysis for Windy Standard

VP	Distance (km)	ES assessment	Site observations	Photomontage
1	9.5	Nil	Not visible	
2	13.5	Impact slight	Not visible, obscured by foreground vegetation	
3	13	Turbines skylined in distance. Impact slight.	27 turbines in centre of view. The only obvious development.	Turbines appear smaller and less as individual units in the pm than in reality.
7	13	Nil	Not visible, but Hare Hill is	
8	11.5	Nil	Not visible, but Hare Hill is	
9	11.5	Nil	Not visible, but Hare Hill is	
10	11	Possibly views of parts of the turbines	Not visible	
11	4.5	Nil	Not visible	
12	13.5	Turbine development would be indistinct. Turbines in view would be set against the hillside and within the cover of Carsphain forest. Impact slight	26 turbines visible in the distance. Smaller in scale than Hare Hill, which can be clearly seen nearer to the viewer.	
13	13	Impact slight compared with the already approved Hare Hill wind farm.	Not visible	
15	7	Nil	4 turbines visible along the river valley. The bulk of the hillsides in this location decreases the turbines apparent size.	
16+17	4	6 turbines would be visible on top of very dominant hills. Significant change in view.	4 turbines visible. Steep sided valley with conifer plantations in a range of topography. Turbines are seen as large-scale skyline elements. Drama of the site appears to reduce impact.	Accurate for the 4 largest turbines. Two above nacelle cannot be seen.
18	5.5	?????	Dodd Hill obscures views	
19	10	Nil	Nil	

4.9.5 From the site observations the Environmental Statement is accurate in its predicted assessment of 9 out of 13 cases. Of the photomontages assessed, one was accurate and one showed the windfarm larger than it appeared on site. There were insufficient photomontages within this ES to comprehensively illustrate the visual effects of the windfarm as built. Visual effects not predicted by the Environmental Statement include: the impact of the views from the A76 travelling south east from Cumnock to New Cumnock is increased by intervisibility with Hare Hill (the two windfarms occupy the highest ridges in the view), although at this distance the significance of intervisibility is limited. However, as mentioned previously, the experience for the driver is of windpower as a noticeable feature in the landscape and the implication of this is for the effects of intervisibility on any future windfarm development. Although the statement refers to the approval of permission for the Hare Hill windfarm there is no information on intervisibility. This is a key feature in long distance views from A76 travelling south east from Cumnock and minor roads (VP 12). This is considered as a major shortcoming, but we understand that commercial confidentiality restricted availability of information to carry out a cumulative assessment.

4.9.6 The topography of the site severely restricts the visibility of the windfarm from close range. The choice of viewpoints close to the development gave an assessment of no effect in 7 of the 20 viewpoints. This could have been picked up as a desk study by a theoretical ZVI to which topographical data had been applied.

Conclusions

4.9.7 The technical details of the VIA are not provided in this ES and potential errors are not acknowledged. There is no ZVI and no wireframes. The photomontages are never analysed or discussed. The landscape and visual effects are not clearly distinguished. Magnitude, sensitivity and significance are not distinguished, justified and discussed and there is inconsistency in the terminology used. Although there is reference elsewhere in the ES to effects on landscape, people, recreation etc, the overall structure of the ES makes it difficult to locate and link each of these elements of a comprehensive VIA.

4.10 Other Windfarms and Environmental Statements

4.10.1 Access to some further ESs was possible (Appendix 3), in hard copy or via the www, and key data on ZVI and distances has been extracted from these (and included in Table 16). A more systematic review of a wider selection of ESs was considered in the original plan for the project, but time limitations, compounded by the fact that a comprehensive collection of ESs for Scottish windfarms is not available in either SNH or the Scottish Executive Library, means that such further research has been restricted.

5 OVERALL ANALYSIS

5.1 Introduction

5.1.1 We now analyse a range of generic issues concerning visual impact assessment, based on a consideration of the evidence gathered from all the assessments made at all the viewpoints visited, and considering the literature examined and the environmental statements reviewed. We concentrate on visual effects and leave the key issues surrounding technical visualisation to the final discussion.

5.1.2 Although it is tempting to try to offer specific and conclusive diagnoses or prescriptions, it is clear that the wide variety of factors that influence the core issues under investigation – magnitude, distance and visibility – are such that any generalisation is dangerous. On the other hand, practice cannot proceed effectively if the conclusion is that there are so many variables that nothing useful can be said. An attempt is therefore made to strike a balance between definitive conclusions and an acknowledgement of the context-specific issues that can affect these conclusions. Whenever we make a comparison – for example, that movement increases apparent size or visibility – this is always assuming that other factors are held constant (e.g. light, distance etc).

5.1.3 This analysis applies to windfarms operating in Scotland and in landscape areas of a particular character. The detailed conclusions may or may not be directly applicable to other areas of the UK and to other landscape types.

5.1.4 The size range of the windfarms examined was from 53.5 – 85.5 m overall height but the majority were 53.5 – 65.5 m. However, a new generation of machines is now under development or construction with overall heights approaching 100 m. It is expected that our conclusions on distances or distance ranges would therefore need to be increased for these taller wind turbines.

5.2 Influences on Visibility

General Visibility

5.2.1 In general we found that the turbines are perceptible at a range of from 15 – 20 km from the windfarm and up to 25 km in specific cases and conditions. These distances only apply in clear conditions and if you are specifically looking for the turbines and not just looking at the landscape. It is likely that the turbines would be perceptible to a casual observer at distances of from 10 – 15 km, unless they were highly sensitive or observant or a resident.

5.2.2 The distance over which turbine detail is noticeable is about 5 - 8 km. At a distance of more than about 10 km it is not possible to identify the taper of the turbine tower or identify nacelle detail. At distances up to approximately 12 km turbines are perceived as individual structures that, dependant on layout, may or may not form a group. At a distance of more than about 10 km the turbines begin to be perceived as a group forming a windfarm, rather than as individual turbines.

5.2.3 Higher turbines are visible over a larger distance and this is reflected in our recommendations for ZVI in Table 17. Taking account of the distance ranges over which effects operate at the case-study sites, we judge that an increase in overall height to something approaching 100 m for third generation turbines will result in these distance ranges increasing by around 20% in many cases. When the number of turbines is

considered, the influence of a greater number of turbines on the visible distance is less certain, and probably depends on turbine layout, grouping, and the scale of the turbines/windfarm relative to the scale of the landscape. Impact diminishes as distance increases, but is not necessarily directly proportional to turbine number.

Proportional Visibility

5.2.4 Sometimes the whole structures (tower, nacelle and blades) are visible, fully or predominantly, above the horizon. Sometimes the view includes a mixture of elements – the whole structure of some, the upper part of the tower or the extreme tips of rotors of others. In extreme cases, the only elements visible are rotors. The first case is more visually coherent and the eye sees the structures with clarity. The appearance of just the rotors, or the nacelle and rotors, above the horizon produces a disconcerting effect when they are moving that we would describe as less visually coherent, although the observer may mentally fill-in the missing elements. The former appearance can have less impact than the latter at the same distance, because the latter effect is unusual and disturbing even when it is familiar.

5.2.5 The visual layout of turbines in relation to the horizon and skyline profile is therefore an important factor for consideration when assessing the effect at a viewpoint. The extent, pattern and proportions of structures in the view in relation to the scale and form of the landscape and the skyline are all important.

Lighting

5.2.6 We observed that direct sunlight shining on the turbines, either intermittently as the sun moves in and out behind clouds, or for longer periods in bright clear conditions, has the effect of increasing the prominence of the structures and this effect operated over a wide middle distance range. Viewpoints to the south of a windfarm (in the arc from east through south to west) experience this effect whereas back-lit effects occur at viewpoints to the north (in the arc from east through north to west).

5.2.7 Glinting, as the sun is reflected directly into the eye of the observer, can occur over long distances, at least up to 12 km, but is very occasional and is also sensitive to very small changes in angle of view. A flickering effect as the movement of the blades casts a shadow on the tower can occur in bright sunlight and can attract the eye at relatively short distances of from 3 - 5 km; this effect is most marked when the angle of the sun is low in the sky. These potential effects should be considered for viewpoints involving residents or motorists.

5.2.8 The seasonal effects of light (linked with weather and cloud cover) should be considered in relation to human receptors. For residents, year-round conditions are relevant. For tourists and other recreationists, winter conditions will affect fewest people and summer conditions will affect most.

Movement and Orientation

5.2.9 The movement of the blades, in all cases where this is visible, increases the visual effect of the turbines because it tends to draw the eye. We could detect movement with clarity at distances up to 15 km in clear conditions or conditions of strong contrast between the rotors and the sky, but only if you are specifically looking for the windfarm. On occasions, movement was not visible at 6 km in weak contrast. At a distance of more than about 12 km blade movement can become hardly perceptible and we judge that blade movement is perceptible to the casual observer at up to approximately 10 km. Movement was more perceptible when backdropped against dark vegetation compared to grey sky.

5.2.11 Since windfarm rotors are designed to move, the only significant circumstance when a static illusion will result in a generally lesser effect is at viewpoints oriented at 90^0 (± a small deviation of perhaps 10^0) to the prevailing wind direction. Because the prevailing wind in the UK is generally from the south west, viewpoints in the quadrants from south through south west to west, and from north through north east to east, will experience the longest periods of exposure to visible movement. Viewpoints in the opposite quadrants will experience more static effects and we observed this effect at relatively short distances of 2-5 km. We also judged that rotors seen in the plane oriented at 180^0 to the viewpoint appear relatively nearer. It was difficult to assess whether the visibility of movement is affected significantly by the diameter of the rotors or the height of the structures.

Distance, Colour and Contrast

5.2.12 At short distances the colour is clearly seen and colour and light do not have a dramatic modifying effect on visibility, except in extreme overcast conditions or at dawn or dusk. As distance increases, the eye cannot distinguish colour and all structures are seen as grey (this effect would apply whether the turbines were pale grey, yellow or blue). Light coloured (lit) turbines appear closer than grey (unlit) turbines at similar distances. Seen against a blue or pale sky, but not sunlit, grey turbines appear dark. As the sky darkens, because of cloud cover or time of day or season, the contrast between sky and turbines decreases and at long distances (e.g. over approximately 10 km) the turbines may become indistinct because of this. Turbines can appear white against a dark sky if they are lit by sun through patches of cloud. At shorter distances, the contrast between sky and turbines still decreases, but the reduction in visibility is much less because the eye and brain use more linked cues including colour and form and texture as well as contrast.

Contrast, Skylining and Backclothing

5.2.13 The recommendation to use off-white or pale-grey for each element of the structures is because the majority of views by the majority of people are of skylined structures seen against a blue or grey sky. This is because sites for windfarms to date are elevated relative to the majority of receptors. In fact the majority of the viewpoints assessed in the study were middle to long range (5 – 15 km) and skylined. The commonest appearances were dark (grey) turbines seen against a lighter sky and light (grey) turbines seen against a darker sky.

5.2.14 Backclothing is a more frequent phenomenon for viewpoints at elevations higher than the windfarm, although there are a few examples from the case-study sites of backclothing against distant hills and mountains, such as at Novar clearly seen at 15 km against the backcloth of Ben Wyvis, and some against middle-distance hills such as at Dun Law from close-range viewpoints. In winter, backclothing can be against snow-covered hills. Because our surveys did not cover many viewpoints of this type, our site appraisals on this issue are more limited.

5.2.15 As the sky darkens, those turbines seen against the darkening sky become more difficult to perceive, and the ones which are seen against a backcloth of landform and vegetation become relatively more prominent. It is clear from some photomontages and some viewpoints assessed that off-white or pale-grey structures seen against a backcloth of moorland vegetation, including heather, semi-natural grassland and conifer plantations, are much more prominent than when seen against either clear or grey skies. This suggests that the effect of backclothing against vegetation is to extend the visible distance considerably. We observed at a few locations when backclothed turbines were lit by sunlight that they were much more conspicuous than when lit but skylined.

Elevation of Windfarm and Receptor

5.2.16 The area occupied by windfarms is sometimes large and several important effects need to be considered from high-elevation viewpoints. Walkers and others at higher elevations will be within sight of the windfarm for longer periods of time. Visual detractors and man-made elements will be more limited and, apart from the mass of the landform, will be smaller in scale. The turbines will also be backdropped to a greater extent than from lower elevations and the colours of the turbines and vegetation types will have an effect of increasing relative visibility. Air clarity may also be higher at elevation. From higher sites with their long distance views of the landscape beyond the windfarm, there is an effect that can appear to make the turbines look closer than those at the same distance but skylined, and intervisibility as a visual factor can increase in importance.

Colour and Design

5.2.17 All of the case study turbines appeared to be off-white or pale-grey and the current study was not able to explore what additional influences colour might have on VIA, nor have we examined other detailed design factors that may also be relevant to VIA, including tower shape and individual turbine design. As noted earlier, colour effects are mainly important for skylined views at close range but could be more important at longer ranges for backclothed views.

Landscape character and receptors

5.2.18 The character of the landscape and especially elements within it affect perceptions of magnitude. In landscapes that were free of man-made elements the turbines were sometimes much more conspicuous in the middle and long-distance ranges and this affected our judgements of their magnitude. Windfarms or turbines framed by other developments sometimes had a greater apparent impact than those with no framing, because the other elements provided visual cues for judging size, depth and distance.

5.2.19 In the south west region of Scotland the character of the southern uplands is of long ridges, which are a strong horizontal element in the landscape. Other horizontal features, river valleys and their vegetation, hedges and walls, built development and coniferous plantings, often increase this horizontal effect. The windfarms seen during this research can create the impression of another horizontal band at middle range and longer distances, especially where intervisibility between two windfarms occurs.

5.2.20 Consideration needs to be given to the heights, layout and numbers of turbines in a windfarm because the visual impact of a larger number of smaller turbines may be lower (as they are in a scale related to the landscape character) than a windfarm with a smaller number of larger turbines which may in turn be perceived as having a higher visual intrusion level owing to their lack of apparent size-similarity with the horizontal bands in the landscape into which they are to be inserted.

5.2.21 The influence of character will vary for different landscape types, although this is not an issue explored in detail in the current project. However, the technology and economics of turbine design will probably be a more important driver of turbine design and tower height.

5.2.22 Cumulation and intervisibility can be important issues, owing to the breadth of some developments on the skyline, as well as proximity. The orientation of windfarms with respect

to others in the visual field needs to be considered to lessen the apparent scale of development. This observation arose especially in the south west region.

5.3 Assessment of Visibility

5.3.1 We discuss this broad issue in greater detail in Section 6. Here, three general points can be made.

5.3.2 We found that there was a general tendency to underestimate the magnitude of visibility in the ES descriptions compared to our judgements on site. This may be related to the frequent under-representation seen in photomontages (paragraphs 6.1.16 – 6.1.17). No doubt consultants use these for evaluation as much as other parties. If this tendency to underestimate magnitude is widespread, for whatever reasons, it does suggest that much of the published guidance and some of the implied judgements on significance in relation to distance will tend to be conservative. Many anecdotal and derivative distance-significance judgements may therefore need to be lengthened to compensate for underestimation caused by reliance on photomontage. In addition, earlier field studies (e.g. Stevenson & Griffiths, 1994) devised distance bands based on first generation turbines, and our conclusion is that these bands need to be increased for second and third generation structures.

5.3.3 We judged that wireframes *tended* to cause less under (or over) estimation of visibility and visual effect, compared to photomontages, perhaps because they do not purport to be other than indicative of potential visibility. Wireframes are used more as a working tool for VIA whereas photomontages are also used to simulate realism. In other words, whilst both wireframes and photomontages are required to be (and generally are) accurate in terms of the positioning, spatial distribution and size (especially height) of the towers, wireframes (unlike photomontages) are not expected to offer a *realistic* visualisation or impression of the on-site view that will exist after construction of the windfarm.

5.3.4 This may also be an appropriate point to raise a subtle presentational point about visibility assessment. Because many factors act to decrease or increase apparent magnitude (and therefore potential significance), there is a tendency in all the ESs examined (and in guidance such as is shown in Table 3) to adopt what might be termed the *"half-empty"* rather than the *"half-full"* approach to assessment. For example, guidance and assessment often emphasises the factors that decrease visibility ("*only prominent in clear visibility*") rather than the factors that increase visibility ("*always prominent in clear visibility*"). Although both statements are in one sense identical, a different adverb produces a different impression.

6 DISCUSSION

6.1 Visual Impact Assessment

Zone of Visual Influence

6.1.1 It proved impossible to carry out comprehensive tests of the accuracy of the ZVI in the case-studies for two main sets of reasons. First, the area covered by a typical ZVI is very large, for example 225 km^2 for a 15 x 15 km ZVI, and a systematic checking of such a large area would have required intensive, time-consuming site visits. Also, almost all ZVI were based on topographic worst case scenarios, making site survey difficult when the bare terrain of the ZVI is in reality populated by vegetation, buildings and other structures and elements (Wood, 1999, 2000). Second, many windfarms were significantly different in the details as built compared to as assessed; such differences included changes in the numbers of turbines, changes in the overall height of turbines, and changes in the site-specific locations of individual turbines. For these reasons, our diagnoses concerning ZVI are largely based on the literature described in the background research.

6.1.2 ZVI are never accurate (Hankinson, 1999). They contain several sources of error and it may not always be feasible to separate these errors or to estimate their size and potential effects. If the errors are known, this should be stated. The existence of error should always be acknowledged. Such errors may matter less if the purpose of the ZVI is to compare the relative effects of two or more sites or to compare alternative layouts, where it is the comparison which is being evaluated, and not the precision of specific locations. They are not necessarily a reliable basis for predicting visibility from exact locations, which must always rely on additional pre- and post-ZVI desk and site assessment. They are a useful basis for selecting potential viewpoints for consideration (but must be subjected to detailed site testing), perhaps using wireframe or photomontage techniques.

6.1.3 Most ZVI examined are worst case, based on a topographic digital terrain model only. Increasing sophistication by the addition of data on forests, woodlands and other elements in the landscape is at the same time both desirable and subject to the introduction of further errors of detail and interpretation.

6.1.4 All ZVI examined are not distance-sensitive, that is they do not attempt to combine the effects of distance and visibility to generate what has been termed a fuzzy viewshed. This is sensible, given the subjectivity and complexity of this factor, which is best considered as a separate and distinct exercise in any assessment.

6.1.5 The presentation of the ZVI in some ESs could be improved. Overlaying the ZVI onto an OS base map (at 1:50,000 or 1:100,000 scales) is essential to help the interpretation of the ZVI and is also necessary in the initial stages of selecting representative or key viewpoints.

6.1.6 Where the degree of visibility is illustrated using a graded tone or a range of colours, careful thought on presentation and explanation is required to minimise the risk of creating a distorted impression. This can arise because the number of turbines visible sometimes increases as the distance increases, due to topography, whilst the relative size or visual effect decreases in parallel. A shaded ZVI that uses denser tones for areas where the number of visible turbines is greater can create an impression that is diametrically opposed to the probable magnitude and significance of the visual effects. One solution might be to adopt the use of the term ZTV (Zone of Theoretical Visibility) for what is now commonly referred to as the ZVI in order to emphasize the theoretical, potential and limited nature of the information shown in such a map. Another solution might be to produce a second map (perhaps called the Zones of Visual Effect: ZVE) where the predicted magnitude of the

effects (Table 18 and Section 6.2) is translated onto the ZTV to illustrate the effects that distance (and other factors) are expected to have on the size and intensity of the visual effects. Finally, a composite map (perhaps called the Zones of Visual Significance) could be considered which combines the ZTV and the ZVE with the thresholds and criteria used for assessing significance, to illustrate graphically what is now only explored using a limited number of key viewpoints. We are not aware that such presentation techniques have been attempted experimentally, nor have we explored fully the potential conceptual, technical and interpretational difficulties, but this may be an area for further research and development in the application of CAD and GIS tools.

Table 15: Published Technical Recommendations for Visual Impact Assessment

		ZVI (distance in km)	ZVI	ZVI	Visualisations	Photomontage
Tower height →		*Not specified*	*c60 m*	*c95 m*		
CC (1991)		10-15				
BWEA (1994)		-	-	-	Recommended but non-specific	Recommended but non-specific
Stevenson & Griffiths (1994)		10			Recommended and specified	Recommended and specified
LI-IEA (1995) & LI-IEMA (2002)		-	-	-	Recommended but non-specific	Recommended but non-specific
Thomas (1996)		-	20	-	-	-
TJP (1997)			15			
CuCC (1999)			20		Key viewpoints within 10 km radius	
CPRW (1999)*			20	30		
CCW (1999)		10-20				
SNDC (2000)		20				
MAA (2000)			20	30		
SNH (2001)		25			Key viewpoints up to 10 km radius	
SE PAN45 (2002)		-	-	-	Recommended but non-specific	Recommended but non-specific

* Sinclair-Thomas recommendations (Table 4).

6.1.7 On the question of a recommended radius for a ZVI in relation to the proposed overall height of towers, we have reviewed the recommendations that appear in published guidelines (Table 15) and the practices in the case-study and other ESs (Table 16). In no case-study has a developer used the recommended radius contained in Sinclair-Thomas (Table 4), and whilst there is a suggestion in Table 16 of a trend for the radius to increase in size as the height of towers increases, this is by no means clear.

Table 16: ZVI in Environmental Statements in Relation to Number and Size of Towers.

	Windfarm	Date of ES	Height of Tower (maximum including rotor)(m)*	Number of Towers*	ZVI (km) **	Viewpoints (number)
1	Delabole	1991?	40.4	10	7.5	Not known
2	Burnt Hill	1993	60	19	17	27
3	Hare Hill	1994	60 (85.5)	20	10 (8.5-13)	8
4	Hagshaw Hill	1994	55.5 (65.5)	30 (26)	12	16
5	Novar	1995	? (55.5)	34	10	13
6	Windy Standard	1995	60.0 (53.5)	40 (36)	16 (10?)	20
7	Dun Law	1996	66.7 (63.5)	34 (26)	8 (16)	8
8	Beinn Ghlas	1997	65 (57)	16 (14)	10	13
9	Beinn An Tuirc	1997?	62.5	50 (46)	15	18
10	Gartnagrenach	1998	63	24	15	9
11	Deucheran Hill	1999	76 (76.5 & 62.5)	12 (9)	15	14
12	Meikle Carewe	1999?	78	14	25	22
13	Kielder	2000	82	107	20	Not known
14	Black Law, Carluke	2001?	90?	70	23	Not known

* First quoted figure is as in ES. As-built height and number may differ and figures in parentheses are as-built if known to differ from as-assessed in ES.
** Two figures are quoted where there is a lack of clarity or contradiction in the ES.

6.1.8 Based on our diagnoses concerning the effects of distance, our arguments that relatively small effects could be significant for highly sensitive receptors, the precautionary principle which is now widely established as best practice in environmental policy, and taking account of the increasing sizes proposed for new developments, we recommend the general guidelines shown in Table 17.

Table 17: Recommendations for ZVI in Relation to Overall Height.

Height of turbines (total including rotors)(m)	Recommended ZVI distance (km)
50	15
70	20
85	25
100	30

6.1.9 The figures in Table 17 are approximate and should be adjusted either upwards or downwards to suit local circumstances and in the context of local or regional landscape character and landscape or visual sensitivity. Despite the trend towards larger and taller structures, it is unclear what ultimate limits might exist, because optimum tower height depends on an integration of economic, meteorological, technological and environmental factors. The recommendations in Table 17 would need to increase for heights greater than 100m, although at distances much greater than 30 km the limit of visibility to the human eye is being approached.

6.1.10 The cost of digital data is very low but computation times will increase for ZVI for larger radii. The calculation of line-of-sight from a digital terrain model (DTM) in GIS is therefore still computationally intensive (Kidner et al, 1997) and such costs may be one reason for developer or consultant reluctance to extend the radii of ZVI. However, we judge that this cost is still a relatively small element of an overall EIA. A further reason for resistance to larger radii might be tactical and psychological, in that increasing even a ZTV increases the likelihood that designated or valued landscapes will appear on the zonal map at the margins, so perhaps fuelling fears among developers that an increase in potential significance will be perceived if the radius is increased. We have commented on this and related issues, and possible ways to address it, at paragraph 6.1.6.

Viewpoints

6.1.11 The general result from our brief interviews with SNH project officers was that they felt that developers had listened and accepted SNH recommendations concerning the selection of viewpoints. Whilst hindsight might occasionally suggest a key viewpoint that was omitted, we judge that any significant underestimation of visibility is often due to post-ES siting and design changes rather than to any key omissions at the scoping stage. For some case study sites, additional post-ES visualisations had been prepared. However, there are occasional instances of omission, an issue that arises particularly in the south west region where intervisibility and cumulative effects were sometimes acknowledged but not analysed and assessed.

6.1.12 From our analysis of the case study sites, we can detect no clear rationale for the number of viewpoints selected that might lead to recommendations. For example, Table 16 shows a wide variation in the number of viewpoints selected, unrelated to the size or number of turbines or the size of the ZVI. The number selected is a result of negotiation between the developer or the consultants and statutory consultees, especially the local planning authority and SNH. Whilst there may be some developer-resistance to producing very large numbers of visualisations on the grounds of time or cost, additional influences must also be the landscape character within the ZVI and the probability or potential significance of visual effects based on the density of human habitation, transport or recreational routes, strategic recreational sites or scenic viewpoints and so on. Local Plans and related Supplementary Planning Guidance may also influence the selection of viewpoints, although we have not examined this issue. A case-by-case approach to viewpoint selection through negotiation is therefore the only feasible option.

6.1.13 We did note that in some ESs, viewpoints are described as being selected to show a *"representative"* range of visual effects. We also noted a frequent tendency for several *"not visible"* viewpoints to be selected for assessment. By way of contrast, the Harehill windfarm is visible at seven of the eight viewpoints assessed (and probably visible at the eighth), but the Windy Standard windfarm is invisible at nine of the 15 viewpoints assessed. Whilst acknowledging that the ZVI, used for identifying potential viewpoints, will contain errors, this phenomenon appears at first sight to be odd. The ES is required by law and regulation to assess potential significance, and if the ZVI predicts invisibility, then detailed assessment seems unnecessary. Although we have not explored the possible reasons behind this, it may be that consultees wish to see further proof of invisibility beyond the ZVI, and that there is deep distrust of the accuracy of ZVI.

6.1.14 The choice of precise viewpoints in the case-study ESs sometimes seemed less than ideal. There were occasions when we assessed a viewpoint and noticed that a very short distance nearer to or even further away from the windfarm the turbines were more prominent. We found this at Dun Law and Deucheran Hill and Beinn an Tuirc. There were some viewpoints for Deucheran Hill from which the windfarm was not visible, but from the same location Beinn an Tuirc was very visible or even dominant. Perversely, this viewpoint was not used in the Beinn an Tuirc ES, but a viewpoint nearby selected for Beinn an Tuirc demonstrated a much reduced or zero impact.

6.1.15 If visualisations are therefore being used for what are effectively three separate purposes, (a) to test the ZVI, (b) to provide a representative selection of visual effects (essentially this is visual survey and not assessment), and (c) to assess the potential significance of effects at key viewpoints, then these three purposes should be distinguished. Although mixing these purposes might appear harmless, it can result in an ES that contains potentially and superficially very misleading information. For example, statements to the effect that *"the windfarm would only be visible from three of the fifteen viewpoints assessed"* can be inserted freely and truthfully, without acknowledging that twelve of these may have

been selected specifically to show just such a non-visible and therefore non-significant effect.

Wireframe and Photomontage

6.1.16 Photographs (and therefore photomontage) are subject to a range of limitations. They may not reproduce small objects or texture, rendering of colour is variable, light levels are not reproduced accurately, the small scale can tend to distort, and contrast is generally lower than in reality. However, and accepting these limitations, they are useful and essential tools in VIA. Our own view is that wireframes can be as useful as photomontage in many circumstances, because they are cheaper to produce, so more can be requested, and because they do not purport to be other than indicative of potential visibility.

6.1.17 The accuracy of photomontage has at least two dimensions. First, a photomontage can and should be accurate in the sense that the positioning, spatial distribution and size (especially height) of the towers is accurate in relation to the landscape and other elements or structures in the picture. This is achieved by meticulous attention to a number of detailed requirements that are familiar in photomontage (and wireframe) technology. Second, the accuracy of a photomontage can be judged on the degree to which it creates a realistic visualisation or impression of the on-site view that will exist after construction of the windfarm. This consideration is more subjective and impressionistic, but realism can be enhanced by avoiding obvious distortions caused by some lenses, and by considering size and viewing distance, discussed below.

6.1.18 A photomontage can imply a degree of realism that may not be robust, and can seduce even a critical viewer into investing more faith in that realism than may be warranted. Certainly our case-study analyses confirm a widespread belief that photomontages almost always underestimate the true appearance of a windfarm from most viewpoints. This is in contrast to statements in some ESs that overestimation occurs because of the technique used to produce the photomontage.

6.1.19 There can be several causes of this underestimation. The most obvious is the use of panoramic or wide angle lenses that produce subtle and sometimes not so subtle distortion. Wide angle lenses in particular have the effect of enlarging the foreground and reducing or receding the background in a manner that directly under-represents the apparent magnitude of windfarms in landscape scenes. We therefore endorse the general use of the 50 mm lens on a 35 mm format camera. For photomontage, the focal length of the lens used and other relevant technical detail should always be quoted.

6.1.20 A second reason is the common submission of visualisations that are relatively small, often accompanied by a recommendation to view them from an unnaturally short distance. For example, some case-study ESs suggested viewing distances of 17, 23 or 24 cm. Our judgement is that this configuration is a strain on the eyes, is difficult or impossible to use and fails to capture any semblance of realism. Because most viewers will in practice observe these images from longer distances, a subtle but powerful under-representation of the visual effect is introduced.

6.1.21 A typical, comfortable viewing distance for reading A4 pages is 30-40 cm, and a typical, comfortable viewing distance for larger images at either A4 or A3 held at arm's length is 50-60 cm. We therefore recommend that what is comfortable and natural for the viewer should dictate the technical detail and not *vice versa*. This means that visualisations should be designed for typical viewing distances of 30 – 50 cm and that most visualisations should be correspondingly larger (a recommendation also made in Stevenson & Griffiths, 1994). A full image size of A4 or even A3 for a single frame picture, giving an image height

of approximately 20 cm is therefore to be preferred, rather than the common use of images with a height of approximately 10 cm.

6.2 Effects of Distance

The Sinclair-Thomas Matrices

6.2.1 We tested the Sinclair-Thomas Matrices (Table 4) during our site visits and found them difficult to use because of the imprecision of the terminology used, and because the separation between magnitude and significance was not always clear or was mixed. In addition they take no account of the influences of different landscape character or visual context. Whilst there is probably not much controversy over a judgement that the visual effect is dominant close to a windfarm and indistinct or negligible at long distances, the matrices lack clear differentiation in the middle-distance zones. It is here, of course, that most debates and controversies over magnitude and significance exist. In general our on-site assessments were in agreement with Sinclair-Thomas at viewpoints near to a windfarm and at long distances, but we consistently rated the visual effect as either much less or lower in the middle-distance zones, or we were unable to reach a robust judgement because of a lack of differentiation in definition between distance classes. For example, we were never able to distinguish the difference between Band C *("Clearly visible with moderate impact: potentially intrusive"*) from Band D *("Clearly visible with moderate impact: becoming less distinct* ") on visual grounds.

An Alternative Schema

6.2.2 We have therefore devised the following schema as an alternative to the Sinclair-Thomas or other distance-magnitude guidelines, based on the results from the current research project. This schema is offered as a suggestion for testing and further evaluation, and our earlier comments on issues of magnitude and significance should underline the inherent difficulties in devising any schema that is likely to enjoy universal consensus, even among trained professionals. We suggest that the following approach might at least help clarify the issues sometimes hidden within the generalised statements that appear in some literature.

6.2.3 First, we suggest use of the conceptual model shown in Figure 2. The issues are complex and this cannot be wished away. The first factor to be considered is physical form of the development, which varies with the windfarm structures, their number and layout. The second factor to be considered is visibility in a physical sense, including distance to the viewpoint, weather effects and the seasons – what we have termed the ambient conditions in Figure 2. The third consideration in terms of magnitude (left side of Figure 2) is a large number of factors that modify the visual effect, some related to human perception and some related to physical elements and design of the environment. We believe that this is a structured and enlightened approach to the assessment of magnitude.

6.2.4 Second, we suggest that magnitude be described as shown in Table 18. The terms large, small etc are used because magnitude means size. For each size class, we offer a single keyword descriptor, which is then qualified with other words to try to paint a verbal picture of the size effect. Each class is a range, and the boundaries are explicitly not fixed or defined. It is important to emphasise that no judgement of significance is implied in this table and the words have been chosen to describe size only, in so far as this is possible.

6.2.5 Our judgement is that in the very large, large and negligible distance zones, there are very few factors that modify the physical visual effects to any great extent, although all will have some slight modifying effect. However, a host of modifying factors needs to be considered in the broad middle distance zones. These are listed in Figure 2, divided into

those that tend to increase the perception of magnitude and those that tend to reduce it. In judging the appropriate size class for any predicted visual effect at a particular viewpoint, these factors need to be considered explicitly.

6.2.6 It is important to stress that the critical classification is the visual size class and not the distance. Three examples emphasise this point. It is the size class descriptor *prominent* that is important visually, not whether the viewpoint happens to be at 1 km or 2 km from the turbines. If the prevailing wind is such that the turning rotors will appear directly facing the viewer for most of the time, the turbines will appear more visible than if the prevailing view is to blades at right angles to the viewer; in this case, it is perfectly feasible for the perceived magnitude to be judged as *conspicuous* rather than *apparent*. If meteorological data shows that aerial visibility will be low for a high proportion of the year, the average magnitude of the visual effect will be correspondingly lower; in this case, it is perfectly feasible for the perceived magnitude to be *apparent* rather than *conspicuous*.

6.2.7 Magnitude must then be linked with sensitivity to seek evaluation of significance, discussed in the next sections.

6.3 Receptor Sensitivity

6.3.1 For sensitivity (right side of Figure 2), we recommend use of the words high and low, rather than large and small, because the words high and low imply a level of intensity rather than a size associated with magnitude. Both the sensitivity of the human receptor and the interaction with their location or the type of viewpoint may need to be evaluated.

6.3.2 Whilst there appears to be a general consensus, expressed in much guidance (e.g. LI-IEA, 1995; LI-IEMA, 2002)) and in ESs and elsewhere, that assessing sensitivity is subjective and depends in the end on experience and balanced professional judgement, we suggest that this consensus should apply mainly to landscape assessment. For the related but distinct area of visual assessment, it seems to us that this is as much a matter for people as for professionals. When a landscape or other professional writing in an ES identifies a range of human receptors – residents, walkers, tourists etc – and then categorises their visual sensitivity as high or medium or low - it needs to be acknowledged that this is the professional acting as a representative or surrogate; they are not applying professional experience and judgement, *per se*.

6.3.3 Although this type of human sensitivity categorisation seems intuitively reasonable, we know of no detailed evidence to support it. Also, of course, people's perceptions, attitudes, preferences and sensitivities are known to be highly diverse and variable. Further, people are not either residents or walkers; most people may be both of these things, and other things, at different times of the day, or seasons, or through their behaviour, lifestyles or lifetimes.

6.3.4 We therefore recommend that in any ES there is an explicit description of who the human receptors are, and a description of their suggested sensitivity, with further detailed justification if possible, including their number, mobility, exposure time etc. If and when detailed research is carried out to test the range and diversity of such sensitivities, then this information can be used directly in EIA.

Figure 2: Conceptual Model for Visual Impact Assessment

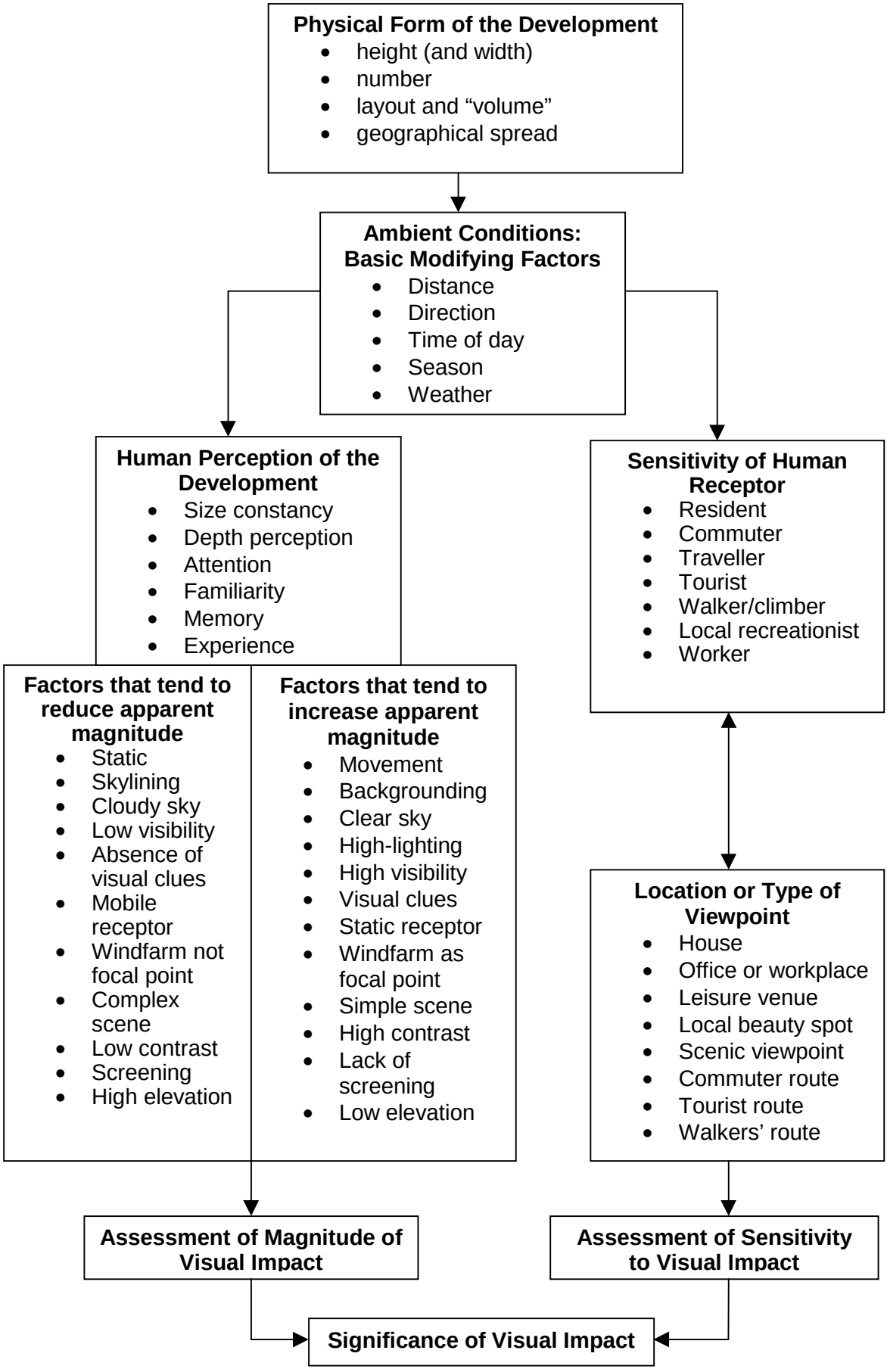


Table 18: Size Classes, Names and Descriptors for Visual Effect (Magnitude)

Size Class	Name	Descriptors – appearance in central vision field	Modifying Factors (Figure 2)
Very Large	Dominant	Commanding, controlling the view	Few
Large	Prominent	Standing out, striking, sharp, unmistakeable, easily seen	Few
Medium	Conspicuous	Noticeable, distinct, catching the eye or attention, clearly visible, well defined	Many
Small	Apparent	Visible, evident, obvious	Many Limit of Potential Visual Significance ↓
Very Small	Inconspicuous	Lacking sharpness of definition, not obvious, indistinct, not clear, obscure, blurred, indefinite	Many Limit of ZVI ↓
Negligible	Faint	Weak, not legible, near limit of acuity of human eye	Few

6.4 Significance

6.4.1 Of all the issues surrounding VIA, significance is the most subjective and intractable. We therefore recommend that the link between magnitude and sensitivity is made explicit to arrive at judgements of significance. The use of simple matrices is, we believe, a helpful tool for mapping and explaining the basis for the judgements made. However, as LI-IEA (1995) has stressed, the matrices in those guidelines are indicative suggestions only, and a case-by-case approach is required in assessing significance for individual windfarm proposals. The LI-IEA (1995) model matrix of three classes on each axis producing 9 cells, only 3 of which are typically judged as significant, is in our view simplistic and unrefined and quite unsuitable as a tool for widespread use. In particular it implies a degree of certainty about a very restricted definition of significance that we do not believe is justified. Expanding a 3 x 3 (9 cells) matrix to 4 x 4 (16 cells) or even 5 x 5 (25 cells) is much more representative of the diversity of size and sensitivity found in visual impact assessment. These matrices do not appear in LI-IEMA (2002), perhaps because of the risk that they will be applied indiscriminately. Instead, LI-IEMA (2002) emphasises that *"Significance is not absolute and can only be defined in relation to each development and its location. It is for each assessment to determine the assessment criteria and the significance thresholds, using informed and well-reasoned judgement supported by thorough justification for their selection …."* and goes on to give several examples (Appendix 6) of criteria, definitions of magnitude and interpretations of significance used by different landscape practices for different project types and landscape settings. There is a lack of statutory guidance on the definition and evaluation of significance and this may be one reason for some simplistic approaches to a complex and difficult issue.

6.4.2 We are not persuaded by the common declaration or assumption found in some of the ESs examined that a medium effect imposed on a medium sensitivity receptor is necessarily insignificant, nor that a small effect on a high sensitivity receptor is also insignificant. For example, LI-IEMA (2002) states that *"in wilderness landscapes the sensitivity of the people who use these areas may be very high and this will be reflected in the significance of the change*". It therefore appears to us feasible that a small change for a

highly sensitive receptor could be judged to be significant. An example of the problem of interpretation of significance appears in the ESs for the Beinn an Tuirc and Deucheran Hill windfarms. Both declare they are based on the EIA Regulations, but the former concludes that moderate and major effects are significant, whilst the latter concludes that only major and moderate-major effects are significant. However, ultimately this is just playing with words, and as we have already pointed out, the law, regulations and statutory materials offer no unequivocal guidance. Until such time as robust consensus on significance, based on detailed research, can be claimed with confidence, best practice requires that the bases for all judgements made are clear and explicit on a case-by-case basis.

6.5 Conclusions

6.5.1 VIA is complex. All the issues surrounding magnitude and visualisation (e.g. factors affecting visibility, human perception, ZVI, camera specifications for photomontages), and all the issues surrounding significance (e.g. the sensitivity of human receptors, and the meanings of words such as material change and fundamental change), are subject to complexity, controversy and uncertainty. This research and report has reviewed, examined and explored these issues in detail. It has tried to explain the influence of different issues and effects and to offer guidance on their interpretation and application to VIA.

6.5.2 VIA requires an explicit recognition of this complexity, controversy and uncertainty. The provision of detailed technical information is essential in any VIA to ensure that the issues can be understood and sound judgements made. The overriding consideration is that the quality of the VIA needs to be high if the evaluation of impacts is to be sound.

6.5.3 Given the wealth of research, guidance and experience revealed by this study (even if some of it is contradictory), we were surprised at the general lack of reference to and use of this material in the ESs examined. This apparent failure of research and even practice-based research to penetrate quickly into EIA and VIA practice is an issue that may need to be examined and addressed.

7 RECOMMENDATIONS FOR BEST PRACTICE FOR VISUAL IMPACT ASSESSMENT

In this section our detailed recommendations are presented and summarised as concise bullet points. Their justification is contained within the preceding review, analysis and discussion. Although some may seem obvious or even trivial, there is such variation in the content of the VIA in the Environmental Statements examined that even these simple points need emphasis in the interests of best practice.

7.1 General

- Generic Best Practice Guidance on EIA should also be followed for VIA, including the requirements for assessment to be rigorously documented and explained, integrated, consistent, balanced and objective and for presentation to be logical, clear and well-structured
- Cumulative effects and the cumulation of windfarm projects should be considered and assessed whenever relevant
- Comprehensive scoping based on consultation should be carried out
- Clear distinctions should be made between magnitude, sensitivity and significance
- The inherent complexity, controversy and uncertainty in VIA should be acknowledged and addressed
- High quality VIA depends on a detailed and explicit declaration of the basis upon which all aspects of the VIA have been made, especially magnitude, sensitivity and significance
- Significant post-assessment changes should be re-assessed, re-visualised and re-evaluated
- Wider use should be made of the existing wealth of research, guidance and practice experience

7.2 Landscape and Visual Assessment

- Visual Impact Assessment is an integral but distinct part of Landscape and Visual Assessment and should be distinguished from Landscape Assessment, including Landscape Character Assessment, Landscape Sensitivity and Landscape Significance
- The *"Guidelines on the Environmental Impacts of Windfarms and Small Hydroelectric Schemes"* (Scottish Natural Heritage, 2001) and *"Guidelines for Landscape and Visual Impact Assessment"* (LI-IEMA, 2002) should be used.

7.3 Zone of Visual Influence

- A ZVI should appear in any Environmental Statement, superimposed on an OS base map at 1:50,000 or 1:100,000 scales
- The data used to calculate the ZVI should always be described. The use of OS Panorama Data and a 50 m cell size is recommended
- The existence of error should always be acknowledged and if possible the errors should be assessed and discussed
- A theoretical (computer generated) ZVI should always be tested and verified by desk and field study and the results of those tests should be described
- Distance for ZVI should be based on the recommendations in Table 17 and should be justified, including any alternative distance used
- Distance for ZVI where cumulative effects is an issue should be adjusted, extended and justified

- ZVI should assess the degree of visibility based on the numbers of turbines visible, at least to the maximum height and if possible based on nacelle/hub height and on total height
- Any extensions to a worst-case (bare ground) ZVI to include computer modelling of built and landscape elements should be subject to these same recommendations

7.4 Viewpoints

- Viewpoints should be selected by negotiation with statutory consultees, including the Local Planning Authority and Scottish Natural Heritage, and public consultation and participation should be considered
- The number should be selected to achieve an effective assessment of key viewpoints and an effective assessment of representative viewpoints, as two distinct considerations
- Viewpoints should be selected in order to identify both potentially sensitive receptors and potentially significant views or locations or landscapes
- Precise selection on site should be made to avoid detailed positioning which underestimates the visual effect by the judicious positioning of screening objects
- If used to verify the accuracy of any ZVI, such verification should be distinguished from its use to assess potential sensitivity and significance
- If viewpoints are also used as part of any landscape assessment, this should be clearly distinguished from the visual assessment
- The precise location (including OS grid reference point), orientation to the proposed development, date, time of day and weather conditions should be stated for each viewpoint

7.5 Visualisations

General

- The focal length of the lens and camera format used for photographs (and derived visualisations) should always be stated
- Use of a 50 mm lens in a 35 mm format is recommended, or equivalent combinations in other formats
- Panoramas should be produced by splicing standard photographs and not by the use of specialist cameras, in order to minimise distortion

Wireframes

- Wireframes should be used in an appropriate combination with photographs and photomontage, as both working and presentation tools
- Wireframes may occasionally be preferred to photomontage because they reduce the risk of implying a false realism

Photomontages

- The limitations of photomontage should be recognised and acknowledged, especially a tendency for photomontage to consistently underestimate the actual appearance of a windfarm in the landscape
- A natural viewing distance of 30-50 cm should dictate the technical detail of their production
- A full image size of A4 or even A3 for a single frame picture, giving an image height of approximately 20 cm, is required to give a realistic impression of reality

7.6 Magnitude

- Magnitude (size) of visual effects should be described and the categorisation justified
- Terminology such as large – small should be used
- The use of the size classes and descriptors in Table 18 is recommended
- Distance should not be used mechanistically to predict magnitude at a particular viewpoint because of the potential effects of other modifying factors

7.7 Environmental Conditions and Human Perception

- The specific environmental conditions at or affecting each viewpoint should be stated and analysed, including factors such as season and weather, air clarity, movement, orientation to prevailing winds, visual cues, screening and elevation of the wind farm in relation to the viewer (Figure 2), as well as the detailed design and layout of the windfarm
- Available data should be used wherever possible (e.g. meteorological data)
- Specific aspects of human perception at or affecting each viewpoint should be stated and assessed, including factors such as size constancy, depth perception, attention, familiarity and experience (Figure 2)

7.8 Receptor Sensitivity

- Different human receptors should be distinguished and described (Figure 2)
- Terminology such as high – low should be used
- Their characteristics and behaviour, including factors such as mobility, should be distinguished
- Their number, degree and time of exposure and other relevant factors should be analysed, using available data wherever possible
- Their assumed sensitivity should be described and justified
- Distinctions should be made between assumed human receptor sensitivity and that based on landscape professional experience and judgement

7.9 Significance

- The basis upon which significance and non-significance has been assessed should be described and justified
- Significance (and sensitivity) is highly context and project specific and this needs to be recognised and addressed
- Every project requires its own set of criteria and thresholds, tailored to suit local conditions and circumstances

7.10 Conclusion

- The increasing development pressures for windfarms require that VIA is approached in a comprehensive, explicit and systematic way and that the inherent complexity, controversy and uncertainty are addressed.

8 ACKNOWLEDGEMENTS

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10 APPENDICES

Appendix 1: List of Environmental Statements and Related Documents Used for Case Study Sites

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Appendix 2: Additional Data Sources for As-built Case Study Sites

Beinn An Tuirc: http://www.tjp.co.uk/eia_files/beinn-an-tuirc.html (accessed 15 February 2002)

Beinn Ghlas: http://www.natwindpower.co.uk/beinnghlas/index.htm (accessed 15 February 2002)

Deucheran Hill: http://www.pgen.com/news/default.asp?display=detail&News_ID=294&Category=16 (accessed 15 February 2002)

Dun Law: http://www.geo.ed.ac.uk/scotgaz/features/featurefirst7717.html (accessed 15 February 2002)

Hagshaw Hill: http://www.ecogen.co.uk/hagshaw.htm (accessed 15 February 2002)

Hare Hill: http://www.scottishpower.com/newsdesk/pr113010_23_10_2001.htm (accessed 15 February 2002)

Novar: http://www.natwindpower.co.uk/novar/index.htm (accessed 15 February 2002)

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Appendix 3: List of Other Environmental Statements and Related Documents

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Appendix 4: Project Brief

Visual Assessment of Windfarms - Best Practice

Background

In reviewing Environmental Impact Assessments (EIAs) for windfarms it is apparent that there is a great deal of variation in the way that assessment of both visual impact and the significance of visual impact are dealt with in these documents. There is also a degree of contention amongst landscape professionals about the appropriate distance for Zones of Visual Influence (ZVI) surveys and a corresponding need for some independent opinion on all the above aspects.

Aims of study

- to identify any relevant work on visibility, visual impact and significance
- investigate visibility of existing windfarms
- to compare as-built visibility with estimates of visibility in EIAs
- draw conclusions about appropriate distances for ZVI in different circumstances

Method

It is anticipated that the study will begin with a brief literature review to identify any relevant work previously carried out on visibility, visual impact, zones of visual influence (ZVI) and criteria for assessing significance of visual impact. This review may include published EIAs. Some consideration of other types of development (such as transmission towers) may be required, where the methods used are relevant to the current study.

A selection of 10 existing windfarms would be visited. Several visits will be necessary to embrace a variety of lighting and weather conditions. These conditions should be documented as part of the assessment.

The selection would be agreed at the inception meeting, but would be drawn from developments located in N England and mainland Scotland. A list of existing windfarms in Scotland is included at Appendix 1 (not attached).

Using the EIAs for each of these developments, consultants would check the visibility from each of the viewpoints identified, comparing actual visibility with that anticipated by the EIA. Consultants would need to liase with the relevant SNH contact and the competent authority concerned to obtain the most recent EIA, establish the degree to which this reflects the as-built development, verify whether the selection of viewpoints took into account SNH comments, and any other relevant background information. Note that consultants must contact the appropriate SNH Area office in order to obtain permission before entering private land. Contact details will be provided at the inception meeting.

Consultants may need to identify and assess further viewpoints, where for example, SNH had requested other viewpoints but the request was ignored, or where an overly restrictive ZVI may have excluded others.

In reviewing EIAs for existing developments, consultants should also review the reliability of wireframe and photomontage representations of proposals and draw conclusions about their accuracy. It is not envisaged that photography will be required as part of this study.

Using all the information gained above, consultants should draw conclusions about:

- whether there is any published best practice guidance available on the topic
- the visibility of existing windfarms in different conditions
- whether this was anticipated by the EIA and accurately portrayed in wireframes and photomontages
- whether the ZVI was broad enough to include all viewpoints with significant visibility

Best practice recommendations should then be made on the basis of these conclusions.

Project outputs

Written report, maps, tables, including extracts from EIAs.

Programme

Project initiation	w/c 17 December 2001
Draft report	15 February 2002
Final report	8 March 2002

References

- Guidelines on the Environmental Impacts of Windfarms and Small Scale Hydro-electric Schemes
- Guidelines for Landscape and Visual Impact Assessment

Appendix 5: Summary of Findings from a Study of Hagshaw Hill Windfarm (Turnbull Jeffrey Partnership, 1997).

"As light conditions change, particularly the colour and nature of the sky backcloth, the perceptibility of the turbines changes. When turbines are perceived against a white or light sky backcloth, they appear dark. As the sky backcloth darkens, those turbines seen against the darkening sky backcloth become more difficult to perceive, and the ones which are seen against a backcloth of landform become more prominent. Also, when sunlight shines on the turbines, they become more prominent.

The turbines are perceptible at a range of more than 20 km from the windfarm (two researchers identified them in excellent visibility conditions at about 29 km). This range only applies if you are specifically looking for the turbines, not just looking at the landscape. It is likely that the turbines would be perceptible to a "casual" observer at a distance of up to approximately 17-20 km.

Blade movement is an important consideration, as it tends to draw the eye towards the turbines. Blade movement is perceptible at a range of about 15-17 km, but only if you are specifically looking for the windfarm. At a distance of more than about 15-17 km, blade movement is not perceptible. Blade movement is perceptible to the casual observer at 10-15km.

At a distance of more than about 12 km, the turbines are perceived as a group forming a windfarm, rather than as individual turbines. At a distance of less than 12 km, turbines are perceived as individual structures which, dependant on layout, may or may not form a group. The distance at which turbine detail becomes noticeable is about 8 km. At a distance of more than about 8 km, it is not possible to see the taper of the turbine or identify nacelle detail.

Turbines generally appear more visually satisfying when they appear fully or predominately above the skyline, rather than partially above the skyline. Where only the turbine blades are visible above the skyline, this looks very unusual.

Visual layout of turbines in relation to the skyline profile in an important factor to consider when assessing the impact on a viewpoint. The issue of the extent and pattern of turbine layout in relation to the scale and form of the skyline is important.

Where the windfarm and viewpoint occur in the same area of landscape character, the potential for a higher impact on the viewpoint is increased. Where they do not occur in the same area, the potential is reduced.

Analysis of the research findings leads to the conclusion that there are a large number of inter-related factors which need to be considered when selecting an appropriate cut-off radius, and that no exact figure can be arrived at with any degree of certainty. Relevant considerations are the size, colour, layout and number of turbines, weather conditions, the type of landscape in which the windfarm and viewpoint are located and whether blade movement is perceptible. Professional experience of siting similar objects in the landscape leads to the belief that use of higher turbines certainly results in a greater cut-off radius. However, when the number of turbines is considered, the influence of a greater number of turbines on the radius is less certain, and probably depends on turbine layout, grouping, and the scale of the turbines/windfarm relative to the scale of the landscape. Certainly, impact diminishes as distance increases, but is not necessarily directly proportional to turbine number.

In considering the above points in relation to the proposed Beinn an Tuirc windfarm, professional judgement has concluded that 15 km is a reasonable ZVI cut-off radius to use for practical assessment purposes as the distance beyond which there is unlikely to be a significant adverse landscape and visual effect because: movement of the blades would generally not be perceptible; the proposed windfarm would appear as a small-scale element in the landscape beyond such a distance ; it is unlikely that the windfarm site would occur in the same area of landscape character as viewpoints which are more than 15 km away from the windfarm; beyond this distance, the turbines would be perceived as a group forming a windfarm, rather than individual turbines. This 15 km radius accords with Argyll & Bute Council's opinion of long and short-range visibility expressed in their Windfarm Policy document: "The choice of representative viewpoints should reflect long and short-range visibility (15 -0.5km)……" [Reference 3, Appendix D].

It is acknowledged that there remains a degree of uncertainty in adopting this distance. It is also acknowledged that, depending on weather and lighting conditions, the windfarm would be visible from greater distances. However, given the range of variable factors which require consideration to determine such a radius, it is considered that a 15 km cut-off radius is a reasonable distance to adopt in this situation in relation to the likelihood of a significant adverse landscape and visual effect occurring."

11 NOTES

[1] "Grey literature" is a term used to describe documents, reports, policy guidance and so on that are not officially published in the sense of having an ISBN or ISSN number and which are therefore not certain to be accessible through official library cataloguing sources.

[2] Environmental Statements are an important resource and data-base for policy development, research and case work (for all project types). We noted that there is no central system within SNH for cataloguing and storing ESs, and apparently no systematic policy of retention in area offices. Considerable effort was needed to obtain the requisite ESs for this project, mainly by the landscape team in headquarters. We strongly recommend that SNH consider establishing a recording and retention system for such documents. In fact there is no centralised and reliable system for ES storage in the UK generally or in Scotland. The Scottish Executive Library in Edinburgh is apparently charged with their retention, at least for a period (lists appear in PAN58: EIA), but enquiries reveal that their collection is partial.

[3] Therivel (2001) and others sometimes refer to the Zone of Visual Intrusion and LI-IEMA (2002) refers to the Visual Envelope Map (VEM).

[4] Other terms used include viewshed, visual envelope and intervisibility maps.

[5] The literature also refers to "fuzzy viewsheds" to describe the degree to which the target might be distinguished given such phenomena as atmospheric conditions, the eyesight of the observer and the object-background contrast etc.

[6] Landscape Institute Advice Note 01/99: Guidelines for Landscape and Visual Impact Assessment. London.

[7] It should be noted that this analysis of the ESs was confined to the VIA elements only and any positive or negative comments do not imply any judgement on the overall quality of the ES or the overall quality of any combined Landscape and Visual Assessment. Research (e.g.Glasson et al, 1997) shows the overall quality of ESs in the UK to be highly variable, based on a wide range of criteria including both technical content and presentation.