



# COMMISSIONED REPORT

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Commissioned Report No. 087

## **Landscape strategy and assessment guidance for wind energy development within Caithness and Sutherland**

(Contract no. 1995–NW27)

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# COMMISSIONED REPORT

# Summary

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## Landscape strategy and assessment guidance for wind energy development within Caithness and Sutherland

Commissioned Report No. 087 (Contract no. 1995–NW27).

Contractor: Caroline Stanton

Year of publication: 2005 (*This version of the report is a reprint of the original produced in 1995*).

### Background

In the mid-1990s an interest was beginning to be shown in the potential for wind energy development in Caithness and Sutherland. In an attempt to take a strategic approach to the possible landscape effects of these expected proposals, SNH undertook this study. In the event, the rush of interest did not materialise until some years later when technological advances meant that both the height and number of turbines were far larger than was envisaged in this study.

This report was completed in 1995 but not published. But now with large numbers of wind energy developments in Caithness and Sutherland, at varying stages of application, SNH is of the view that this report contains information, on the process as much as the conclusions, that is relevant to the debate.

### Main findings

- that there are certain key landscape characteristics that are particularly relevant to consider in respect of wind energy development.
- that some landscape character types in Caithness and Sutherland are likely to be able to accommodate wind energy developments more easily than others.
- that cumulative effects will be an issue particularly in areas with a great extent of visibility and areas with small scale characteristics.

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## **Preface**

This study has been completed by Caroline Stanton on the behalf of Scottish Natural Heritage. It must be emphasised that in its present form, it does not attempt to represent Scottish Natural Heritage opinion or policy.

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### **Summary**

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## **1 INTRODUCTION**

In recent years, there has been a great deal of interest expressed in the potential of renewable energy within Scotland. Although the country has a tradition of hydro-electric power generation, a wider range of renewable technologies such as commercial wind energy have only been recently explored in detail; this is partly a result of their increased economic viability since the introduction of the Scottish Renewables Obligation (SRO), whereby fossil fuel operators pay a subsidy towards non-fossil fuel generation.

There is currently over 170 MW of installed wind energy capacity within England and Wales (January 1995), where the Non Fossil Fuel Obligation (NFFO), the equivalent of the SRO, was introduced in the late 1980s. It has been suggested that the potential for wind energy generation could be much greater within Scotland, mainly due to its high wind speeds and large areas of extensive, often sparsely inhabited land; this wind energy potential has been estimated to be as much as 1314 MW within Caithness and Sutherland (Department of Trade and Industry *et al.* 1993). In practice, however, there may be restrictions to the availability of this resource, by for example the ability of the existing National Grid to export additional amounts of energy, the region already having a net excess of electricity production. Although these limitations may be reduced, by for example an upgrading of the Electricity Grid, commercial wind energy development may be restricted within this region in the near future, with interest growing in non-commercial small scale wind energy developments as a result.

Scottish Natural Heritage (SNH) is the Government Agency responsible for the protection and enhancement of the natural heritage of Scotland; it is in favour of sustainable development and therefore supports renewable energy in principle. SNH policy states that (Scottish Natural Heritage 1994a, p 38):

“Renewable energy should be promoted where its environmental impacts are acceptable, so that the use of non-renewable energy sources is reduced” and that “SNH will:

- support and help to develop a strategic approach to renewable energy development which directs these activities away from nationally important, fragile and rare species, habitats and landscapes
- be sympathetic to the development of renewable energy technologies in Scotland where these do not lead to significant impact on the environment”.

Part of SNH’s remit is to conserve and enhance a landscape diversity throughout Scotland; to be effective in this role, SNH staff need to ensure through both statutory and non-statutory consultations, that the landscape is considered as an essential part of the decision making process of any wind energy development.

### **1.1 Rationale of study**

In its nature, wind energy development will have an impact on the Scottish landscape. As part of SNH’s role mentioned above, information is needed to enable staff to be able to assess the potential impact of a development and provide subsequent design guidance, whilst also considering the strategic issues of wind energy, particularly important because of potential cumulative impacts.

Windfarms\* have an impact on a variety of physical characteristics which impinge on the experience of a landscape, such as noise, flora and fauna, safety and electro-magnetic interference. Although these are interrelated in how a windfarm is seen and perceived within its surroundings, this study will concentrate on the visual impact of windfarms; this is a particular concern of wind energy developments, for which information is notably lacking.

Although it is recommended that windfarm design guidance should be developed for application throughout Scotland, this study is limited to Caithness and Sutherland; these areas have already been under a degree of pressure from windfarm proposals, and because of their substantial area and variety of landscape types, provide a suitable base upon which to develop such a study process.

## **1.2 Aim of study**

To address the need for information outlined above, this study produces material at two levels. Initially it provides *strategic* guidance for SNH staff, highlighting the main issues of windfarm development within the different landscape types of Caithness and Sutherland. Secondly, it identifies the main issues which should be addressed within the *assessment of an individual* wind energy proposal. The study does not attempt to define what is the best type of windfarm design or location; this would be impossible with the infinite variety of landscape and windfarm characteristics that exist. In contrast, it highlights the main issues that should be considered by SNH staff, allowing them to weigh up all the 'pros and cons' of a potential development.

This guidance will ultimately enable SNH to advise planners, the public and developers of the issues which must be considered when locating and designing windfarms within Caithness and Sutherland.

As it has been previously identified, there is a great need for this kind of information within SNH throughout Scotland; it is hoped that this study will aid in developing a process upon which future studies in other areas can be based upon. It must be recognised however, that because the nature of landscape assessment is site specific, the application of this method and assessment criteria in any other area, will require a degree of refining and adaptation.

## **1.3 Method of study**

To provide the information outlined above, this study assessed the potential impact of windfarms within Caithness and Sutherland, as illustrated within Figure 1. Landscape assessment is an iterative process however, and modifications were constantly made in response to particular issues raised during the assessment. As there are many factors that comprise a landscape character type, only those key characteristics which distinguish them are discussed within the following chapters.

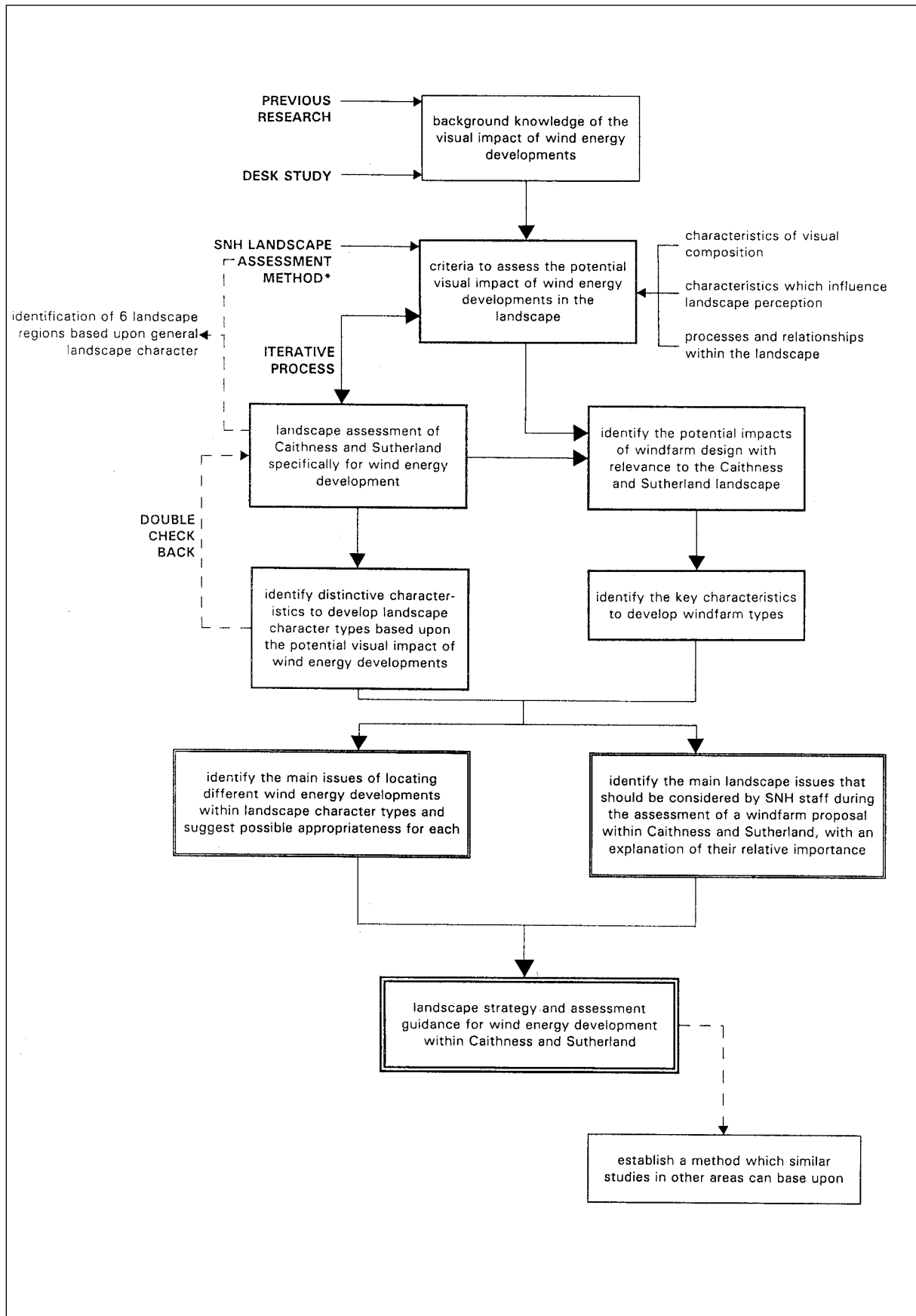
The landscape assessment method involves making observations which are essentially subjective in nature; professionals such as landscape architects however, are trained to make such judgements based upon their knowledge of well known design principles of visual composition, for example visual balance, order, clarity, harmony and hierarchy.

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\* this term is used within the report to generally describe any form of wind energy development including single turbines



Figure 1 Method of study



## **2 LANDSCAPE REGIONS AND CHARACTER TYPES**

### **2.1 Northern Scotland landscape regions**

There are several broad landscape characteristics that are evident throughout the study area of Caithness and Sutherland; these may result in general similarities in the landscape impact of windfarms and include:

- a perceived value of the area, as a result of its remoteness and large expanses of relatively undisturbed land
- an inhospitable and harsh climate
- northern light conditions
- a fragility of ecosystems, characterised by a slowness to recover from disturbance, often as a result of low vegetation growth rates
- the physical inaccessibility of the landscape
- the visual dominance of human elements such as key dwellings, coniferous plantations and pylons, in contrast to generally extensive land use
- a small, distributed population

The landscape character types identified within this document are distinguished purely upon the potential impact of windfarms in relation to landscape characteristics. In the course of this study, however, it was noted that although certain areas may be within different landscape types based upon the impact of windfarm development, they may appear to have broad similarities in their overall character due to dominating cultural, geophysical or locational features. These were subsequently identified as 6 landscape regions and are briefly described within Figure 2, in order that the regional implications of windfarm development can also be considered during the study of more detailed strategic information.

It should be emphasised that although regions and strategic areas are defined within the following maps by lines, the boundaries between them are by no means rigid; landscape types tend to blend from one in to another, with the lines separating them on maps being purely indicative. It must also be stressed that the relationships and hierarchy of characteristics within these areas may change with seasonal and weather conditions, particularly as a result of changing contrasts of colour and texture, for example the varying angle of the sun tending to 'spot light' different features, and the whiteness of snow cover often accentuating a contrast with features such as rock faces and woodland plantations.

**Figure 2 Landscape regions within Caithness and Sutherland**



- 1 North east lowland plateau
- 2 Forsinard
- 3 North west coast
- 4 North central highlands and moorland
- 5 Ancient foreland
- 6 East coastal shelf and Dornoch Firth

### **1 North east lowland plateau**

This area is physically distinctive from its surroundings due to its flat/gently sloping topography, being very exposed with a high extent of visibility. The main land use of the area is agriculture, with relatively fertile land overlying Old Red Sandstone. Settlements and residences tend to be scattered throughout the entire area, although the main concentrations are on the coast, particularly at Thurso and Wick. This scattered distribution of residences often results in a visual confusion of land use pattern and services, with no clear hierarchy of landscape elements.

The nature of light and atmospheric conditions, especially with the proximity of the coastline throughout this area, results in a clarity and sharpness of visibility which is distinctive and often appears quite 'uncanny'. The low angle of the sun at this latitude also means that any vertical structures are highlighted in an abrupt contrast to the ground plane, which often appears muted in colour because of its horizontal elevation and smooth texture. The region frequently offers spectacular views of rapidly moving weather systems approaching and passing through the area. Its 'harshness', however, is often exaggerated in the winter months, when the period of daylight is very short and many facilities tend to be closed.

This area is historically and culturally very distinctive, and there are many archaeological features evident throughout the landscape, often forming foci on hill and cliff tops. The area has visibly undergone great change in the last few centuries and the presence of many abandoned crofts, especially in the south of the area, leads to an almost 'depressed' atmosphere, particularly when new residences are built with their 'backs' to traditional buildings.

## **2 Forsinard**

The landscape within this area is very simple in composition, with a clear contrast of visual elements, namely the horizontal plain, sky, water, rough grassland and regular blocks of coniferous woodland. There is a perception that this area is particularly 'special' because of its remoteness, resulting tranquillity and rarity of landscape type. These qualities also result in the area being especially valued by wildlife, with the noise and activity of birds being notably evident at certain times of the year.

The Forsinard area appears to some extent 'surreal' in contrast to its surroundings, creating a powerful image with its horizontality, unfamiliarity and the sense of 'mystery' which may occur with visual distortion of distance and scale.

Although, to some extent commercial forestry has become a part of this area's character, as an introduced human-made element, it does provide a strong contrast of shape, pattern, texture, colour, elevation and spatial enclosure within the landscape. The woodland access tracks also have a visual and physical impact in the landscape, in an area which is otherwise inaccessible to vehicles and contains few lines as visual elements. The relative visual impact and relationship of these woodland characteristics vary, however, as the cycle of stand maturity and management is constantly changing over time.

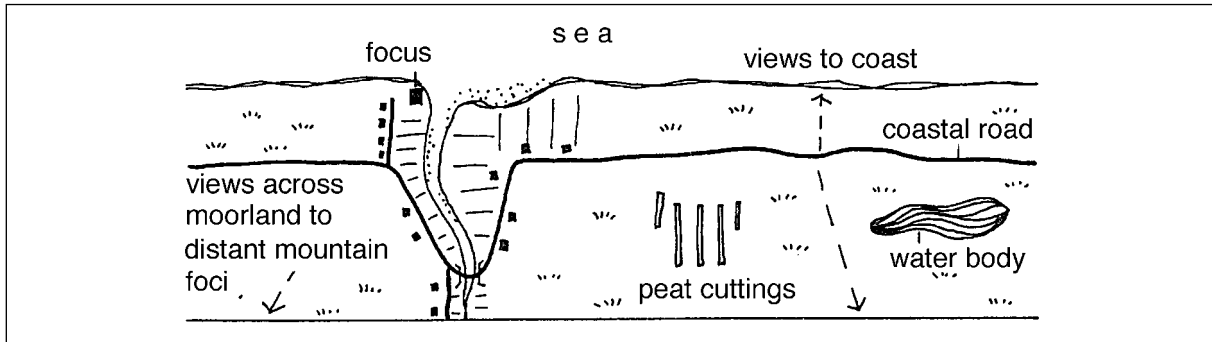


## **3 North west coast**

This area is dominated by the northern coastline and a number of valley mouths, with sandy estuaries and beaches occurring at rhythmic intervals to separate lengths of sheer cliff. The land use, settlements and infrastructure within this area directly relates to the coastline and valley structure, with the coastal road acting as a linear link.

Human activity tends to be concentrated on the coast and within the valleys, with the area being very popular as a circular route for tourists travelling around the north Scotland coastline. Where areas of moorland meet the coast there is a spectacular image created by the combination of these two very powerful 'wild' landscape types valued for their exposure and perception of remoteness.

The topography within this region tends to be fairly flat, rounded, or gently sloping towards the sea, with the coastal road integrating into local undulations. There are many inland pools of water, with southern views directed over smooth, gently undulating moorland towards distant mountain peaks.



#### 4 North central highlands and moorland

This area consists of groups of mountains separated by major valleys running mainly northwest/southeast and large expanses of gently undulating moorland. The area comprises mainly metamorphic rocks with igneous intrusions such as Ben Loyal forming foci within the heavily glaciated landscape; it is generally more open and exposed in the north, with the formation of complex ridge and valley systems in the south.

There tends to be a low diversity of landscape elements within this area, human-made features being highlighted against the almost uniform clothing of thick peatland, which results in a smooth and rounded landform throughout the area.

Human settlement, agriculture and commercial woodland is typically concentrated within small areas of elevated or sloping land, often within valleys or on the top of small mounds. These are often related to the location of historical estates and lodges, many of which are surrounded by mature woodland shelter planting. Access routes tend to travel along the valley floors within the area and act as linkages between the more major coastal roads.



## **5 Ancient foreland**

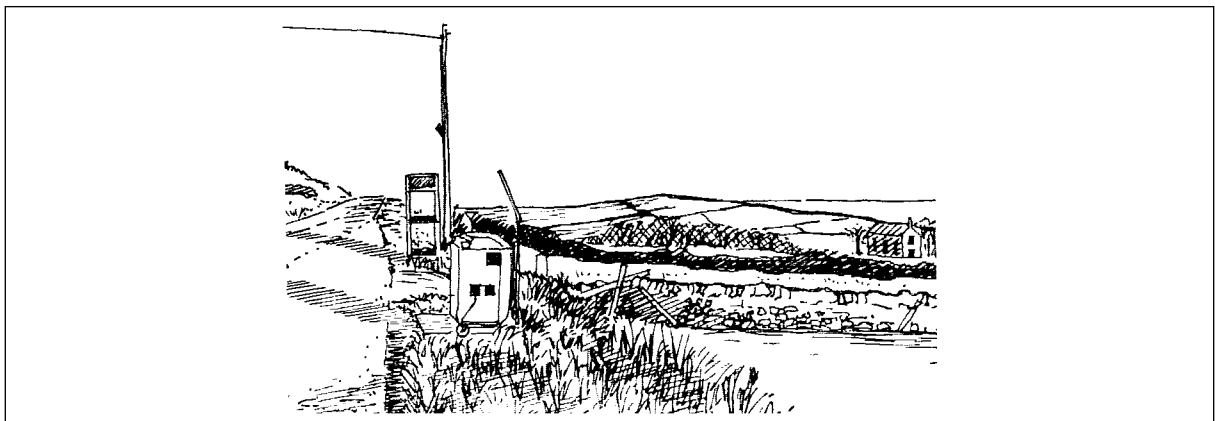
This area is characterised by intensely glaciated lowlands and low plateaux of metamorphic rock, together with relatively isolated massive sandstone mountains. The area is bordered on its eastern side by the Moine Thrust, along which earth movements have created complicated mountain and valley systems. There is a dominance of bare rock within the area, the glaciated metamorphic geology providing an unrefined mammilated surface with only a sporadic covering of thin, infertile soil. The well-bedded and jointed nature of the Torridon Sandstone has resulted in strikingly individual mountain landmarks being formed with weathering and erosion.

This area is particularly valued for its rarity of landscape type, with its remoteness and unrefined quality being perceived as being 'untouched' and 'wild'. Settlements tend to be concentrated on the indented coastline, with the main source of income coming from the small scale fishing and tourist industry. Inland residences are few and far between, usually consisting of estate lodges or visitor facilities; the area has only extensive land use, with agricultural practice mainly restricted to sheep grazing and red deer management in isolated areas.



## **6 East coastal shelf and Dornoch Firth**

This area is influenced by its proximity and direct access links to the settlement concentrations immediately south of the study area. This has resulted in an intensive and varied land use around the Dornoch Firth, extending to linear development up the east coast. An inland range of smoothly rounded mountains restrict visibility and create spatial enclosure in the south of the region; this opens out in the north to meet up with the gently undulating expanses of moorland and agricultural land within adjacent regions.



The whole landscape is dominated by the location and characteristics of the sea and intersecting estuaries. Settlements tend to be located where these valleys meet the coast and there is clear evidence of historic landscape elements, with the location of castles, old churches and stone walls dividing agricultural land.

The area is very popular with tourists, especially for those visiting en route to John O’Groats and the north. This has contributed to the area being particularly busy, providing an active corridor up the east coast.

## **2.2 Landscape Character Types**

Eight landscape character types were defined within Caithness and Sutherland; these resulted from the landscape assessment of the study area specifically for wind energy development, as previously outlined within Chapter 1. The essential characteristics of each landscape type will be discussed in the following section, together with a suggestion of the potential implications for wind energy development. The aim of this process is not to rank landscape character types by whether they are suitable for wind energy development or not, but rather to highlight the main issues which should be considered when designing and assessing a potential windfarm development within each landscape character type.

Many of the characteristics and resulting design issues discussed within the following chapter may seem to contradict each other in the potential implications for wind energy development. The relative importance of these characteristics however, can not be determined at the strategic level, due to the impact of an infinite variety of design and location details; as a consequence, they should be further evaluated for a specific proposal, the ‘pros and cons’ weighed up in relation to windfarm design.

The study area of this assessment will comprise the entire Local Authority districts of Caithness and Sutherland. It will not be limited by development constraint sieves, as other wind energy strategies within the UK have applied. This is for the following reasons:

- Physical constraints such as minimum wind speed are considered excessively restrictive as the available regional data does not take into account the contribution of local winds or the impact of surface physical features. It is also difficult to define an economically viable wind speed threshold, as technical improvements in turbines and the potential for non-commercial development results in a flexibility of this level.
- Economic restraints such as the proximity to access routes or the National Grid are also not applied, for it is again difficult to define a threshold level of viability, considering that these may vary with the estimated value of a development and similarly because there is the potential for non-commercial wind energy generation within Northern Scotland.
- The application of planning restraints such as landscape designations are considered inappropriate as these do not actually prohibit windfarms and are not necessarily adversely affected by their development. It is also considered that the gathering of information on the potential impact of wind energy developments within designated areas should be particularly encouraged because of the landscapes’ sensitivity.

- There are other factors such as areas of archaeological importance within a landscape setting which can not be adequately considered at the strategic level within Caithness and Sutherland. This is due to a lack of available information; as an alternative these subjects will need to be addressed at site specific locations as necessary, the regional issues being highlighted as increased information enables.

Although the above mentioned factors are not applied as sieves within the study assessment, areas of high wind speed, at close proximity to electricity transmission lines, with no landscape designation or evident archaeological importance may be targeted for commercial wind energy exploration, due to their apparent favourable conditions. For this reason, maps illustrating these characteristics are included within the appendices of this report.



**Figure 3 Gently undulating moorland**



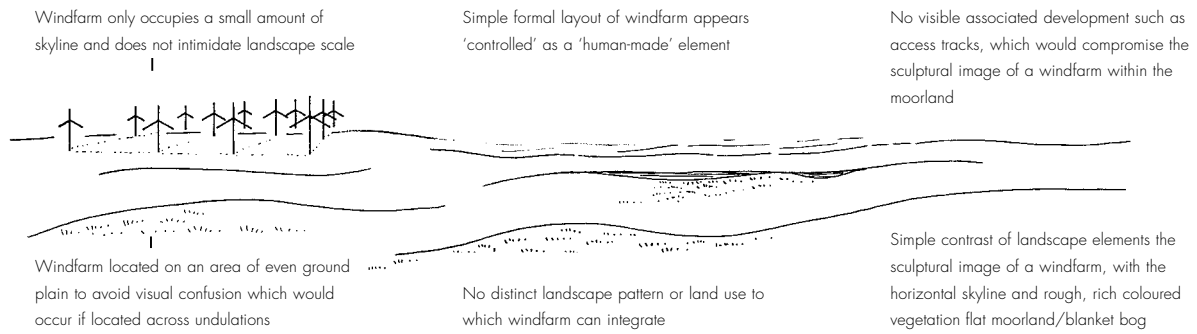
### **Landscape Characteristics**

- Extensive landscape of gently undulating topography.
- Very exposed landscape with high extent of visibility and often panoramic views.
- Moorland vegetation with subtle variations due to differences in landform and ground conditions, resulting in a range from blanket bog to slightly improved grassland. Changes in level are often not clearly evident due to their gradual nature and because the smooth convex slopes intermittently limit mid-ground visibility.
- The landscape has no dominating pattern and is simple in visual composition. The ground undulations provide smoothly curved fore, mid and background horizon lines, with human made features such as fence lines, electricity cables, peat cuttings, commercial woodland plantations and houses being highly visible, often providing a superimposed concentration of visual elements, such as lines, focal points etc.
- It is very difficult to perceive actual scale or distance within this landscape character type. The nature of the distant skyline also varies, sometimes gradually 'fading' into the sky or sweeping up to ridge or mountain areas.
- Vehicular access within this landscape character type is restricted, with only a sparse network of routeways; the main settlements tend to be isolated lodges and residences associated with rural estates.

### **Main issues of wind energy development**

- Due to the extensive and open nature of this landscape type, a wind turbine or windfarm is likely to be a focus within the area. Although such development will probably have a high extent of visibility, it is unlikely that it will intimidate its surroundings due to the spatial exposure of the landscape; a windfarm will only occupy a small amount of the visible skyline and may seem to disappear into the background horizon when viewed from a distance.
- As any windfarm development will have a visual impact over a large area, it may be more appropriate to develop a small number of larger windfarms within this landscape character type. As the landscape pattern and land use is often indistinct, a windfarm will appear as an unfamiliar human intrusion; such a development should portray a sculptural and 'controlled' image, probably as an intensive grid layout.

- With a simple composition of only a few visual landscape elements, a windfarm will usually form a very strong positive image within this landscape character type. Small variations in topography may lead to some visual confusion however, and wind turbines should be located on areas of similar elevation and landform.



**Figure 4 Flat moorland/blanket bog**



### **Landscape Characteristics**

- This landscape character is similar to type one, but tends to be simpler in composition; it forms extremely exposed vast open spaces of flat moorland with many water bodies. There is a perception that the landscape is of great value due to its remoteness, ecological interest and rarity of type.
- This landscape conveys a powerful image due to its extreme simplicity of landscape components, with clear contrasting horizontal layers of moorland, water, woodland and sky.
- It is generally difficult to perceive scale and distance within this landscape character type due to the lack of pattern and fixed scale indicators, although areas of woodland may indicate their own shapes and elevation as isolated superimpositions.
- This landscape character is typically inaccessible by surfaced roads, with only the few scattered rural residences and woodland plantations being serviced by rough tracks. The Inverness to Thurso and Wick railway line bisects the area and at present provides panoramic views across the landscape; these may be at risk, however, together with the whole exposed nature of the landscape, due to the growing proliferation of woodland planting within the area.

### **Main issues of wind energy development**

- The development of a windfarm within this landscape character type would result in a very clear image, due to the simplicity of the existing visual composition and the strong contrast that a vertical feature would form in this very exposed horizontal landscape. Similar to landscape character type 1, any development should be as an intensive, formal arrangement with a sculptural image, due to the lack of any existing distinct landscape pattern or land use.
- The introduction of a windfarm would provide a strong focal point within this landscape type. This may actually be perceived as being comforting to a viewer, in a landscape which has few landmarks to indicate orientation; however, this undifferentiated nature is one of the distinct characteristics of this landscape type and so to some extent the introduction of any foci should be restricted.

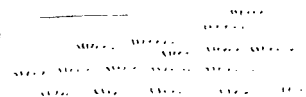
- Although any windfarm is likely to be highly visible within this very exposed landscape character type, its visual impact will be restricted as the development will be seen against the wide expanse of the landscape, with no comparable features to indicate its relative scale. As a vertical feature, in contrast to the horizontal landform, a windfarm will most probably be seen to blend into the background sky and despite the high extent of visibility, the number of people which will actually be affected by visual impact is likely to be very low, as this landscape character type is extremely inaccessible, with only a few inhabitants.
- Irrespective of the visual issues of windfarm development within this landscape, the main factors which are likely to be restrictive may be due to potential physical disturbance, such as to wildlife, specifically birds, and because of the problems of inaccessibility and ground stability and recovery. The rarity and perceived international value of this landscape character type may also mean that planning control may restrict development in this area, whether a windfarm would be visually successful or not (especially as existing commercial woodland planting has already been seen to severely change the visual character of this landscape).

Similar to character 1, a windfarm will only occupy a small amount of the visible vast expanse of landscape skyline

Clear contrast of vertical and horizontal elements with no visual confusion



Wind energy utilisation complements the exposed, wind dominated landscape character



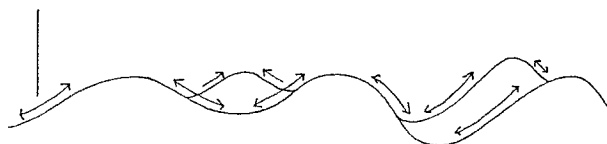
**Figure 5 Mountain landscape**



### Landscape Characteristics

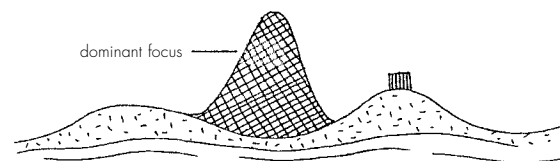
- This landscape character type typically comprises a number of mountain ranges, which tend to be highly visible due to their elevation, although the extent and nature of this visibility will differ with variations in topography.
- The visual composition of this landscape is dominated by the intimidating scale of the mountains and the variation of enclosure due to alternating peaks and valleys. The main visual elements are a number of focal points linked together by diagonal lines. The relative importance of focal points vary with their character and context to produce a hierarchy of attraction; many of the focal peaks appear very individual in character increasing their significance as landmarks and aiding a viewer's orientation and therefore perceived order.
- The nature of the skyline, vegetation, land use, and resulting landscape pattern and texture all vary with topography; the latter often vertically banded due to altitude and the steepness of the land, with links often made in-between by drainage channels.
- Vehicular access to this landscape type is typically restricted, the few roads tending to run along valleys, the coastline, or around the outside of the mountain ranges. A large number of people, however, visit this landscape, many choosing to explore it by foot. Their attraction to the area may be a result of its perceived aesthetic beauty, possibly as a result of its variety, image of 'magnitude' and 'power', and perceived remoteness because of sparse inhabitation and minimal indication of human impact.

Slopes encourage and imply visual movement, directing views to peaks and troughs



Distributed foci – non hierarchical

Visibility varies with location, in relation to relief



Hierarchical arrangement of foci

## Main issues of wind energy development

- The scale and exposure of a mountain landscape means that it is unlikely to be intimidated by the relative size of windfarms. The perceived aesthetic value, derived from its rarity, remoteness and unrefined character however, means that any windfarm development should appear sculptural (with no visible functional elements such as access tracks), in order to result in a powerful visual image as a simple contrasting human element.
- The variation of topography within this landscape character type may mean that it is difficult to locate a development to result in a clear sense of order and visual clarity. To some extent the vertical element of wind turbines will always visually conflict with the diagonal lines of slopes, the nature of visibility varying with orientation and aspect. For these reasons, it is preferable to locate developments on the skyline (although in practice this may be restricted due to inaccessibility); this will be most successful in direct contrast to a smooth, visually 'strong' skyline, so that the turbines appear to be part of the sky, rather than conflicting with the background contrast and confusion of a landform.

### Background



A vertical element will conflict with a diagonal slope, although this may be acceptable for a single turbine, in relation to an existing focus

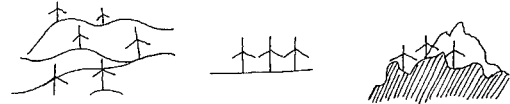
### Landform



A single turbine will punctuate slopes as a focal point

Line development relates to slope but may intimidate due to perceived visual imbalance

### Skyline



A conflict of the vertical and diagonal line will result in visual confusion

There is a clarity of contrasting form along a clear simple skyline

A variable skyline may result in visual confusion

**Figure 6 Rocky undulating moorland**



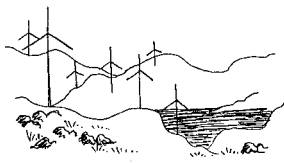
### **Landscape Characteristics**

- The main characteristics of this landscape are derived from its unrefined and 'austere' nature, comprising harsh rocky undulating landforms with thin infertile soils. A number of large angular peaks intermittently rise from this rough ground surface to provide a series of landmarks within the landscape; the undulating nature of the topography, however, means that these may be intermittently obscured, to result in 'unsettling' undifferentiated views with no obvious orientation or foci.
- The basic visual elements are sky, rock, water, sporadic rough vegetation and a variable skyline. The relative visual dominance of these vary greatly with seasonal and weather conditions, for example wet rock is often highlighted like sheet metal, and snow collection often accentuates depressions within the landform, appearing as 'blotches' and patterns throughout the landscape.
- The crude nature of this landscape character type, with its 'moonlike' quality and only sparse inhabitation and sporadic land use, results in it being valued for its unfamiliarity, rarity and perceived remoteness.
- This landscape type tends to be fairly inaccessible, with the main settlements located along, and related to, the coast. Due to the lack of space restriction and the undulating nature of the landscape, inland settlements tend to occur in a very scattered nature, often resulting in no readily perceived order or rationale; there is very little integration of these buildings into the landscape and they often seem to be almost perched on top of their surroundings, the functional elements dispersed around them in a haphazard manner.

### **Main issues of wind energy development**

- The undulating and variable nature of the landform and spatial enclosure within this landscape character type, means that it would be extremely difficult to locate any large scale windfarm development to result in an image of visual simplicity, clarity and order. As a consequence, this landscape character type may be more appropriate for the location of single turbines, as a focus to individual mounds, or with a functional relationship to an existing focus, or alternatively as a small scale windfarm with a direct relationship to a regular landform or elevation:

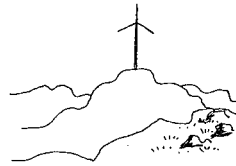
- It is important that any wind energy development relates to a particular landscape feature, so that its location appears rational, despite the complexity of topography within this landscape character type. A wind turbine should portray a function image in relation to a particular land use or building; if there is no such relationship, a windfarm should convey a sculptural image to create a powerful image of contrast with the rough unrefined surrounding landscape.
- The nature of the existing built environment in this landscape illustrates how features with no apparent function or order can appear muddled and 'messy' when there is little visual integration. For these reasons, it is particularly important that wind energy development within this landscape character type appears neat and ordered, with no visible associated features such as roads and power lines to confuse an image.



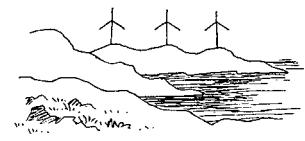
Windfarms may appear confusing due to varying visual relationships



A single turbine may be appropriate in relation to an existing focus



A single turbine may form a simple focal point to an individual mound



A small windfarm may appear suitable in relation to a repetitive feature



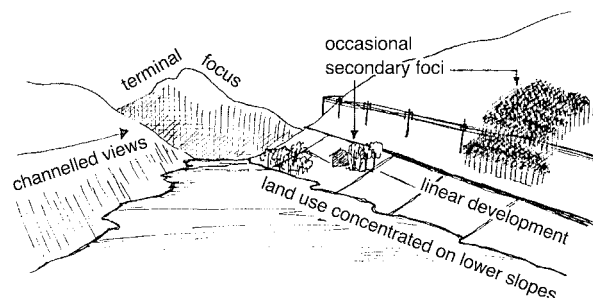
**Figure 7 Valley/Inlet**



### Landscape Characteristics

- This landscape type is dominated by its linear spatial enclosure, being particularly valued for its shelter and the perception that it is tranquil, relaxing and spatially secure, especially in contrast to its exposed surroundings.
- The visual elements of this landscape type are arranged in a linear fashion along the valley, views being directed up or down the space, with diagonal slopes ultimately concentrating them to a terminal focus. Within this spatial arrangement, visual balance is very important in determining visual stability, the occasional location of lodges often acting as intermittent focal points.
- The skyline of this landscape character type generally appears smooth and gently curving, as a clear simple line; this is because the valley ridges tend to be undeveloped and comprise simple rough vegetation. They are not always clearly distinguishable, however, from lower viewpoints, due to the often convex nature of the valley or inlet slopes, which may limit visibility.
- This landscape character type tends to be only sparsely inhabited, except for occasional settlement concentrations on the coast. The land use and landscape pattern are usually related to the valley or inlet space in a linear arrangement, with buildings, services, agriculture and woodland generally located along the lower slopes or on the valley floor. The location of these features will also depend on orientation, however, with aspect having a great significance on light, shadow and resulting microclimatic characteristics.

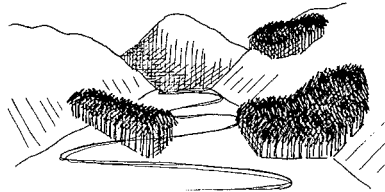
Valley/Inlet indicates horizontal plain, occupied by meandering river or water body



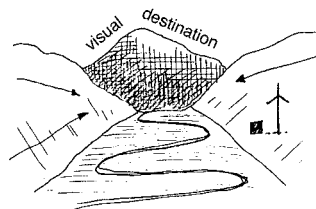
## Main issues of wind energy development

- Valley and inlet landscapes have not typically been developed for wind energy; this may be due to their restrictive low wind speeds as a result of the sheltering topography and characteristic areas of woodland. Within Caithness and Sutherland, however, this may not necessarily be a technical constraint, as wind speeds are typically high throughout the region and local winds may be of greater significance within this landscape character type.
- As a wind turbine or windfarm is likely to form a focus within the landscape, it is important that such a development does not punctuate the linear spatial quality of this character type; it is also imperative that it does not disrupt the balance of the visual composition within a valley or inlet.
- A wind energy development must not appear to threaten the spatial enclosure of this landscape character type, by intimidating it with its scale or perceived disruption due to motion.

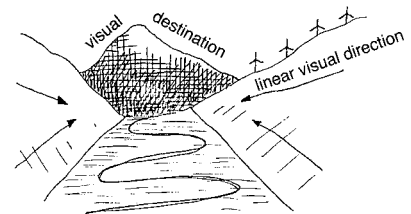
disrupted focal hierarchy



Visual balance is of extreme importance within a valley or inlet, as illustrated by the visual disruption caused by many existing woodland plantations



A wind turbine may appear appropriate as an inferior focus, in direct relationship to an existing landscape focal point



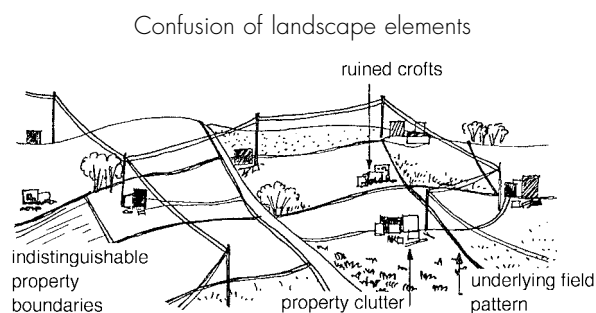
Windfarm does not disrupt space due to inferior scale and by relating to linear character

**Figure 8 Extensive agriculture/crofting**



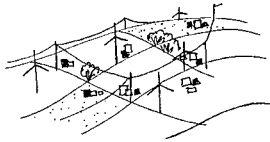
### **Landscape Characteristics**

- This landscape is characterised by its undulating or gently sloped landform and extensive low quality agricultural land.
- The composition of landscape elements within this character type is extremely confusing. Although there is a fairly regular underlying field pattern, this confusion arises partly as a result of the scattered location of residences in relation to land holdings, the boundaries of which are often indistinguishable as a result of variable levels of management and some abandonment of land. It is also complicated by the variable landform and the confusion of services which link all these distributed elements together, such as power lines and roads.
- The landscape is often perceived to have a 'neglected' image, due to the location of many ruined and abandoned crofts. This despondent image may indirectly result in lack of personal pride or effort in maintaining neighbouring land, causing even further neglect. As there is very little pressure for space, new development often 'turns its back' on these areas, building new residences which do not relate to the historical element of the landscape. The abundance of space also results in many properties being dispersed, frequently with areas of unused 'wasted' space between them.
- Agricultural land use and pattern may vary within this landscape character type, due to local difference in ground and microclimatic conditions. Areas of richer, intensive agriculture often occur on sloped or higher land where drainage is superior, and may indirectly result in more active land management, for example with the maintenance of traditional stone walls.

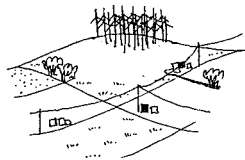


## **Main issues of wind energy development**

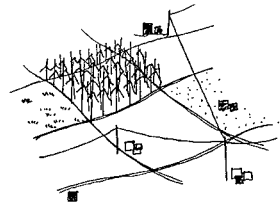
- The visual confusion and variation of landscape elements and spatial enclosure within this character type suggests that it would be extremely difficult to locate a wind energy development to result in a simple, ordered image. This may mean that it is either more appropriate for isolated single turbines with a functional relationship to a building, or as an intensive windfarm that becomes a dominating and organising element in its own right. Whatever the type of development, it is imperative that it does not merely add to the existing disorder of the landscape image.
- The introduction of a wind energy development may appear to improve the 'neglected image' of some areas within this landscape character type, as a feature which symbolises positive interest, modern technology and new investment in a locality.



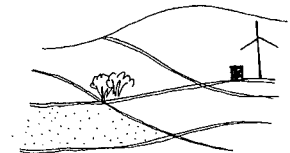
Dispersed windfarm confuses landscape image with conflict of form and line



Isolated intensive windfarm may appear as dominating focus, spatially organising its surroundings



Intensive windfarm may seem to 'intimidate' its surroundings due to spatial enclosure and weakness of landscape pattern



A single turbine may appear appropriate in an isolated area of simpler landscape composition

**Figure 9 Intensive flat/gently sloping agricultural land**



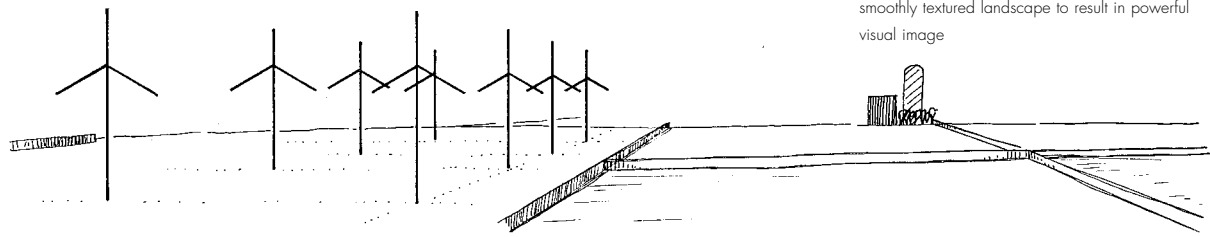
### **Landscape Characteristics**

- This landscape is typically exposed, with a flat or gently sloping landform; it tends to be located at close proximity to the coast within Caithness and Sutherland.
- The agricultural land use is fairly intensive, with a formal layout of large improved grassland or arable fields; these tend to be highly managed and are often bounded by walls, wire or flagstone fences. The landscape is easily accessible, with a network of main and minor roads linking the few large farm residences which form focal points; these human elements seem to integrate and be an essential part of this landscape's character's quality, rather than appearing to intrude upon it.
- The landscape is organised by the underlying geometric field pattern (usually related to the coastline), which contrasts with the horizontal skyline and the smooth flowing texture of the ground cover, in a simple arrangement of visual elements.
- The exposure of the landscape generally results in a great extent of visibility, although this may be occasionally restricted by foreground structures. The impact of the wind is clearly evident throughout the landscape and the perception of openness and exposure is often valued by visitors to the area, who appreciate the simplicity and rich image that this intensive landscape portrays in contrast to its surroundings.

### **Main issues of wind energy development**

- The location of a windfarm within this landscape character type should result in a clear positive image, due to the simple arrangement of landscape elements. The distinctive ordered landscape pattern should provide a strong framework to organise such a development, the vertical character of the wind turbines simply contrasting with the horizontal landform and skyline.
- The spatial exposure of this character type should ensure that a windfarm development does not intimidate the landscape scale, only occupying a small amount of the visible skyline.
- A windfarm should complement the existing human elements within this landscape type, also relating to its wind dominated character. Many of the most appropriate areas for windfarm development may be located near to the coastline, where there are areas of open space sufficiently separated from structures. Ultimately, however the size of developments may be limited by the overall small area of this landscape character type.

Simple composition of landscape elements



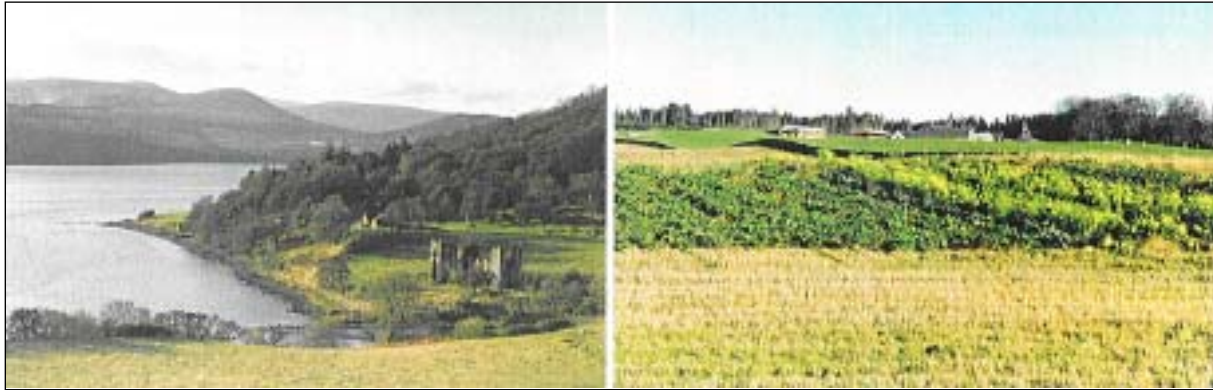
Simple contrast of line and form within flat, smoothly textured landscape to result in powerful visual image

Intensive formal layout of windfarm incorporated into field pattern extends 'human-made' character, almost appearing as an elevated crop

Windfarm is easily accessible across well drained agricultural fields, so that additional tracks are not necessary, maximising the sculptural image

Windfarm is dominant focus within landscape, but without intimidating secondary foci such as farm buildings due to exposure and visual 'buffer' of open space

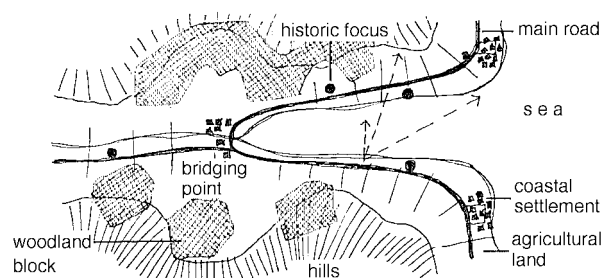
**Figure 10 Variable intensive land use/services**



### Landscape Characteristics

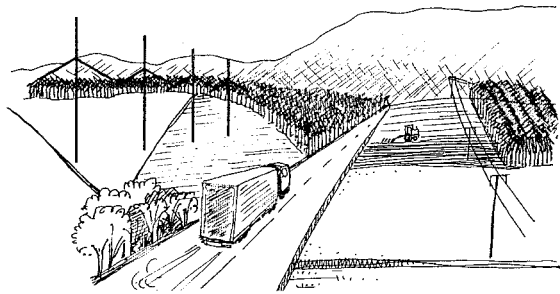
- This landscape character type has intensive land use, dominated by a concentration of services such as busy roads, electricity transmission lines and tourist development. Within this network, there is a mixture of woodland, fairly rich agricultural land and a scattering of farm residences, settlements and small scale industry.
- The landscape type is generally active with noise and movement, and comprises a variety of land use and spatial enclosure. The Dornoch Firth and Loch Fleet tend to visually dominate this character type; they are spatially exposed and allow panoramic views across the water, along the coast and inland towards the mountain areas, their importance as a wildlife habitat also being particularly evident. The wooded and agricultural areas within this character type tend to form enclosed and semi-enclosed spaces, the landscape pattern changing with the varying vegetation and landform.
- This landscape character type is valued for its historic importance, often conveying a grand and majestic image, with ancient deciduous woodland, hedges, stone walls and a number of historic buildings appearing as dominant focal points adjacent to the waters edge.

Sketch plan

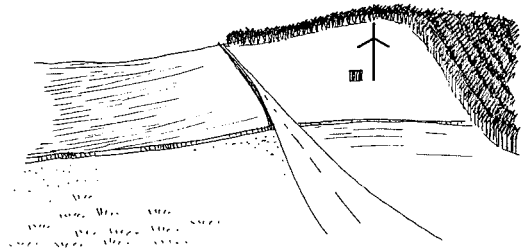


## Main issues of wind energy development

- A windfarm may seem to complement the active and existing human element within this character type, its relative impact seeming reduced, not necessarily becoming the dominant focus. The variety of landform and land use, however, could result in a windfarm development adding to the visual confusion within this landscape and may conflict with its perceived historic value.
- The variable spatial enclosure of this area may also result in a windfarm seeming to intimidate the area with its scale, although its visibility may be restricted by fore- and mid-ground visual obstructions. It is imperative that a windfarm relates to the spatial definition and shapes of these landscape elements such as woodland and buildings.
- The intensity of land use and settlements within this character type may limit the scale of a wind energy development, as it should be located within a single area of particular land use and pattern to minimise visual confusion.



A windfarm may relate to the existing human impact and active character of the landscape, but it is likely to conflict with the variable visual elements, spatial enclosure and landscape pattern. The use of more than one turbine may confuse the image, as there is a visual relationship between each turbine as well as with the landscape.



A wind turbine may appear as a simple focal point within a semi-enclosed space if there is a sufficient buffer of open space surrounding it to prevent visual confusion.

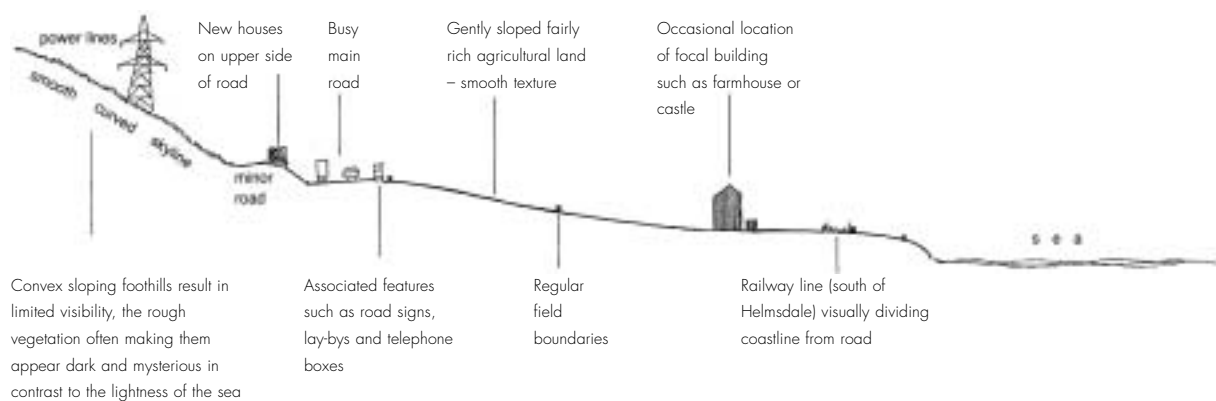


**Figure 11 East coastal strip**



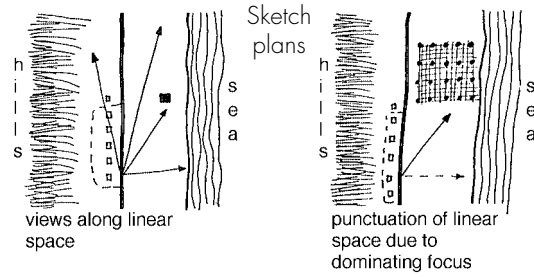
### Landscape Characteristics

- This landscape character type is distinctively linear in spatial enclosure; it almost appears to be squeezed between the coastline and sheltering inland hills, the latter directing views along the space and out towards the sea.
- The landscape pattern and land use relates to the linear quality of the landscape, emphasising it with the route of power lines, the main A9 and adjacent residences, and a parallel and perpendicular field pattern. There are also a number of settlements within the landscape; these tend to be located at intermittent intervals along the character type, usually where inland valleys open out to meet the coastline. This landscape character type forms a service corridor linking the south to the north and although most of the coastal settlements do offer tourist facilities, most visitors tend to only stop in the area en route.



### Main issues of wind energy development

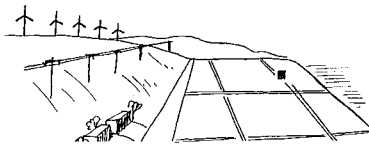
- The location of a windfarm development should directly relate to the linear character of this landscape type.



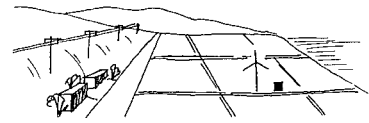
- A windfarm may appear to intimidate the scale of this landscape, due to the restricted visibility and spatial enclosure. It may also seem to punctuate the linear quality of the landscape if located and designed as an overwhelming focal point.
- The existing views of the landscape tend to be directed along and across the coastline towards the sea. A windfarm should not obstruct these views, or in contrast, act as such a powerful image that the balance of the visual composition is disrupted by diverting them away from existing foci.
- A windfarm should be located away from any landscape elements which may result in visual confusion, such as buildings and power lines; this may mean that it is more appropriate to site them along the smooth linear ridges of the foothills, within the open agricultural land, or adjacent to the coast.



Windfarm conflicts with linear character and intimidates space with no evident order or rationale



Windfarm relates to linear space. Convex slopes restrict visibility of windfarm from residences

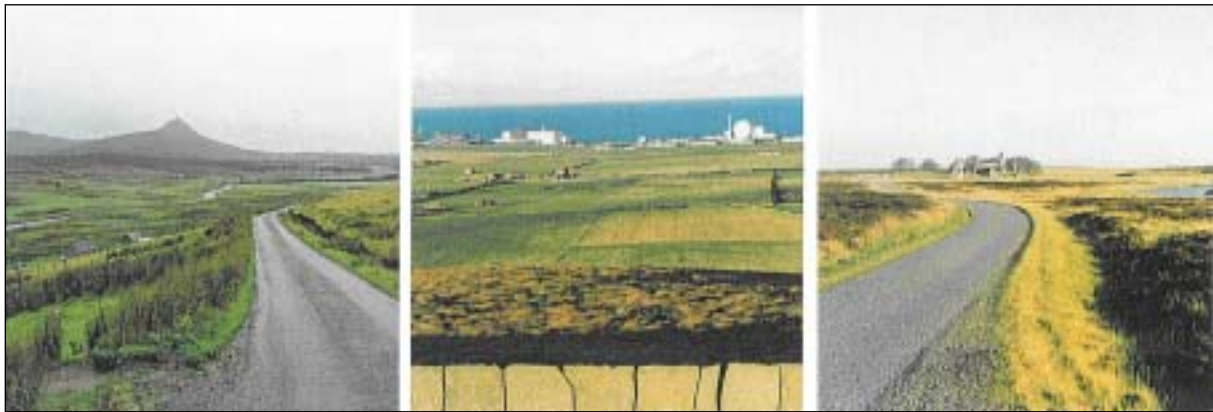


Wind turbine relates to existing focal building and the 'wind dominated' coastline

## 2.3 Landscape Features

During the process of landscape assessment within this study, four different landscape features were identified in addition to the landscape character types. These are distinctive features which appear within a variety of different landscape character types, but yet have similarities in their influence on the potential impact of a wind energy development.

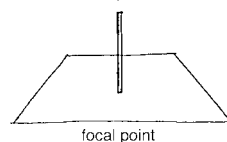
**Figure 12 Focus**



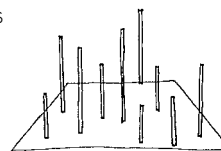
### Characteristics

- A focal point is defined as the centre of attention or interest, marking a point in space. What comprises or forms a focus within the landscape will vary, ranging from a lone tree, to a pond, building or mountain, etc. They are distinctive, however, in being the dominant visual element within the landscape to which views are directed.
- A focus within the landscape provides a landmark, helping people to orientate themselves within an area; the location of a 'powerful' focus may actually result in its surroundings being ordered and organised around it.
- What constitutes a focus within one landscape character type, may not in another, as its relative importance will depend on the nature of its surroundings. An individual element within open land may create a focus, where many of the same elements would distribute their impact, no one appearing more important than another.

Relative importance of elements

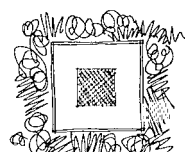


focal point



distributed importance

Focal context



visual clarity of focus with  
buffer of open space

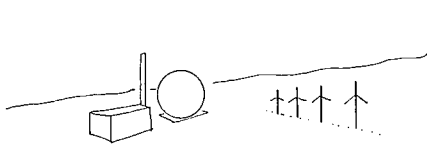


visual confusion with  
conflicting elements

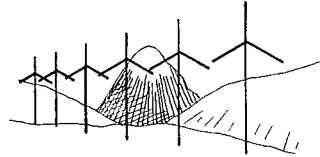
- An element tends to be most successful as a focus where there is a clear buffer space around it, or where it is elevated, so that it is not confused with its surroundings, comparable to the impact of mounting a picture within a border.

**Main issues of wind energy development**

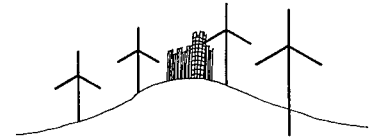
- The location of a windfarm may conflict with the image of a focus, by compromising its importance or conflicting with its form; it may however complement a focus as an additional element of the landscape composition, depending on its nature and context.



Windfarm may complement existing focus as additional sculptural element

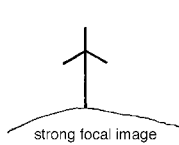


Windfarm may conflict with previous focal point, confusing the visual balance

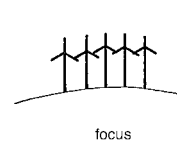
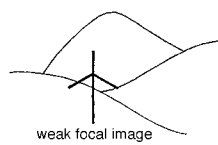
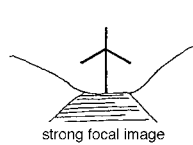


Windfarm conflicts with historic focal point and intimidates its monumental scale and setting

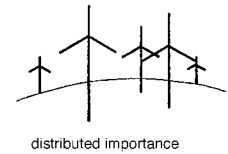
- The success of a windfarm or wind turbine to form a focal point within the landscape, will depend on its design and the characteristics of its surrounding landscape. A focus does not necessarily comprise a single feature; if a windfarm contains many closely spaced wind turbines, it may appear as a single intensive focus in its own right.



The impact of landform on focal importance



The impact of windfarm intensity on focal importance

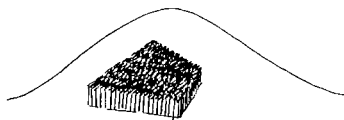


**Figure 13 Woodland block**



### Characteristics

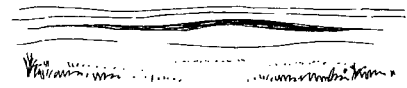
- This landscape feature varies in its characteristics, but tends to comprise formal plantations of coniferous woodland, planted mainly for commercial reasons, or occasionally for shelter. The properties of woodland as a dynamic element means that the relationship between this feature and the landscape is always changing.
- Woodland blocks indicate human impact, in areas such as moorland, which often appear otherwise unrefined; the woodland blocks introduce visual elements such as lines, points, shapes and patterns into the landscape, also enclosing or semi-enclosing spaces and indicating scale and relative distance.
- The nature of commercial forestry often results in woodland blocks bearing no relation to the characteristics of the landscape. The location of large areas of woodland in open, fairly flat expansive landscapes, however, may seem to almost disappear into the mid-ground of a view and become a part of the landscape character itself.



Woodland conflicts with landform shape and indicates vertical elevation



Woodland block overwhelms and 'smothers' landform



Large woodland block seems to disappear into the middle distance of open, expansive landscape

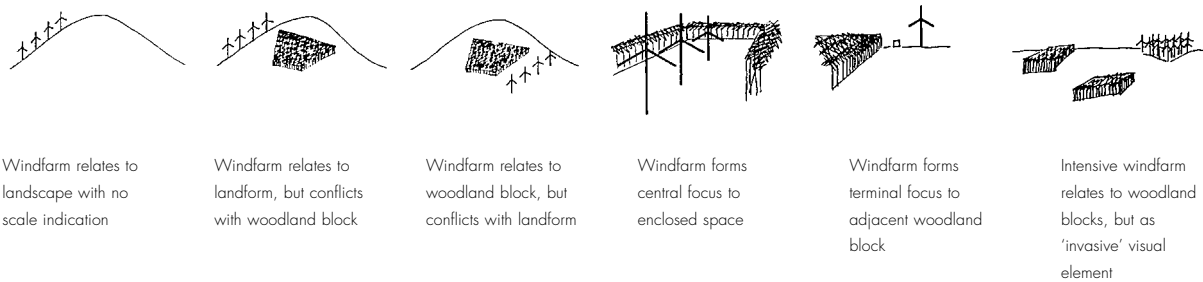
- Areas of woodland block are usually accessible via a network of rough tracks, if not immediately adjacent to public roads. The visual impact of these tracks can be substantial in addition to the woodland itself, often travelling for many miles across areas of moorland or blanket bog, introducing lines of perceived human impact. There is the occasional location of visitor provision within these areas of woodland.

### Main issues of wind energy development

- Areas of woodland are not typically targeted for wind energy development, because it is often considered that the wind resource would be inadequate or turbulent in quality; due to the elevation of a wind turbine in relation to woodland, however, it is now generally accepted that the utilisable wind resource is usually relatively unaffected by woodland blocks.

- The existing tracks to woodland areas may aid the development of an adjacent windfarm by providing access. A windfarm may also complement the human-made image of a woodland block, although its size may appear to be additionally intimidating, in relation to the woodland which will indicate scale.
- The location of a wind energy development adjacent to a woodland block may cause visual confusion, in contrast to the lines, shapes and patterns introduced by the woodland, particularly if these conflict with the other characteristics of the landscape.
- The location of a wind energy development must relate to the spatial enclosure of any woodland, as a complementary or focal feature. It is important that, whatever the arrangement of a windfarm in relation to existing woodland, their respective images do not clash in form, line or visual dominance; otherwise they may appear 'out of control' as conflicting landscape elements.

The relationship between a windfarm, woodland block and the landscape



## **Figure 14 Settlement**

### **General characteristics**

Large settlements may form a landscape character in their own right. The small settlements within Caithness and Sutherland, however, tend to be dominated by the landscape character in which they are located, although as a feature they may possess several similarities in relation to the potential impact of windfarms. Settlements do not tend to be targeted for wind energy development due to the potential impact of several characteristics, in addition to visual impact, for example lack of wind resource, noise and shadow flicker. It is generally accepted that a windfarm should not be located within 500m from the nearest residence, and preferably at least 1000m away; despite this restriction, there may be areas of potential windfarm development within or surrounding a town, especially if located on the coast, for example:

- within a harbour area, where there is an adequate coastal wind resource and yet there tends to be few residential buildings
- within the 'buffer' space between most coastal village settlements and the sea
- within the 'un-used' spaces of scattered settlements
- adjacent to a specific building as a functional image, in direct use by a private individual or community
- on areas of high ground or coastline sometimes surrounding settlements

The location of a wind energy development within, or adjacent to, a settlement, may result in a number of common design issues:

- buildings are likely to indicate the scale of wind turbines so that their relative size may appear more intimidating
- the location of windfarms within settlements may result in them being stereotyped as an industrial/urban feature, so that if located in other landscape character types, they may seem to degrade the visual image
- windfarms may occupy areas of 'wasted space' and therefore be perceived to improve the economic value of an area
- a wind energy development owned by a private individual or community may appear more acceptable, as a functional element which has not been built purely for commercial gain
- windfarms or individual turbines should relate to the form and layout of a settlement or building; otherwise they may result in visual confusion due to a variety of conflicting landscape elements

## Main settlement types

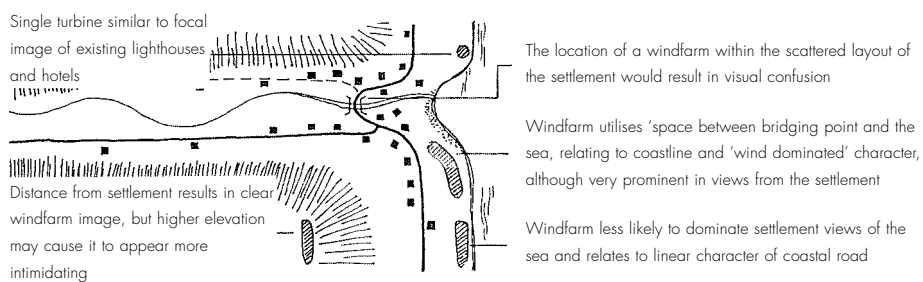
### Major settlement

- There are two major settlements within Caithness and Sutherland: Thurso and Wick. The towns act mainly as tourist, service and small scale industrial centres for the surrounding area, typically orientated to the coast around a harbour.
- The towns contain a variety of features that may cause visual confusion with the location of a windfarm. As a consequence, the most appropriate site for such a development may be adjacent to the waters edge, where a windfarm will be viewed against the exposed scale of the sea, and it can relate to landscape elements such as the harbour jetties and roads. The existing industrial features in these areas will mean that a windfarm is unlikely to dominate the area and will merely appear to complement its human influenced character.



### North west coastal settlements

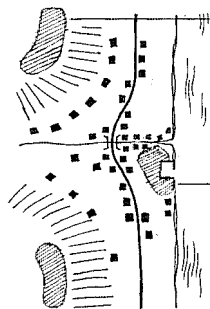
These tend to be located at bridging points, where inland valleys meet the coast.





**East coastal settlements**

- The main east coast A9 access road tends to dominate these settlements so that they are either bypassed or bisected. They tend to have no distinct edges to the north or south and reach into their open surroundings, typically providing local services and tourist facilities, with small scale fishing based around the harbour.



A windfarm may be located on the hills adjacent to the town, relating to the coastline and main road, although possibly intimidating the scale of the settlement

A windfarm may be able to utilise the typically unused space surrounding the harbour

**Figure 15 Coast**



### **Characteristics**

- Caithness and Sutherland are surrounded by a coastline which varies from stretches of high angular cliffs, to beaches, estuaries and large areas of sand dunes. The coastal landscape is visually dominated by its linear edge, separating the land and the sea.
- The sea appears as a very powerful horizontal visual element within coastal areas, with views tending to be directed towards its skyline. Its exposure results in a high extent of visibility and perception of openness, providing a simple backdrop to the variable landscape features along a coastline.
- This area appears to be controlled by 'the elements', the impact of wind being clearly evident with features such as high background noise, waves crashing on the shore, migrating dunes, erosion and weathering of the cliffline and the location of wind pruned trees and scrub. This wind domination is further illustrated by how people use the landscape, with the planting of shelter belts and also recreation such as wind surfing, kite flying and sailing.
- Human impact on the coast tends to differ between fairly busy areas comprising settlements, roads, tourist facilities and a number of hydrocarbon extraction rigs and fish farms within coastal waters, in contrast to areas of remote moorland meeting the coast in a spectacular combination of 'wild' exposed landscape types. Agricultural land use is often concentrated along the coastline around the settlements, due to the existence of well drained, fairly rich soils, the provision of local services and access roads, and also because many people in these areas split the source of their income between the land and the sea.

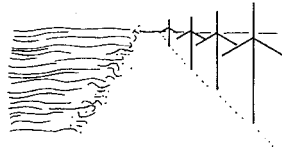
### **Main issues of wind energy development**

- A windfarm is unlikely to appear intimidating within a coastal area, as the relative spatial exposure of the sea is likely to dominate in scale.
- The location and layout of a windfarm must relate to the distinct edge of a coastline, so that it does not conflict with the linear spatial quality of the area. A windfarm is likely to form a clear visual image on the coast, due to the simple sculptural contrast of the vertical turbines with the horizontal element and deep colour of the sea expanse.

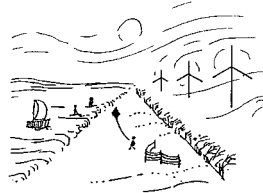
- The location of a windfarm will complement and relate to the 'wind dominated' character of coastal areas. Although high numbers of tourists often visit the coast, they tend to enjoy the area for this quality, so that the introduction of a windfarm should not necessarily conflict with their appreciation of the landscape. Some coastal locations, however, for example where moorland and mountain areas meet the sea in a spectacular combination of 'powerful' exposed landscape images, may be particularly valued for their remoteness and rarity, so that the introduction of a windfarm development could be perceived to disturb this character in some locations.



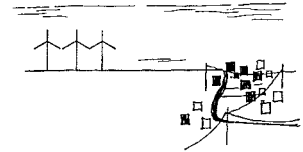
The scale of the windfarm appears inferior to the wide exposed expanse of the sea. There is a simple contrast of horizontal and vertical elements.



A windfarm should relate to the edge of the coast and its linear space.



A windfarm may relate to the active nature of recreation within a 'wind dominated' landscape.



A windfarm should be located apart from any visual clutter, to result in a simple focal image.

### **3 TYPES OF WIND ENERGY DEVELOPMENT**

Background information on the potential impact of windfarm design was combined with the results of the landscape character assessment within this study, to identify a number of wind energy development types. These are distinguished by their potential impact in the Caithness and Sutherland landscape and are broadly divided within the following section by their size (as a single distinctive characteristic). It should be emphasised, however, that the visual impact of a windfarm is not directly proportional to the number of turbines within a development, so that the boundary between the windfarm types is flexible, dependant on all the other characteristics of windfarm design and its relationship to the surrounding landscape (these components are outlined within Chapter 5).

For each wind energy development type, the main design issues are described, in addition to design suggestions and an indication of the possible implications of cumulative impact. Although this division of wind energy types is only very generalised, the aim of this process is to allow the main issues of locating certain types of wind energy development to be considered in relation to the landscape character types within Caithness and Sutherland.

## **Figure 16 Types of wind energy development**

### **Single turbine**



#### ***Design issues***

- A single wind turbine will portray either a sculptural image, similar to existing monuments within the landscape, or alternatively functional image, in relation to a specific land use or building.
- A single turbine may form a focal point within the landscape. A point does not have direction or movement and may therefore seem appropriate as the focus within an open area, but can appear unsuitable within a linear landscape where it may punctuate the space. The location of a single turbine as a focus should relate to the positioning of existing foci within the landscape, for example churches on hill tops.
- The use of single turbines may allow individual or community ownership; these may be preferred within the landscape due to their perceived local value, rather than being seen to be developed for commercial gain.

#### ***Design suggestions***

- Although single turbines may be viewed as individual features, multiple numbers of turbines should all relate to each other with similar design and relationship to a particular landscape characteristic, so that they collectively result in a clear simple image.

### **Small windfarm (2–5 turbines)**



#### ***Design issues***

- A development containing more than one wind turbine will result in a visual relationship between each turbine, as well as with the landscape. This relationship should always appear simple, ordered and rational.
- A windfarm development of this size rarely appears to dominate the scale of the landscape, but nevertheless should be arranged to appear as a single concentrated group.

**Design suggestions**

- This size of windfarm should generally consist of either three or five turbines; similar to other features within the landscape, the eye tends to group even numbers of objects into pairs, which can appear to disjoint a development.
- The most appropriate layout of a small windfarm will be as a simple line within a linear or open, flat landscape, or as a cluster on the top of a hill.



- This size of windfarm can still portray a functional and non-commercial image.

**Medium windfarm (5–25 turbines)**



**Design issues**

- Most commercial windfarms are proposed within this size range, as site area and ownership restrictions may prevent larger developments.
- A concentrated windfarm development within this range may appear as a focal point within an open landscape, or if located on a hill or ridge top.

**Design suggestions**

- Windfarms in this size range may be arranged within an irregular layout, if related to specific landscape features, such as hedgelines. As a general rule, however, they should be located within a regular layout, to allow the relationship between turbines to appear ordered.
- Whatever the layout of a windfarm, the spacing of turbines should be identical, to result in the development being seen as a cohesive group (between 150–350m for 300–600kW turbines).

### **Large intensive windfarm (10+ turbines)**



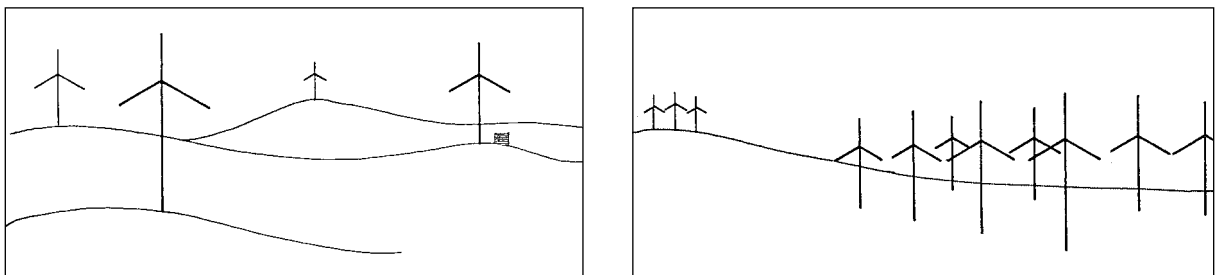
#### ***Design issues***

- A large windfarm (greater than 10–25 turbines depending on spacing, layout and location) may be viewed as a single intensive feature, similar to that of a commercial woodland plantation.
- This type of windfarm, due to its size, may possibly dominate its surroundings and actually change the character of the landscape.

#### ***Design suggestions***

- It is important that this type of windfarm does not seem as if it is ‘invading’ the landscape. It should be regularly ordered, to appear ‘in control’ as a human-made feature.
- If this type of windfarm contains over 70 turbines, it may be appropriate to sub-divide it into units of at least 35 turbines; the windfarm should appear as a single development but its division may help each section to be visually ‘graspable’ and less intimidating.
- To enable a large intensive windfarm to appear ordered, with each turbine having a similar relationship to each other and to the landscape, the turbines should be arranged as a grid layout, probably most successful within a fairly flat, simple landscape.

### **Cumulative impact (more than one wind energy development in an area)**



#### ***Design issues***

- Cumulative impact occurs when more than one wind energy development is located within a landscape.
- Although windfarms may be located as individual features within a landscape, their unfamiliarity is likely to result in them being viewed as a collective feature.

- The location of several wind energy developments within an area may increase the perception of their suitability for a landscape type. This perception of a 'windfarm landscape' may result in a development within another area of similar landscape type being perceived to appear additionally appropriate.

***Design suggestions***

- As a collective group, multiple numbers of windfarms or single turbines should relate to the same landscape characteristic within an area. This may mean that it is inappropriate to locate a development on or across the border between different landscape character types.
- The layout, size and design of a windfarm will ideally be the same throughout an area. Individual developments should be slightly separated to prevent visual confliction of form, or intimidation of each other's space.



## 4 CONCLUSIONS

Figure 17 illustrates some of the main landscape issues connected with establishing a wind energy development within different landscape character types, following the descriptions of landscape character and wind energy development in previous chapters. The information within this table is general and purely indicative in nature. *It should not be adopted as determining the type of wind energy development which should be developed within a particular landscape.* The appropriateness of any development cannot be decided at this level, its suitability depending on the many detailed characteristics of the specific site and windfarm design.

Despite the above reservations, the indication of solid arrows within Figure 17 represents what may be the most appropriate range of windfarm types for a particular landscape character type, for the reasons indicated. The broken arrows also indicate a possible range of windfarm type, but whilst acknowledging that these may involve addressing a greater number of problematic design issues at the strategic and site specific level.

**Figure 17 The main issues and suggested appropriateness of windfarm types within landscape character types**

Windfarm type	Single turbine	Small windfarm 2–3 turbines	Medium windfarm 5–25 turbines	Large intensive windfarm 10+ turbines	Issues of cumulative impact
1 Gently undulating moorland			←—————→ Large scale intensive development will be accommodated most effectively. This should appear clearly ordered. Windfarm should not be located across undulations, to prevent visual confusion.	—————→	Due to exposure and high extent of visibility, may be most appropriate for a few larger scale windfarms, rather than the spatially ‘inefficient’ scattering of smaller developments.
1b Flat moorland/ blanket bog			←—————→ Large scale intensive development will be accommodated most effectively. This should appear clearly ordered. Flat relief and simple arrangement of landscape elements should result in clear, sculptural windfarm image.	—————→	This landscape type is often perceived to be of national/ international importance; therefore windfarm development should not appear to cover or intimidate the whole area.
2 Mountain landscape	←—————→ Single turbine may relate to existing building or landform as an inferior focus to mountains.	-----→ It is difficult to locate a windfarm within this landscape to result in a simple, ordered image, due to variations of topography, spatial enclosure and skyline. The most appropriate sites may be ridge lines or plateaux, in areas where there is no visual conflict with existing mountain foci.			Few windfarms could be accommodated within this landscape type, due to the potential visual confusion and the high extent of visibility. Its perceived aesthetic value may mean that character change is undesirable.
3 Rocky undulating landscape	←—————→ This landscape is only suitable for single turbines or small scale windfarm development, as the location of turbines on undulating land would result in visual confusion.	-----→			This landscape type could possibly accommodate several single turbines or small scale developments. This should be restricted to certain areas, so they do not appear to intimidate this unique character type.

Figure 17 (continued)

Windfarm type Landscape character type	Single turbine	Small windfarm 2–3 turbines	Medium windfarm 5–25 turbines	Large intensive windfarm 10+ turbines	Issues of cumulative impact
4 valley/inlet	Single turbines may punctuate a linear space. they should relate to existing foci.	Windfarm development must relate to the linear quality of the landscape. It must not conflict with the balance of the visual composition. Medium size windfarms may intimidate and punctuate the enclosed, linear space.			The accommodation of a windfarm may be restricted by the potential to upset the visual balance and intimidate the scale of the landscape. It may be most suitable for small scale development arranged as a simple line.
5 Extensive agricultural/crofting	It is generally difficult to locate windfarms within this landscape, due to the risk of visual confusion in contrast with the existing variety of landscape elements. it may be most appropriate for small scale or single turbine development in areas of isolated open land where a simple, clear image can be formed.				It is unlikely that this landscape will be able to accommodate more than a few windfarm developments without resulting in visual confusion.
6 Intensive flat/gently sloping agricultural land	A single turbine may seem appropriate as a functional image, but may be inefficient use of area.	This landscape may be most appropriate for large scale windfarm, development, in relation to its flat, intensive existing agricultural land use. Windfarm size may be limited to up to 40 turbines however, within Caithness and Sutherland, due to the small area of this landscape type.			Windfarm type may be limited by the area of the landscape character type. It may therefore, only be able to accommodate up to 2 medium/large scale developments.
7 Variable intensive landuse/services	The existing variety of land use, pattern and spatial enclosure may result in a windfarm causing visual confusion. An appropriate type of development may be single turbines, related to a particular landscape characteristic.				This landscape character type may be appropriate for the location of single turbines. it may be able to accommodate up to 3 turbines within concentrated areas of a single visibility zone.
8 East coastal strip	Windfarm development within this landscape should relate specifically to its linear spatial character. It may be able to accommodate small/medium scale development (<10 turbines) on the coastal 'shelf', and larger developments (<30 turbines) within the foot hills, without the landscape appearing excessively intimidated.				The spatial enclosure and limited visibility of this landscape may mean that only a few windfarm developments can be accommodated within concentrated areas, without the character of the landscape being changed.

Figure 17 (continued)

Landscape features				
A Focus	← A single turbine may complement an existing focus, possibly as an inferior focal point.		→ A medium or large scale development may be appropriate within landscape types 1, 1b, or 6, where it can complement a focal point as a large, intensive development appearing as a single contrasting visual block.	If many similar features are located within a landscape, their impact will be distributed, the relative importance of each diminished. Windfarms should relate to existing foci, without conflicting with their form or image.
B Woodland block	← A single turbine may relate to an existing adjacent large woodland block.	A windfarm development may relate to an existing block of woodland as a similar single intensive feature. They should be separated however, by a buffer of open space to prevent visual conflict of form, pattern and shape. The location of woodland may also increase the perception of windfarm intimidation, due to scale indication.		→ Windfarms, as complement the intensive masses may location of woodland blocks within a landscape, although they may contrast in form, shape and scale, resulting in visual confusion.
C Settlement	← Single turbines or small scale windfarm development should relate to a particular building or landscape characteristic. Windfarms should be located slightly apart from a settlement to avoid visual confusion.		→ Medium sized windfarm may be appropriate if there is a sufficient separating buffer of open space.	Individual or community owned wind energy developments may be preferred for their local value. the location of numerous windfarms within this landscape may however, stereotype them as an urban feature.
D Coast	← A single turbine may relate to an existing coastal feature, eg a cliff or lighthouse.	Windfarm development may be appropriate in direct relationship to the coast, as a simple parallel linear development.	→ Large scale windfarm would need to be arranged as a grid, parallel to the coastline.	Windfarms relate to the coastal 'wind dominated' character, appearing inferior in scale due to spatial exposure. The perceived remoteness and rarity of some areas, however may mean that change is undesirable.

General conclusions identified by this study are summarised below:

- It can be suggested that **most landscape character types are suitable for some kind of wind energy development, however the type of this will vary considerably in relation to a particular location and windfarm design.**
- **A wind energy development will only appear appropriate if it relates to the particular characteristics of a landscape;** this is more significant than whether the development is actually unfamiliar within an area, for every landscape character type can accommodate change to some extent if it appears suitable and fitting.
- **For any wind energy proposal, an assessment of its suitability should be completed at the strategic, as well as the site specific level.** It should be emphasised, however, that only a Planning Authority would be able to strategically define 'windfarm free' zones, preventing blanket development, and SNH is unable to show individual preferences towards two developments, if equally appropriate.

- **A windfarm proposal should be considered in three stages, assessing the specific characteristics of the landscape within which the development is proposed, assessing the nature of the windfarm design, and then finally how each of these relate to one another.** It must be emphasised that the information within a landscape assessment should not be produced as a final product, for **there is no right or wrong design solution for a development, and the assessment of potential impact is part of an iterative design process.**

### **Further research**

The wind energy industry within the UK is as yet still immature; this means that there is insufficient information readily available concerning many of its related subjects, of which visual assessment is particularly lacking. This study should build on this deficiency of knowledge and should be flexible enough as a process, to allow further modification as the available information allows.

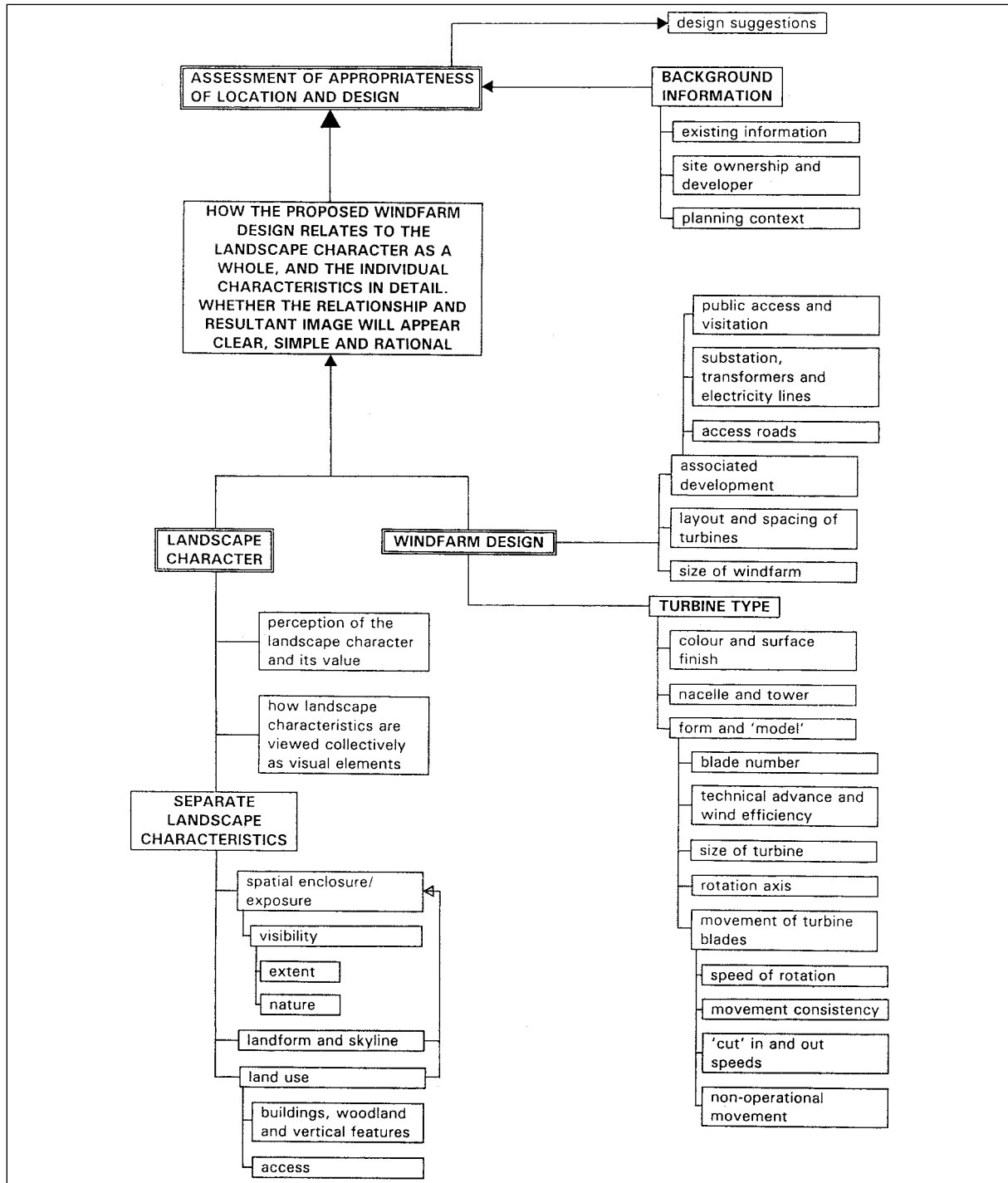
Many of the criteria for assessment applied within this study are based on previous research into the visual impact of existing wind energy developments; consequently, as the industry expands and the numbers of these case studies increase, a greater amount of detailed information should be available on the potential impact of windfarm design and landscape characteristics.

This project has developed a process of visual impact assessment for wind energy development which can be applied in other areas. Ideally, this would be completed throughout Scotland, so that the strategic issues could also be identified at the national scale, providing SNH with assessment information at all levels as a result.

## 5 GUIDELINES FOR THE ASSESSMENT OF WIND ENERGY PROPOSALS

Many issues of windfarm location and potential visual impact are previously discussed within the strategic study of Caithness and Sutherland. The following chapter summarises some of the major points, however, which should be considered as part of an assessment of a specific wind energy proposal within this area, the components of which are illustrated within Figure 18.

**Figure 18 Issues to be considered within the landscape assessment of a potential wind energy development**

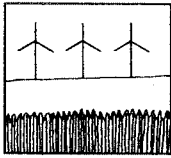
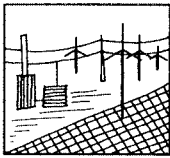
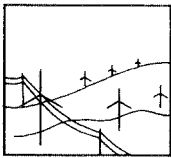


Subject	Question	Notes/Explanation
1 Background Information	1.1 Who is proposing the windfarm development?	There may be greater public support within a neighbourhood for community or private individually owned windfarms, in contrast to commercial developments.
	1.2 Have any landscape character studies been previously carried out in this area?	Although providing a base to work from, general landscape character assessments will have to be refined so the information is specific for windfarm development.
	1.3 Has the Regional or Local Planning Authority carried out any previous studies on wind energy in the area?  Is there policies within the structure or local plan for wind energy development?	Most Planning Authorities merely reiterate general Planning Policy Guidance within their development plans. Some Authorities, however, have prepared wind energy guidance and policies, although these frequently tend to rank areas by their 'suitability' for a 'typical' windfarm rather than providing strategic design guidance.
	1.4 Is the proposed windfarm within a designated landscape?	Landscape designation does not legally prevent the location of a windfarm, indeed such developments are not necessarily inappropriate in relation to the characteristics of some designated areas, for example a SSSI for geological importance. Other designations were initially developed to prevent urban and industrial intrusions in the landscape, windfarms being neither. As a consequence, designations should not be used as a tool for locating this kind of development. In contrast, the suitability of a windfarm location should be judged on whether it relates to the character and essential qualities of the landscape (although this may indirectly relate to the essence of a landscape designation).

**Windfarm location**

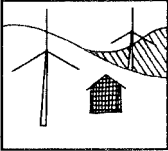
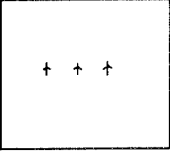
Subject	Question	Notes/Explanation
<p><b>2</b> <b>General landscape character</b></p>	<p>2.1 What are the essential characteristics of the landscape?</p> <p>How is the landscape perceived?</p>	<p>A windfarm will only appear appropriate if it relates to the particular characteristics of a landscape. This is of greater importance than whether the proposed development is unfamiliar within an area for every landscape character can accommodate change to some extent, if it appears suitable.</p> <div data-bbox="810 573 1374 725" style="text-align: center;"> </div> <p>Windfarms should relate to the particular characteristics of a landscape to appear rational</p> <p>The location of a windfarm should relate to the experiential characteristics of a landscape, as well as the physical features, for example whether it is perceived as being 'wind dominated' and therefore seems appropriate for wind energy utilisation.</p> <p>The location of a windfarm will not necessarily be any less successful in an area perceived as having high aesthetic value. Although a windfarm will obviously indicate human impact within a landscape and may reduce the feeling of 'wild land' in some areas; Its symbolic and sculptural qualities may be a positive addition, comparable to Stonehenge or the Fylingdale 'Golf Balls' on the Yorkshire moors. In addition, our perception of windfarm development is likely to change over time, as it appears more familiar within landscapes and is not viewed as a 'foreign' element.</p> <p>A windfarm may conflict with the perceived value of a landscape, for example if it is particularly valued for its remoteness and rarity of type, or possibly for its historic quality. If the latter is the case, a windfarm may be inappropriate as a modern element which will contrast with the existing character of the landscape, although it may possibly appear stunning in a contrast of old and new landscape features.</p>

**Windfarm location** *(continued)*

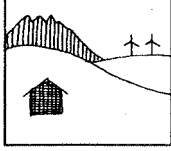
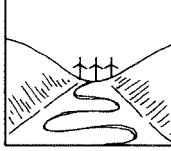
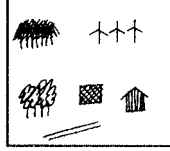
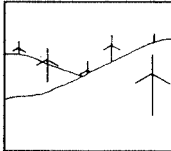
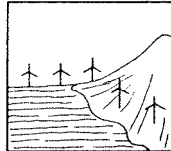
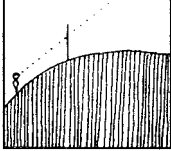
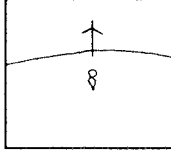
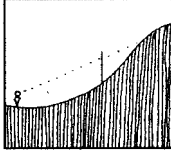
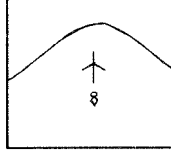
Subject	Question	Notes/Explanation
<p><b>2</b> <b>General landscape character</b></p>	<p>2.2 Does the windfarm design relate to the visual elements of the landscape such as colour, lines, points, pattern and texture?</p>	<p>A windfarm has a visual relationship with the landscape and also between each turbine. This must appear simple and comprehensible, for the development to seem rational. Although a windfarm may seem to be accommodated within a confusing image to some extent, in that it is not a dominant focus, the image will not be positive. This only occurs with the clear contrast of landscape elements (for example the powerful image of the 'flow country' is to some extent a result of the clarity of the basic features – water, sky, horizontal lines, rough texture).</p> <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>Clear contrast of landscape elements</p> </div> <div style="text-align: center;">  <p>Confusion of elements</p> </div> <div style="text-align: center;">  <p>Varying relationship elements</p> </div> </div>



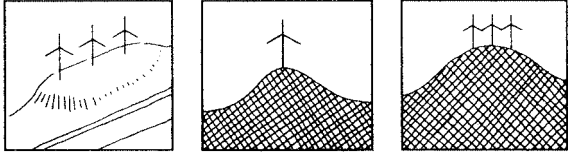
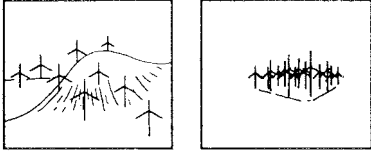
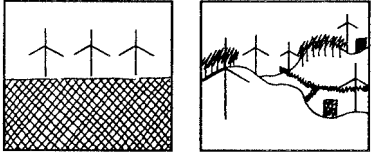
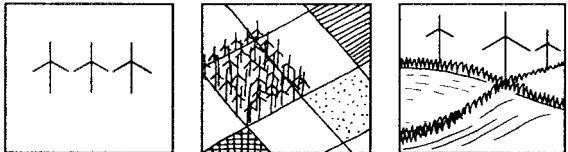
**Individual landscape characteristics**

Subject	Question	Notes/Explanation
<p><b>3</b> <b>Spatial enclosure/ exposure and visibility</b></p>	<p>3.1 Is the site spatially exposed or enclosed?  Is there a great extent of visibility?</p>	<p>Exposed landscapes are often dominated by the impact of wind, so that the utilisation of wind energy may seem appropriate to the landscape character type. Although the extent of visibility is great within exposed areas, a windfarm tends to occupy only a small amount of the visibility zone and skyline, so that it does not actually intimidate the landscape scale, its appropriateness however, will also depend on the nature of visibility (see section below).</p> <p>Within spatially enclosed areas, the extent of visibility tends to be less, but the windfarm is likely to occupy a greater proportion of the visibility zone and may therefore appear to dominate an area.</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Enclosed landscape – turbines dominate</p> </div> <div style="text-align: center;">  <p>Exposed landscape – unintimidated</p> </div> </div> <p>The following list suggests possible characteristics of visibility extent, although the distances may have to be increased for application within Highland Region. This is because the quality of light and atmosphere may result in clearer visibility within this region, and the areas of simple landscape composition may also heighten the visibility of a windfarm due to its appearance as a dominant focus.</p> <ul style="list-style-type: none"> <li>up to 500m: windfarms are the dominant landscape element</li> <li>0.5–2.0km: windfarms may dominate the space and some landscape features</li> <li>2.0–5.0km: windfarms are less likely to dominate the space, and may appear as one of the many landscape elements</li> <li>5.0–15km: windfarms may be discernible in clear visibility conditions, but are only seen as part of the distant background landscape</li> </ul>

**Individual landscape characteristics** *(continued)*

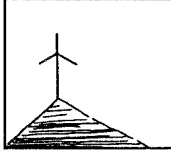

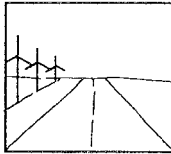
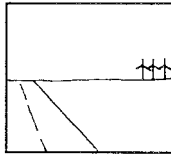

Subject	Question	Notes/Explanation
<p><b>3</b> <b>Spatial enclosure/ exposure and visibility</b></p>	<p>3.1 What is the nature of that visibility?</p>	<p>Of greater importance than the extent of visibility, is the nature of the visibility, ie how a windfarm is seen within a landscape, for example whether it appears balanced within the visual composition of the landscape, whether it occupies a focal point, or whether it blends into the background.</p> <p>The image of a windfarm may be confused if the whole development is not seen as a single feature, or if it covers the boundary between two different landscape character types. If the nature of the landscape means that a development is only partially seen, with the view changing with orientation and distance, the size and limits of the development will be unclear and cause confusion (an unfamiliar feature such as a windfarm should appear 'controlled' so it does not seem to 'invade' its surroundings).</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>As part of the wide landscape view</p> </div> <div style="text-align: center;">  <p>Focused location</p> </div> <div style="text-align: center;">  <p>Distributed foci</p> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="text-align: center;">  <p>Partially obscured</p> </div> <div style="text-align: center;">  <p>Varying relationship on landscape character border</p> </div> </div> <p>The visibility of a windfarm within variable topography will also depend on the slope of land in relation to a viewer. Convex slopes tend to limit mid-ground or distant visibility and result in a windfarm being seen against the skyline; concave slopes tend to result in a windfarm being seen against a landscape backdrop, increasing the complexity of image with its relation to the skyline.</p> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="text-align: center;">  <p>Gently sloping convex slope limits visibility and windfarm is likely to be seen against the skyline</p> </div> <div style="text-align: center;">  </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="text-align: center;">  <p>Steep concave slope means that windfarm is likely to be viewed against backdrop of hill</p> </div> <div style="text-align: center;">  </div> </div>

Individual landscape characteristics (continued)

Subject	Question	Notes/Explanation
<p><b>4</b> <b>Landform and skyline</b></p>	<p>4.1 Does the windfarm design relate to the landform?</p> <p>Does the windfarm conflict with the nature of the skyline?</p>	<p>There should be a rational relationship between the windfarm and the landform, with a simplicity of image.</p>  <p>Linear landscape      Point      Cluster</p>  <p>Obliterates landscape characteristics      Intensive layout appears as focus within no distinct landscape pattern</p>  <p>'Simple' skyline results in clear visual contrast      Varying relationship on skyline causes confusion</p>
<p><b>5</b> <b>Land use</b></p>	<p>5.1 What is the land use, does it vary within the windfarm area?</p>	<p>A windfarm may relate to the land use of an area, for example within an agricultural landscape where shelter belts and wind eroded soils are evident. The location of a windfarm will seem rational if it directly relates to a land use or building; in this way it will appear to have a functional relationship with its surroundings. If a landscape has no distinct land use or pattern, it should aim to portray a sculptural image to appear 'in control' as a contrasting visual feature.</p> <p>Care must be taken that the location of windfarms within a particular land use, such as an industrial or urban area, does not stereotype them in the future to be of that character, even when located in for example, a mountain landscape.</p>  <p>Monoculture - clear contrast of elements      Integrated into landscape pattern as component      Integrated into landscape feature</p>



**Individual landscape characteristics** *(continued)*

Subject	Question	Notes/Explanation
<p><b>5</b> <b>Land use</b></p>	<p>5.3 Are there any roads adjacent to, or within, the windfarm site? (Refer to 10.3)</p>	<p>Existing access routes will relate to current or past land use. Windfarms, however, are essentially temporary structures, so the location of permanent access tracks may be unjustifiable.</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Track relates to turbine</p> </div> <div style="text-align: center;">  <p>Turbine is removed – track appears as irrational element</p> </div> </div> <p>A windfarm may relate to the human-made and active nature of a busy road. If windfarms are located adjacent to roads however, they should either be located close to the route, so that a driver can view the development without taking their eyes off the road, or they should be located far away enough that the complete windfarm can be viewed with a quick glance. If windfarms are located out of the drivers range of vision of the road, and yet close enough to warrant detailed inspection, they may cause visual confusion, resulting in a safety risk.</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Close by – easy to see whilst ‘eyes are on the road’</p> </div> <div style="text-align: center;">  <p>Far enough to view with quick glimpse</p> </div> <div style="text-align: center;">  <p>Close enough to invite detailed look, but have to take ‘eyes away from road’</p> </div> </div>

## Windfarm design

Subject	Question	Notes/Explanation
6 Wind turbine type  form and model of turbine	6.1 Are all the wind turbines identical within the development?  What energy generation capacity are the wind turbines?	Wind turbine type should be consistent within a development to avoid visual confusion.  Most wind turbines currently used within the UK are 300–600kW. The characteristics of a windfarm may vary with the energy capacity of wind turbines and generally the use of the most efficient turbines in terms of their impact related to generation should be encouraged.
	6.2 What is the size of the turbines?	Turbine size should be proportional to the scale, exposure and function of a site. The scale of a wind turbine is difficult to perceive unless there are other comparable structures of a known size within the area; if this is the case, care must be taken that the turbine does not appear to intimidate its surroundings. In most cases, the use of fewer large wind turbines should be encouraged as this has been supported by existing public opinion surveys (Thayer and Freeman 1987).
	6.3 Around what axis do the turbine blades rotate?	Vertical axis wind turbines are rarely used within the UK, most windfarm developments comprising horizontal axis wind turbines which tend to be considered more visually acceptable, their function being recognisable in relation to traditional windmill form.
	6.4 Is the wind turbine one of the most technically up to date and advanced models?  Are the wind turbines being proposed within a wind efficient site?	Many of the early models of wind turbine are excessively noisy, visually unattractive and technically unreliable. The use of these machines often leads to public mistrust in the technology, especially if turbines are often stationary due to faults, resulting in a windfarm being viewed negatively. If individual turbines within a windfarm are non-operative, they will visually contrast with the moving turbines, leading to visual confusion. Windfarm operators should develop some system to inform the public if there is any major operational problems with a development, as people tend to be more forgiving if they understand the reasons why a certain system is faulty (Carlman 1986).  Similar to the above, if wind turbines are located in inefficient areas they may often appear stationary, leading to public mistrust. Care must be taken to ensure that all turbines within a windfarm utilise the same winds, otherwise visual confusion may arise with differences in wind turbine blade operation and orientation.
movement of turbine blades	6.5 At what speed will the wind turbine rotate?	The speed at which turbine blades rotate may affect visual impact. The movement of wind turbine blades should be able to be followed comfortably by the human eye (generally accepted to be less than 45rpm) so as not to appear disturbing or incomprehensible.

**Windfarm design** *(continued)*

Subject	Question	Notes/Explanation
6 Wind turbine type	6.6 Will the turbines operate at one constant speed or more?	If turbines operate at more than one speed, varying local winds may result in turbines within a windfarm differing in their rotation speed. This will reduce the uniformity of the development and lead to visual confusion.
	6.7 What are the 'cut-in' and 'cut-out' speeds of the wind turbines?	Most wind turbines tend not to operate during very low or high wind speeds, due to efficiency and safety reasons respectively. There should be some attempt to notify local people and visitors of this characteristic, as if turbines are stationary during windy weather conditions, it is often assumed that the machines are faulty, leading to a degree of public resentment due to failed expectations (refer to point 6.4 above).
	6.8 Do the wind turbines 'free-wheel' whilst non-operational?	Some wind turbines may 'free-wheel' during periods of low wind speed. Although this may satisfy public expectations that wind turbines should always be moving during windy conditions, there is a risk that this may cause distrust if people feel that they are being deceived. If 'free-wheeling' occurs at variable speeds, the uniformity of a windfarm development will be disrupted (refer to point 6.6).
wind turbine blade number	6.9 How many blades do the proposed wind turbines possess?	<p>Blade number within a windfarm, and also each landscape area, should always be consistent, so that a development appears uniform and repetitive.</p> <p>Three bladed wind turbines are preferable in most cases: they are visually acceptable due to their recognisable function, being comparable to traditional windmill form and they are visually more balanced as a structure (being particularly important when stationary). The movement of three bladed turbines appears continuous and it is difficult to identify variations in blade position within an operational windfarm, so that the development appears unified and cohesive as a group.</p> <p>The use of two bladed wind turbines may be acceptable when developments are very small in scale with a functional image, or in a mountainous or moorland area where a large windfarm development takes on an 'invasive futuristic' image. It must be noted in this latter case, however, that the impact of the windfarm will be heightened; this is due to the erratic visual movement of two bladed turbines and because differences between wind turbine blade position are very apparent. Two bladed wind turbines also seem to sweep down in an accelerated manner when viewed from the ground at a tangent, as the distance, between the blade tip and the ground varies considerably between their vertical and horizontal position.</p> <p>One bladed wind turbines are generally considered inappropriate due to their visual imbalance.</p>

**Windfarm design** *(continued)*

Subject	Question	Notes/Explanation
<p><b>6</b> <b>Wind turbine nacelle and tower</b></p>	<p>6.10 What are the characteristics of the wind turbine nacelle?</p>	<p>The wind turbine nacelle should be small and simple in form, positioned centrally over the supporting tower. The yaw mechanism of the turbine should be small and located at the rear of the nacelle to avoid it compromising the sculptural form. The hub of the nacelle should be small and appear as part of the blade composition.</p>
	<p>6.11 What are the characteristics of the wind turbine tower?</p>	<p>Generally, wind turbine towers should be solid in construction. Lattice towers may be acceptable, however, for single turbine developments where there is a functional relationship to a land use or building; although due to their minimal framework structure, the nacelle may appear 'top heavy' and seem to be floating above the ground from a distance, as the tower may be less visible.</p> <p>Solid turbine towers should be cylindrical if supporting a square nacelle, or cylindrical/slightly tapering with a nacelle which is oval in elevation. Tapering towers may seem more elegant, however, cylindrical towers may seem more sculptural, the nacelle and the tower appearing as part of the same structure. If tapering towers are used, care must be taken that the nacelle appears balanced upon the tower and does not seem precariously 'perched', due to a weak visual connection between the two turbine elements.</p> <p>Tripod towers should not be used; they appear visually insufficient in supporting a turbine nacelle and blades, so that the turbines seem 'top heavy' and unbalanced.</p>



**Windfarm design** (continued)

Subject	Question	Notes/Explanation
<p><b>6</b> colour and surface finish of wind turbines</p>	<p>6.12 What is the proposed colour of the wind turbines?</p>	<p>Wind turbines should be painted just one colour. If the colour varies, the component parts will be accentuated, the turbine losing its sculptural image. The painting of brand names on turbines should also be avoided for this reason.</p> <p>Wind turbines, due to their very nature, can not be hidden. An attempt to 'camouflage' them will be unsuccessful and if this occurs, by for example painting them grey, the perception of wind turbines changes; at once they are seen as something that has been unsuccessfully hidden, a negative feature, often appearing 'grubby', urban or mechanical in nature, similar to disused 'military structures', that have been occasionally abandoned in our landscape.</p> <p>Wind turbines should normally be white in colour; this acknowledges the human made and sculptural image of wind turbines. White is also associated with purity and neutrality within our culture and the white painting of turbines relates to the tradition of having white houses in the landscape. The neutrality of white means that whatever the weather conditions or nature of the surrounding landscape characteristics, the turbines will never aesthetically clash in colour. This is particularly important within Caithness and Sutherland where they may be frequently seen against a backdrop of white snow, which if they were grey would result in them appearing 'dirty', as a negative element.</p>
	<p>6.13 What is the proposed surface finish of the wind turbines?</p>	<p>Turbines should be matt in finish to avoid excessive visual distraction and to reduce visibility extent. It must be understood, however, that the nature of some wind turbine manufacture means that a matt finish can only be achieved after several months of weathering.</p>
<p><b>7</b> size of windfarm</p>	<p>7.1 How many wind turbines does the windfarm contain?</p>	<p>If there is more than one wind turbine within a development there is a visual relationship between each turbine, as well as with the landscape.</p> <p>The size of a windfarm should relate to the size of a site and the surrounding landscape character, taking into account its exposure so that it does not intimidate the landscape scale.</p> <p>The impact of a windfarm is not necessarily proportional to the number of wind turbines it contains; this will also depend on the characteristics of the wind turbines, the landscape type, and the layout and spacing of turbines. These will all in turn condition whether a windfarm is viewed as a single cohesive development and whether its scale appears appropriate to the landscape in which it is located.</p>

**Windfarm design** (continued)

Subject	Question	Notes/Explanation
<p><b>8</b> spacing and layout of a windfarm</p>	<p>8.1 What is the rationale behind the windfarm layout?</p>	<p>It is important that a windfarm layout relates to landscape character if it is to be perceived as being appropriate.</p> <p>The location of wind turbines must appear logical to the viewer (although economic reasons are often given for wind turbine location, there are generally several viable wind turbine layouts for any economic solution).</p>
	<p>8.2 Does the windfarm relate to specific landscape features such as roads, ridges, hedges etc?</p>	<p>If a landscape has distinctive physical features, pattern or spaces, it should relate to these (note that contour lines are not visible physical features and wind turbines should therefore not be directly sited along them, as their location will seem illogical on-site).</p> <p>If a landscape has no distinctive features or pattern, for example moorland, wind turbines should be arranged in a regular layout which will appear ordered and 'controlled' as an honest uncompromised image of a human-made element.</p>
	<p>8.3 At what spacing are the wind turbines located?</p>	<p>The spacing of wind turbines should depend on their size, layout and the landscape type. Wind turbines should be arranged at uniform spaced distances, whatever the pattern of their layout, so the wind turbines appear repetitive and ordered within a group.</p> <p>Wind turbines which are spaced too close together will visually overlap and may seem confusing from a distance. Wind turbines which are located too far apart, however, may result in a windfarm appearing disconnected and uncohesive as a group, causing visual confusion.</p> <p>For 300–600kW wind turbines, the most appropriate spacing distance will probably be:</p> <p>Single line layout: 100–250m Grid layout: 150–350m Informal layout: 200–300m</p>
<p><b>9</b> associated development</p>	<p>9.1 Is there any associated development with the windfarm proposal?</p>	<p>A windfarm is essentially a temporary structure; therefore any additional associated development should be minimised, so that if the windfarm is removed in the future, the site will appear relatively unchanged above ground.</p> <p>Any functional elements associated with a windfarm development will compromise its sculptural image.</p>

**Windfarm design** *(continued)*

<b>Subject</b>	<b>Question</b>	<b>Notes/Explanation</b>
<p><b>9</b>  <b>associated development</b>  <i>(continued)</i>  <b>access</b></p>	<p>9.2                      Have new access roads been proposed for the development?                      If so, could they be avoided or constructed as temporary features and the site restored?</p>	<p>As above, the most appropriate windfarm sites should not require new access roads. If it is suggested, however, that access over fields or using existing tracks is not suitable for construction traffic, alternative options should be explored, rather than constructing permanent access routes which may have a greater physical and visual impact in the landscape than the turbines themselves. Alternative forms of access could be, for example, using temporary 'raft' platforms, accessing the site by air or sea, or by restoring or 'degrading' temporary routes after construction is completed.</p>
<p><b>sub-station transformers and electricity power lines</b></p>	<p>9.3                      Is a new sub-station required for the development?</p>	<p>If necessary, the construction of a windfarm sub-station should be planned and designed subject to standard development conditions.</p> <p>As windfarms are generally located on areas of high exposed land, the location of a building may seem inappropriate, and will probably conflict with the sculptural image of a windfarm. It may therefore be more appropriate to locate a sub-station slightly apart from the windfarm site or underground.</p>
	<p>9.4                      Are any additional electricity transmission lines proposed?</p>	<p>Any additional electricity transmission lines linking to a windfarm should be buried underground. The horizontal lines of wires will conflict with the vertical element of a windfarm, the pylons contrasting in their form, leading to visual confusion.</p>

**Windfarm design** (continued)

Subject	Question	Notes/Explanation
<p>9</p> <p><b>public access and visitation</b></p>	<p>9.5</p> <p>Are transformers proposed within the windfarm development?</p> <p>Is any provision being made for public visitation?</p>	<p>Transformers can either be located at the base of individual turbines, within their towers, or between many turbines which share their facility. As above, the location of these functional elements may compromise the sculptural image of the turbine and disturb the clarity of its form.</p> <p>Experience has revealed that the public do express interest in wind energy developments, especially at the moment when they are often seen as a novelty within the landscape.</p> <p>As a minimal provision, lay-bys allowing visitors to pull off main roads to view windfarms may be advisable, together with interpretation boards providing information on the development. For most people, this provision will be sufficient, however some will try to access the windfarm site, whether public visitation is encouraged or not, especially as windfarms form such dominant focal points within the landscape. This will not necessarily cause problems, but it may mean that a site, possibly sensitive to human impact, could be visited in excess of its carrying capacity. In these locations, the construction of site access tracks may encourage people to enter the development, however they will also limit impact to some extent, by directing human movement in certain routes.</p> <p>At the highest level, some existing windfarm developments have visitor centres, where the public can be informed of the nature of the wind energy industry. These should only be located in landscape character types which can accommodate such visitor or tourist development. They must be able to incorporate change in future demands for visitation, as the public becomes more familiar with wind energy development.</p>

The following major issues of windfarm impact should be assessed when considering the wider landscape implications.

- Flora and fauna
- Electromagnetic influence
- Shadow flicker
- Construction and maintenance disturbance
- Noise
- Safety

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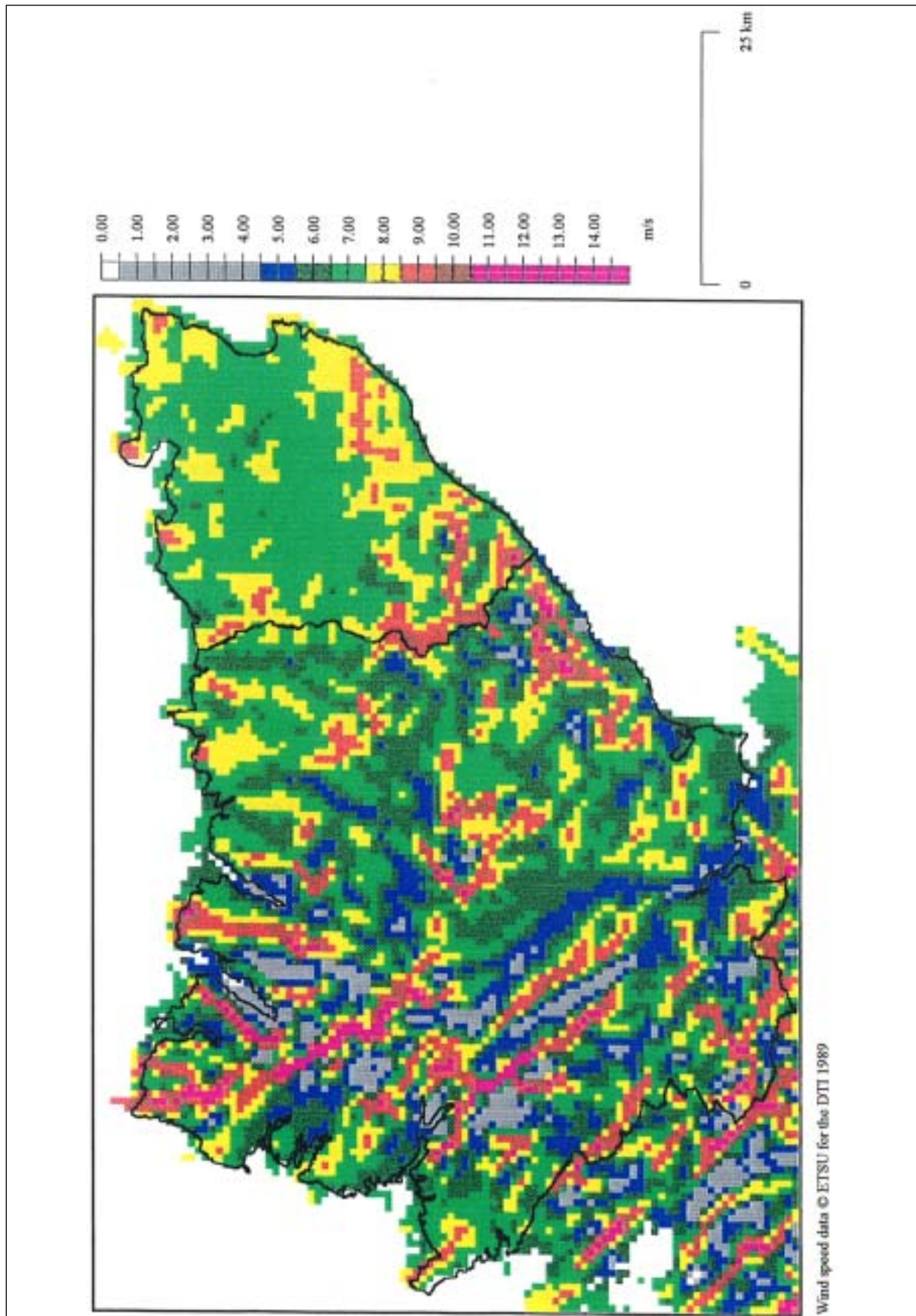
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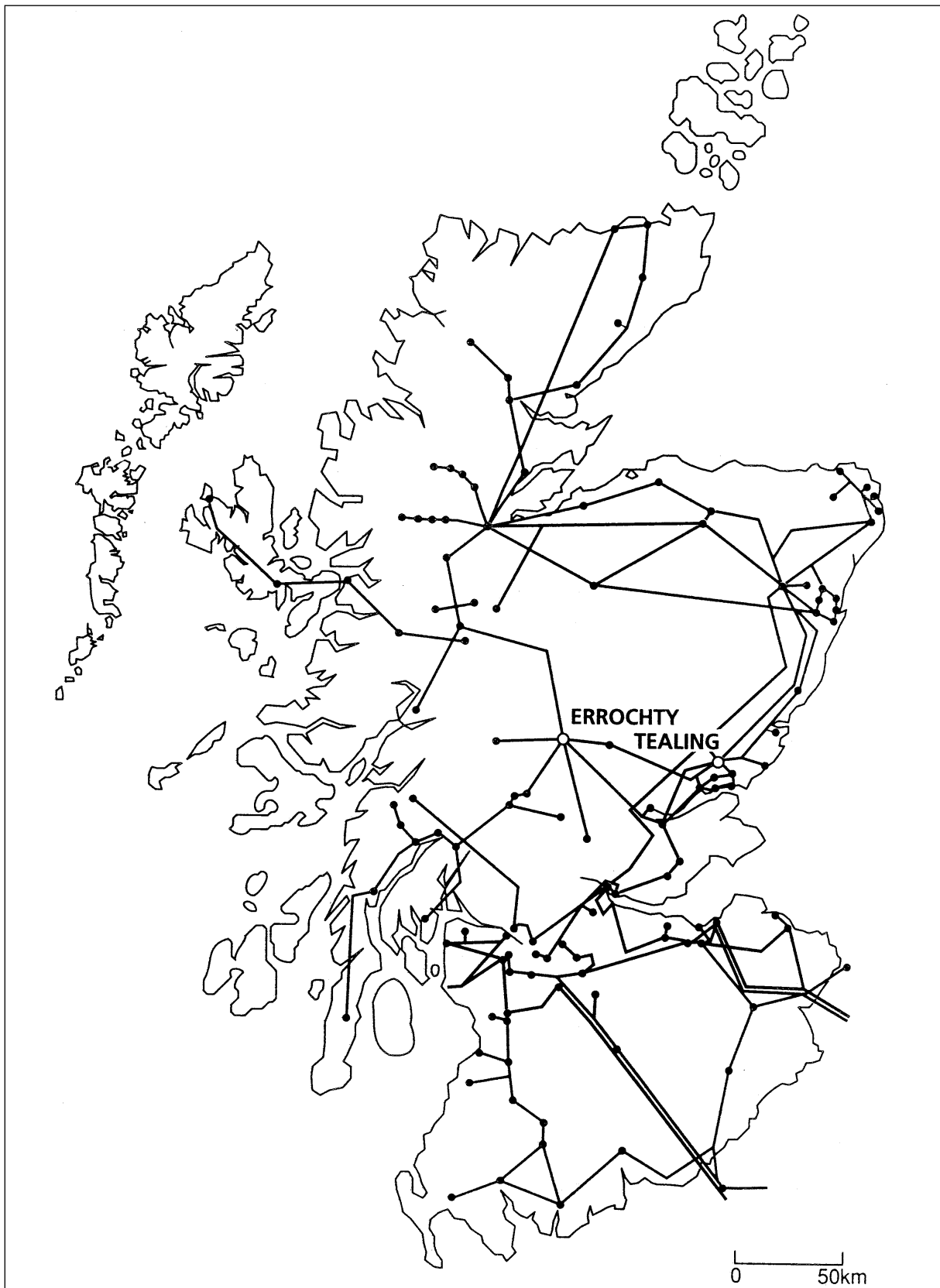
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## APPENDIX a – Wind speed data for Caithness and Sutherland



## APPENDIX b – Plan showing the major electricity transmission lines within Scotland





## APPENDIX d – Areas of archaeological interest within Highland Region

