

Peter Suttie Award 2002



Report on
Danish Wind Energy
Planning & Development:
by Peter Fraser

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1.0 Preface

1.1 Wind energy development is an issue which is coming increasingly to the fore with a number of Scottish local authorities including Aberdeenshire Council. In recent months it has become apparent that a number of developers are keen to proceed with relatively large scale wind farms in areas which have seen nothing of this nature in the past.

1.2 Recently in Aberdeenshire there have been a number of full wind farm planning applications, including Meickle Carewe, north of Stonehaven, and Glens of Foudland east of Huntly which consisted of 31 turbines in total. To date there are a number of other sites in Aberdeenshire which developers are well into the process of scoping as potential applications of similar scale. Around a further dozen sites are known to be of interest to wind energy developers as potential wind farm locations for a variety of scales of development, including single and small clusters of turbines.



Fig. 1 Dun Law, Scottish Borders

1.3 Aberdeenshire, as well as its neighbouring authorities, has relatively recently become the focus of attention for a number of wind energy developers. For this reason it is essential that the planning authority is as informed as practical in relation to all wind energy development issues.

1.4 This report sets out to look at current wind energy planning and development issues in Denmark, currently Europe's most experienced wind energy nation. This is in order that some Danish experience can be summarised and used to the advantage of Aberdeenshire Council, as we continue with the process of administering wind farm planning applications for this area, and reviewing wind energy planning policy.

2.0 Introduction

2.1 Because of the current nature of the wind energy industry, there is an almost inexhaustible amount of information available. This is due to the rapid global expansion of the industry and the rate at which the technology is evolving. The shape of generators has changed over the past few years, and the size of proposed turbines is increasing all the time, to improve efficiency.

2.2 With the potential large scale of wind energy development, and evolving nature of the industry, it is important that planning committees and officers are as informed as possible in relation to current wind energy issues. Wind energy developments, by their nature, tend to be visually high profile and tend to be proposed for areas of valued rural landscape. Local authorities need as much information as possible in relation to wind energy development, if balanced decisions are to be taken in the best interests of society.

2.3 It needs to be borne in mind by the reader that this field of development is rapidly changing, and the information in this report is a snap shot of the situation in November 2002. By its nature, some of the information in this report will be out of date in a few months time as the situation in the wind energy industry further evolves. Having stated that, there are general planning principles used in Denmark which will be worthy of further research with a view to informing the current situation in Aberdeenshire.

2.4 This report would not be possible without the invaluable enthusiasm and support of Per Toppenberg, Regional Planner with responsibility for the North Jutland regional wind energy plan. Per spent a full working day explaining background policy and showing me around wind energy development sites in the region and for that I would like to express my thanks and gratitude.

3.0 Background to Report

3.1 Windfarm development can be an emotive subject. It's a type of development which attracts a great deal of argument for and against it. These developments are often proposed for areas well known for their attractive rural character. Local people especially, feel great attachment to the landscapes concerned, and any change to the qualities they value can cause great anxiety and objection.

3.2 Having been asked as an internal consultee, to comment on the two windfarm applications, fully processed by Aberdeenshire Council in recent times, I felt that the authority could benefit from more experience in relation to best practice for planning, designing and implementation of wind farms. Questions regularly arose, in relation to wind farms, especially in relation to site specific issues, to which policy or the development plan offered no clear guidance.

3.3 Further to a meeting of the North Sea Commission in September 2000, I learned of the wind energy development taking place in the North Jutland area of Denmark. The wind energy industry in Denmark is at an advanced stage having begun in the early 1980s. North Jutland features some of the highest levels of wind energy development in Denmark, and some of that development is now considered to be out of date and in need of replacement with more efficient second generation technology.

3.4 I contacted Per Toppenberg, the regional planner for wind energy in Aalborg North Jutland. Per's main task is to prepare and update the regional wind energy plan. The purpose of the wind energy plan being to convert central government sustainable electricity production targets into on the ground wind energy production at a strategic or regional scale.

3.5 The Peter Suttie Award scheme gave me the opportunity to visit Denmark in April, to find out from Per about Danish wind energy policy and visit some of North Jutlands wind farms. The following report is a description of what I learned, and how the Danes experience might assist wind farm planning in Scotland.

3.6 This report is primarily summary of what I learned in the course of my visit to Denmark. I was specifically interested, as an environment planner, in site design best practice, and wind energy strategic planning at a regional level, and this has been my principle line of inquiry and research. Limited information has been included in relation to development control in Denmark. I considered this to be relevant to the main line of inquiry of the report, but information on issues such as this is not exhaustive and interested readers will need to take these areas of research forward elsewhere.

4.0 Current situation in North Jutland

4.1 The North Jutland region within Denmark is the most northern territory in the country. Separated from Norway and Sweden by the North Sea/Baltic, the area has an east and west coast. Aalborg is the largest city in this part of Denmark.



Fig 2 General plan of Denmark

4.2 Wind energy development is a common feature of the North Jutland landscape. It's almost impossible to travel any reasonable distance through the region without seeing either individual, clusters of, or entire parks of wind turbines. Throughout the countryside, in hilly areas, on the plains, and even close to population centres, turbines can be seen. So how has wind energy development been planned and controlled and what are the main siting issues in relation to this type of development?



Fig 3 Typical North Jutland scene

5.0 Background to Danish wind energy planning

5.1 Denmark has had significant wind energy development over the past twenty years. The Danish government identified renewable energy sources as an important policy to pursue, and incentives and subsidies were therefore put in place to encourage development of this type. These included subsidies on electricity produced by wind turbines, and assistance with connection to the national grid etc.

5.2 The planning of wind energy development is carried out primarily through Danish central government directives on planning issues and goals on wind energy production. Strategically these directives are interpreted through the 14 Danish counties or regions of which North Jutland is one. At local level these requirements are further developed into detail local plans for the 275 Danish municipalities. The original 1994 central government requirement was specific in that potential areas for locating wind turbines should be investigated and identified, and that a national wind generating output target of 2000 megawatts, or 10% of the nations electricity need, should be met by 2005.

5.3 Responsibility for wind energy strategic physical planning lies with the 14 Danish counties, who are also responsible for strategic planning of infra structure, health care, tourism, urbanisation and landscape designations etc. The regional wind turbine development plan is reviewed and updated every four years.

5.4 The main goal for the regional planning system being to achieve 10% or 2000 megawatts of the nations electricity supply from wind energy by 2005. An agreement was reached between the electricity companies and the Danish Ministry of Environment and Energy, committing the country to this level of wind energy production, and it was the responsibility of the regional planners to identify suitable locations for the necessary number of wind energy facilities. The regional planners were aware of the area of wind energy sites needed to achieve allocated wind energy production goals, and this information was converted into detailed plans.

5.5 This process was started at county/regional level by identifying local wind conditions. This is important because wind strength has economic implications in terms of energy production, general efficiency and minimising the number of turbines/area for development required. The higher the average wind speed, the fewer turbines will be required to meet production targets. With wind conditions creating the basis for a wind energy development plan, the framework was then refined by identifying

areas of special landscape designation, conservation and heritage interest etc, where wind energy development would be unacceptable. Strategic issues such as telecommunications, the presence of main roads, military installations, density of local housing, and airports also had a bearing on the regional plan for wind energy which was formulated. All potential wind energy development areas also have to have potential for linking to the Danish national grid.

5.6 The regional plan enforces policies on the required size and design of wind turbines and outlines zones where various scales of development are acceptable. Zones include areas where wind turbines are prohibited, zones where individual turbines may be acceptable (although increasingly the development of individual turbines is being discouraged), zones where local wind farms and clusters are acceptable, and zones where large-scale regional wind farms are identified as being appropriate.



Fig. 4 Typical Samples of Regional Plan Information

Base regional plan information is held in GIS format. Information can be read at a variety of scales and covers areas with conservation, landscape and agricultural interest. Areas of tourist and recreation interest are included as well as details of infrastructure such as transportation corridors, pipelines and existing wind energy installations.

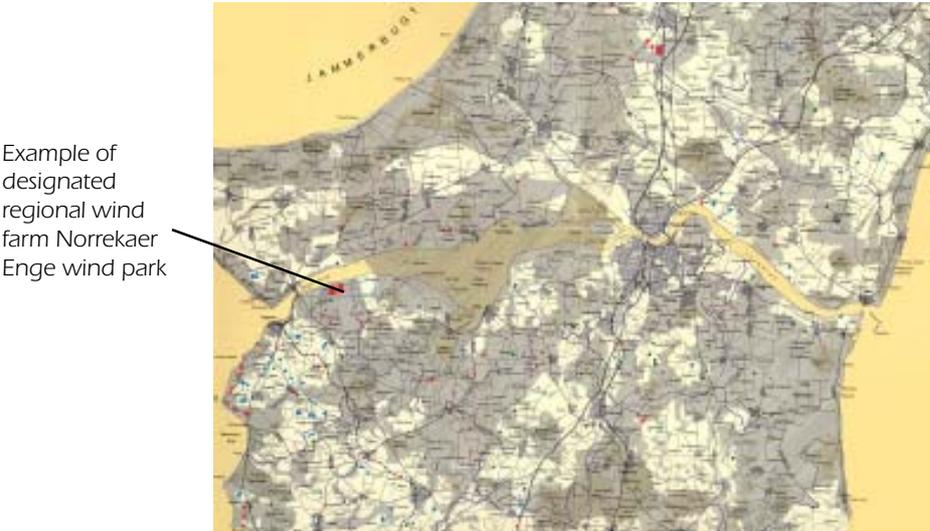


Fig. 5 Sample of Danish regional plan information

5.7 Planning for wind energy at municipality/local level goes into the detail of particular sites identified for wind turbine development, and includes detailed specifications for wind energy implementation.

5.8 Currently North Jutland has the highest wind energy production of any county in Denmark. The energy produced from North Jutlands wind energy facilities amounts to 25% of the over all wind energy goal for Denmark. The national goal of achieving 10% by 2005 of electricity production from wind energy has already been achieved.

6.0 Background to regional/county wind energy plan

6.1 The first regional plan for North Jutland was produced in 1989. The region was divided into 4 zones, comprising of areas where various scales of wind energy development were identified as being acceptable. Through that 43% of the county was identified as being suitable for wind farms of up to 10 turbines (local windfarms) and 2% of the country was identified as being suitable for regional wind farms of more than ten turbines. 25% of the county was identified as not being suitable for wind farm development. For local wind farms and single turbines the municipalities (local) plan dealt with detail issues of precise location within the framework of the regional plan. The planning process resulted in the whole of the energy plan being reviewed on a four year basis.

7.0 Background to municipal (local) plan

7.1 The approach to municipal or local wind turbine planning goes back to 1990 when The Danish Minister of Environment and Energy instructed the 275 municipalities to create local plans to indicate possible areas for siting wind turbines and farms. The municipal plan fits into the regional plan and interprets strategic issues at local level. This report concentrates on Danish policy prepared at regional level, but planning at municipality level is generally outlined.

8.0 Reviews of the regional plan

8.1 The first regional plan was, with experience, viewed as being too loose in terms of planning regulation, and changes were made in 1993. The changes included keeping large scale undeveloped landscapes free of turbines, concentrating development into designated wind farm areas, locating single turbines only according to the local plan, and creating clear regulations regarding height of turbines and distances in relation to implementation. Distance regulations included a minimum distance of 1000 metres between local wind farms. The upgraded regulations redesignated a local wind farm as being up to 15 turbines, and made clear stipulations regarding efficiency of equipment. The regional wind farm category, more than 15 turbines, was identified as being an issue for the regional plan.

8.2 Further changes were made as the regional plan was reviewed in 1997. A minimum wind energy capacity was set for each municipality in accordance with central government directives. Minimum and maximum capacities were set for regional scale wind farms through the planning system. At this stage municipal plan areas were also identified with existing turbines which were too small, too few and located in areas which were poor in terms of the wind resource. The municipalities at this time started to develop specific plans for large (more than 70 metres high) and small turbines (5-15 kw). Single wind turbines were prohibited at this time except for small domestic units of less than 25kw. The reason being that single turbines were being located in areas which could potentially take multiple turbines. Advice on siting patterns was improved with this review. The main issues effecting the regional wind farms, at this stage, included rights of access by the public, reducing the numbers of wind farms, restricting the size of the units and placing a limit on the maximum size/production capacity of each farm. Minimum distances between wind farms were set at 3 kilometres in 1997, although in

more recent guideline this has been changed to 5 kilometres. If proposals were for a windfarm less than the stipulated distance from its nearest neighbour, then specialist documentation is required with additional environmental impact information. It was also stipulated at this point that the distance between housing and turbines should be at least eight times the tower height. In addition to this the design standard requirement of all turbines having three blades was established. A cluster of wind turbines was defined as being at least 5 towers.

8.3 The planning issues effecting local wind farms during review included there being too many and too small in numbers. The issue also arose of whether turbines in sensitive landscapes should be removed altogether, or replaced on a one for one basis in order to restrict numbers in such areas. The revised plan also detailed the design, finishes and size for all turbines. Turbines size as a result of the review process was now required to be uniform across a site. All turbines in the regional plan area also needed to comply with these regulations and guidelines covering illumination at night and restrictions on advertising. These design guidelines were developed through experience and observation over time. The pattern of layout was also identified as being important especially on flat sites. Observations for example identified offset parallel rows of turbines as working most successfully. This uniformity suits the generally low rolling Danish landscape and minimises effects of visual clutter and confusion etc. In addition to stipulated guidelines, interpretation of local features and site conditions were also taken into the wind turbine layout process.



Fig.6 Turbine farm featuring parallel row layout, designed to minimise visual clutter

8.4 With the review of the 1993-1997 regional wind turbine plan, minimum and maximum wind resource capacities were established for individual sites at regional and local levels. With pressure to establish increasingly large turbines, an ongoing feature of the industry, additional planning research was undertaken at regional level. Small turbines of less than 25 kw, proposed for domestic use, were only permitted for rural areas with no designation for larger scale wind development, or close to houses. It was during this period of review that it was identified that minimum distances between turbines and the nearest houses could be dealt with at local level.



Fig. 7 Turbine location in relation to local property

9.0 A summary of information contained in the 1997 regional wind energy plan

9.1 Strategically the regional plan of 1997 carried up to date information on basic wind resources and included details of minimum required production capacity for regional and local wind farms. Detailed technical information is also needed to be considered in relation to this issue. For tall structures, 100m plus, for example, there is changes in wind pressure between the base and the top of turbines, which puts turbines under additional strain and shortens their operational life. The regional plan at this time comprises of three outlined zones which identified areas where wind energy development is inappropriate, areas suited to regional wind energy development (15 turbines plus), and areas where local wind farms (less than 15 turbines) could be established. Turbines could only be located in designated wind farms which appear on plan. At this time it was also identified that turbines should only rotate clockwise, and that reflective materials should not be used on the structures.

9.2 In terms of historically poorly located turbines, it was recognised in the regional plan, at that time, that these should not be replaced. However with time this policy has proved to be almost ineffective as there is no economic incentive for owners, often farmers, to remove badly located turbines. These are some of the issues which will need to be addressed in future for good management of wind energy facilities.



Fig.8 Example of poor turbine planning practice in terms of being located in a relatively low lying area



Fig.9 Example of poor turbine planning practice in terms of turbine design and location

9.3 It was also at this stage in the Danish wind energy development plan evolution that visualisation information was made a basic requirement for all wind energy development applications. At this stage it was also recognised that visual coalescence between neighbouring wind farms was an issue, and visual information would need to be supplied with planning applications which fall into this category.

10.0 The regional and local plans post 1997

10.1 The municipal plan/local plan, dealt with the details of local wind farms (less than 15 turbines) and small turbines proposed for rural locations. The strategic implications of increasingly large development was dealt with in the regional plan, but detail on site location remains the responsibility of the municipal plan. In relation to this, applications have been received for constructing large turbines (100 metres plus) in regional wind farm areas (15 turbines plus). Because the zones concerned have an assumption in favour of development of appropriate scale, planning permission should be granted in

principle. The regional plan is now being reviewed in the short term, to take into account further possible developments of this unprecedented scale throughout North Jutland. It is currently considered appropriate to locate these large turbines close to existing large scale industrial infrastructure, and locations such as Aalborgs East Harbour have recently had single experimental large scale turbines which will stand at more than 125 metres installed.



Fig. 10 Turbines located close to Aalborg harbour industrial area

10.2 Generally the objective of the regional plan, to build turbines in accordance with central government goals has been achieved. The central government target for electricity production from wind power was reached in 1999, six years early. This has resulted in some municipalities continuing with wind energy expansion, and in others this policy has been curtailed, depending on local priorities.

10.3 A problem in relation to local planning, is lack of coordination between neighbouring municipalities resulting in discordant development along authority boundaries. The regional plan encourages local municipalities to co ordinate wind energy planning frameworks, but this is not currently a statutory requirement. The strategic inter relationship between regions is very important to establish a continuous, harmonious pattern of development.

11.0 Contemporary issues being addressed by the regional wind energy plan

11.1 The main issue now being addressed by the regional plan includes the implications of off shore wind energy development. Denmark now has the potential to meet a high proportion of its future wind energy needs with off shore wind farms, some of which have been constructed. This has implications for the land based turbines in terms of future wind energy needs being potentially met off-shore. The issue is currently being discussed, and at the end of 2002, there were indications that the Danish government may be reconsidering the promotion of off shore development.

11.2 How to proceed with the output targets for regional and municipal plans needs to be considered and brought up to date in the light of the current wind energy production.

11.3 The removal of turbines which are poorly designed or located, especially in relation to sensitive landscape designations is an issue which may need to be planned at region level.

11.4 With the current production capacity having been achieved, there is an issue that new turbines should only be set up to replace poorly located turbines (in a more appropriate location) or replace obsolete or inefficient technology.

11.5 All aspects of the regional plan are reviewed as part of the planning process, and that includes revisiting the wind energy development restricted zones. The validity of original designations are fully appraised taking into account recent experience and the result of the process may be to allow some development where there was none before.

12.0 General issues in relation to planning at regional level in North Jutland

12.1 Putting together the regional plan is a complicated process which needs to strike a balance between the needs and interests of a number of diverse groups. The Regional plan is driven by specific energy goals ultimately set by central government. The Danes indicate that clear aims in terms of energy production is important to the process of energy planning, and North Jutlands current output goal is 1500 megawatts from wind energy by 2005. Clear objectives make strategic planning simpler and the development process faster. In North Jutland, experience has indicated that careful planning in relation to the needs of the environment and local people in combination with clear energy goals is a good method in achieving a practical wind energy development plan. In relation to the development of finite design criteria, much of the policy, such as distances between turbines and neighbours etc has been worked out through experience and observation.

13.0 The review of the most recent regional plan

13.1 The regional planning process has been through a number of reviews and updates since its inception. In the latest edition, taking into account past experience, and changes in the industry, clusters of turbines now have to comprise of at least 5 units and the minimum distance between farms is to be no less than 3 kilometres. Further expansion of the existing wind energy capacity in the county is to be restricted. The organisation of large-scale turbines, with towers of 45 metres or more will require a supplement to the regional plan to be developed, as technology on this scale is relatively new.

14.0 Danish wind energy planning policy and planning guidelines

14.1 Generally, wherever possible, the Danes create prescriptive guidelines for wind farm development. For example, there are clearly dimensioned restricted areas where development is forbidden along the coastline, around historic monuments, adjacent to lakes and watercourses larger than a certain size, adjacent to woodland, churches and other landmarks/points of interest etc. Experience has allowed them, for example to stipulate that wind energy development should not come within 200metres of telecommunication corridors.

14.2 This approach to planning extends into detailed guidelines for visual and landscape impact

assessment and on the ground layout requirements. The 1999 Danish planning laws covering landscape protection for example stipulate that the minimum distance from turbines to the nearest neighbour should be not less than 4 times the total height of the structure. Wind turbines located within 500 metres of the nearest neighbour will require a special planning application covering issues associated with an environmental assessment. Wind turbines located within 2.5 kilometres of other turbines will also require supplementary planning information covering additional details on visual impact etc. For a cluster of more than three turbines, or turbines standing at more than 80 metres in height, additional information in relation to visual and environmental impact is now required.



Fig. 11 Turbine location in relation to local property

14.3 The main current issue effecting wind energy development in North Jutland, is the fact that the landscape is now considered to have reached capacity in terms of the total number of turbines it can comfortably accommodate. Also many of the turbines installed in the 1980s are considered to be poorly located, obsolete and need to be replaced or relocated.

14.4 The Danish answer to the general landscape capacity problem is to start the process of preparing to site wind farms off shore. The advantages of siting wind farms off shore, include generally smoother wind flows and lessening pressure to develop on the land. With regard to the replacement of obsolete technology, this is viewed as an opportunity to make good planning mistakes of the past in terms of poor siting and design problems, and improve production of energy by installing more efficient technology. All this will be done through the regional planning process and the continuous cycle of revision which the plan goes through.

15.0 Main issues in relation to Danish wind energy planning

15.1 The main Danish wind energy planning issues fall into three main categories of economy, general public acceptance of wind energy development and related minor issues. The basis of the economic factor is available wind resource, existing infrastructure (access to the national grid) and the market price for electricity (including available subsidies). In terms of general acceptance, visual impact is a major factor in people accepting the need for, and presence of wind energy development. Local land ownership, usually by farmers is also an issue in public support for wind energy development, and if the local jobs market benefits from the development then that is a positive factor also.

16.0 Anticipated problems in relation to wind farm development

16.1 Issues which were anticipated to be problematic, in relation to wind energy development, but which with implementation have proved not to be significant impacts include the following. Anticipated disruption to both natural habitats and flora and fauna, possible problems with noise, shadow flicker and negative impacts on tourism. Location of turbines of 750 kilowatts or less near airports have had no significant impact on communications, flight safety etc. The problem of ice flying off early turbines in certain weather conditions was a difficulty associated with old technology.



Fig. 12 In some countries, the presence of wind energy development is used as good tourist post card material

16.2 Regulations within the planning guidelines have been developed to cover any anticipated problems. In relation to noise for example, the local authority has the power to close down a turbine which has proved to be noisy. The onus is on the developer to meet stipulated health and safety requirements.

16.3 The Danes recognise that the wind energy sector is a relatively new area of development which is in a continuous state of change. Technology is evolving and in real terms turbines are getting bigger. Best practice guidelines in terms of design and site layout are being established with experience. In Denmark there is a changing economic situation with subsidies and other types of economic assistance being under review, and changing priorities for the countryside. Tourism is an increasingly important issue also, and technology for generating computer visual perspectives are all factors which effect the planning of wind energy development. The main message from North Jutland is that close cooperation between all interested parties, including wind energy companies, conservation groups and

the community, is an important factor in developing a feasible regional plan. The planning regulations have been developed to guide/encourage individual, small scale developers as well as larger organisations. In terms of achieving a balanced wind energy plan, assessing real environmental impacts, taking aboard the needs of the local population as well as having finite energy production targets have all contributed to a workable method of managing wind energy development.

17.0 Public input to planning process

17.1 In Denmark, the public have been encouraged to directly enter into all aspects of the debate on wind energy planning issues. The planning authority holds seminars and public meetings to gauge local people's opinion on proposed development designations for their locality. With recent reviews of existing wind farms, the public has been encouraged to enter into the selection process for second-generation wind energy sites. For example (fig 13) there are now options in terms of potential numbers of turbines and the size of turbines for particular sites, and the choice facing all parties is whether to go with fewer but larger second generation turbines, or increased numbers of smaller turbines. The issue relates to energy production and scale of development in the landscape and what people think is appropriate to that location.



Fig. 13 Photomontage options which appeared in a published pamphlet for the Norrekaer Enge Wind Park to allow people to indicate preference in terms of second generation wind energy development at this location

17.2 Methods by which local people can contribute to the process, include public meetings and/or logging onto web sites and registering preferences and comments. There are general issues which form the basis to this process. In opting for wind based renewable energy, the Danish people were aware, and supported the government policy of not pursuing more conventional sources of energy such as nuclear power.

Windfarm Name	Planning Authority	Generating Capacity from number of turbines
Ryå	Brønderslev Kommune	15 MW på 10 møller
Nørrekær Enge	Løgstør Kommune	30 MW på 20 møller
Rønbjerg	Løgstør Kommune	3 MW på 4 møller
Flejsborg	Farsø Kommune	4 MW på 4 møller
Ravnshøj	Frederikshavn Kommune	6 MW på 6 møller
Røgelhede	Dronninglund Kommune	7 MW på 7 møller
Kjellingbrovej	Dronninglund Kommune	5 MW på 5 møller
Gretterholtvej	Dronninglund Kommune	5 MW på 5 møller
I alt		75 MW på 61 møller

Energy output from given number of turbines

Ryå	Brønderslev Kommune	14 MW på 7 møller
Nørrekær Enge	Løgstør Kommune	22,5 MW på 9 møller
Rønbjerg	Løgstør Kommune	3 MW på 4 møller
Flejsborg	Farsø Kommune	3 MW på 3 møller
Ravnshøj	Frederikshavn Kommune	3 MW på 4 møller
Kjellingbrovej	Dronninglund Kommune	6 MW på 6 møller
Gretterholtvej	Dronninglund Kommune	6 MW på 6 møller
I alt		57,5 MW på 39 møller

Energy output from given number of turbines

List of wind farms to be replaced with updated technology

Specifications of replacement wind farms

Fig. 14 Table of results of wind energy consultation. The updated 2001 regional plan will result in second generation technology in wind farms being more efficient

18.0 Expected planning application information in North Jutland

18.1 The main purpose of this report is to consider strategic wind energy planning and detail design policy issues. The following is a brief outline of specialist information expected to be included in a Danish planning application for a wind energy development.

18.2 When a wind energy development proposal is made, which is in accordance with the regional/county framework and the municipal/local wind energy plan, environmental impact information is required in accordance with regulations. The emphasis is on visual impact, and illustrated information needs to be to scale and of a standard which members of the public can relate to. The local authority stipulates what information is required, but the production of the information is the responsibility of the applicant.

18.3 The Danes have a fairly prescriptive approach to required visualisation information, and the process starts with an analysis of the existing landscape/topography. In order to ascertain the sensitivity and vulnerability of a landscape to wind energy development, key sensitive viewpoints are identified and agreed to assess the proposal in terms of photomontages, and computer generated perspectives. The identification and agreement of sensitive viewpoints is very important to the process. From the key viewpoints, main elements of the landscape are analysed such as plains, ridges/knolls, high points and depressions, woods, watercourses and areas of conservation interest. Artificial elements in the landscape are also taken into account including historic buildings and features etc. Lines of site and the scale of the landscape are also included in the assessment.



Fig. 15 Typical photomontage information

18.4 The sensitivity of the landscape character to change in relation to the proposed development is assessed by ascertaining the appearance of the wind turbine proposals from various viewpoints and by assessing the scale of the development in relation to the existing landform and sensitive landscape features.

18.5 Further issues to be taken into account include the potential dominance of the new development, the possible impact on built heritage and who will experience the site such as neighbours, passing motorists and tourists etc. The relative sensitivity of each group also needs to be taken into account. Seasonal changes in the appearance of the site are also taken into consideration including angles of sun light, shadows/flicker, and viewpoints from which the development may appear discordant, disorganised or jarring on the eye. This is an effect, for example, where multiple turbines line up, when seen from one view point, and a number of blades are turning at slightly different heights, or only portions of a blade can be seen over a horizon etc.

19.0 The visit to North Jutland



Fig. 16 Turbines in the North Jutland landscape

19.1 One of the first characteristics which a visitor to North Jutland notices, is the many wind turbines featured throughout the region. In many areas of North Jutland wind turbines can be seen. The spread of turbines is not continuous, with some areas, often agricultural, featuring an array of different layouts and types of wind turbines, while other localities, often with conservation interests and extensive woodlands etc have few turbines to be seen. The character of North Jutlands landscape features low-lying groups of rounded hills, with often extensive relatively flat agricultural and forested land in between. Towns and villages are featured at regular intervals often featuring the clean lined timber architecture typical of Scandinavia.



Fig. 17 Skagen - typical scene of a Danish Town

19.2 Tuesday the 9th of April 02 was spent in The County of North Jutland, to discuss wind energy planning issues with Per Toppenberg the Regional Planner with a remit for wind energy.

19.3 The purpose of the visit was to get an introduction to the Danish wind energy situation, and the main issues facing it currently. It also provided an opportunity to see large scale wind energy development in the field, and discuss the successes and problems encountered by the Danish planning system since wind energy development got under way in the 1980s.

19.4 Per discussed the background to wind energy development and the Danish planning system, as previously outlined in this report. He then took me to a number of sites to see in the field wind energy developments where examples of good and bad implementation and planning practice could be seen.

20.0 In the field experience

20.1 The main issues discussed were problems which relate to the first generation of wind energy installations. Some of the wind turbines featured in the Danish landscape are now over twenty years old. Wind energy being a relatively new type of development resulted in a completely new planning approach having to be formulated, refined and improved with periods of review. Initially there were few planning guidelines and best practice had to be worked out with experience. The result is that on the ground, there are examples of good planning practice, examples of poor siting practice, and issues peculiar to the improvement of the technology such as the replacement of existing wind farms with fewer, larger more efficient turbines.



Fig. 18 Typical North Jutland agricultural area scene

20.2 Single turbines often located next to farms have emerged as a source of contention for Danish planners. Often poorly placed in the landscape, they have contributed to a feeling of localised clutter and often feature various sizes and designs. Single turbines have also placed limitations on general areas zoned for local or regional wind farms. The planners problems are further exacerbated by there being little incentive for farmers to improve the situation by replacing or removing the technology concerned.



Fig. 19 Example of poor layout and detailing of turbines.
These turbines fall under policy to relocate and replace.

20.3 Factors other than planning and design best practice have led to this situation. Farmers, for financial reasons, were keen to establish turbines on their land. The result has been at strategic level, increased implementation of turbines in poorer agricultural areas. At local level, the distribution of turbines located, on behalf of farmers, tend to follow field boundaries and local roads, rather than be located in sympathy with the character of the landscape. Turbines in this category also have been noted to be sometimes located at low points in the topography and can be of a variety of scales and design. Machines concerned are often poorly located and are often not sited in the most wind efficient position.



Fig. 20 Example of wind farm with location problem.
Not wind efficient location - low in land form, poor cluttered layout.

20.4 During the day we visited 9 sites, the majority of which function relatively well in relation to their surrounds. Main points noted however included, the design of turbines needs to be standardised. Mixing latticework towers with non-latticework towers has proven to be visually unsatisfactory. Similarly, only 3 blade turbines all turning in a clockwise direction should now be developed. For turbines being developed on relatively flat ground, regularly laid out patterns of turbines has proven to work well rather than a more random approach.



Fig. 21 Turbines in an agricultural location

20.5 Very close to Aalborg in an area of industrial development there is a cluster of turbines which demonstrate poor siting policy. This was as a result of little experience on the part of the planners and few guidelines to go on at the beginning of the period for wind energy development in the 1980s. The turbines siting demonstrate towers located too close to a dual carriageway, various sizes of turbine installed on the same site, and a feeling of general clutter caused by general poor location and design. The Danes are fully aware of the problems which early developments have had, and these issues have positively contributed to the regular review and updating of wind energy plans and policy.



Fig.22 Early wind energy development close to Aalborg

20.6 The issue of experimental location of new large wind turbines (100 metres plus) was also discussed. Aalborg harbour east is considered to be an appropriate location for such a development because of the existence of large scale industrial infrastructure on site. The construction of large wind turbines at this location will not drastically alter the character of the area, but will allow the implications of these turbines to be assessed.

21.0 Political effects on wind energy development

21.1 Politics inevitably effects the siting and location of wind energy development. Denmark committed itself to producing a significant proportion of electricity from wind power, and each county was instructed to take a proportional share in this requirement. In the case of Denmark local political pressure resulted in some municipalities, whos local administrations were not pro wind energy, locating the majority of wind farms towards the boundaries of the authority area, away from the administrative centre. This has resulted in the pattern of wind energy development in certain areas following the administrative boundaries of the region. The resulting turbine distribution often does not reflect best practice in terms of locating wind turbines in the landscape. The density and spread of wind energy development across regional areas of similar landscape character also varies for this reason.

22.0 Danish Conclusion by Per Toppenberg

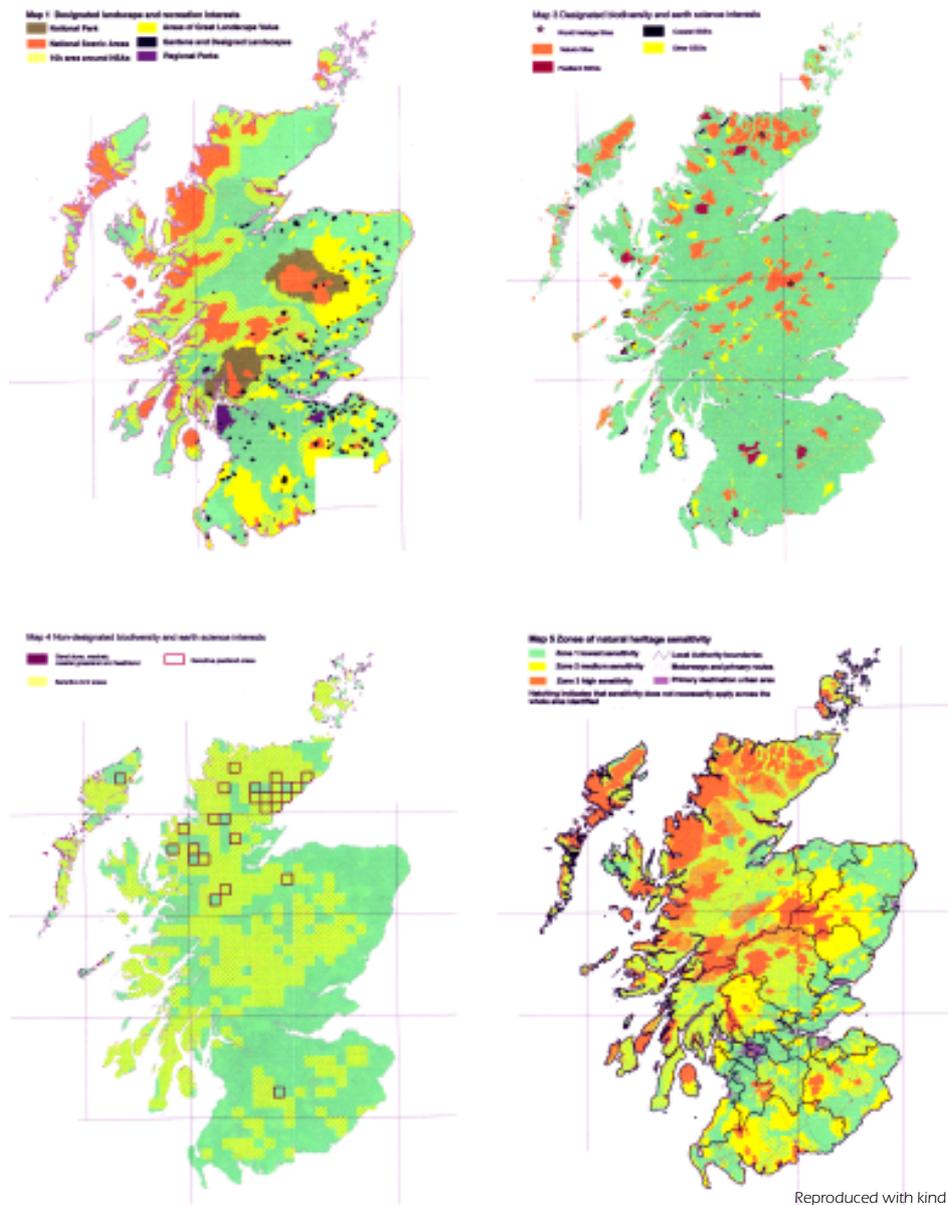
22.1 *'As regards planning, wind energy is an interesting area, undergoing constant development due to changing views of nature, changing attitudes towards energy policy, changing economic conditions, a changing attitude to the use of the countryside, greater emphasis on tourism and better opportunities for visualisation of wind energy proposals. There are many participants in this process, and the greater the number of precise planning conditions including energy output goals to aim for, the simpler the process will be, and the quicker expansion can take place.*

The experience gained in North Jutland shows that close cooperation between parties effected by wind energy development is vital, and in relation to that the continuation of the co-operation between municipalities and the county that has taken place up until now. In North Jutland it has been demonstrated that careful municipal planning with due respect for natural surroundings, the local population and over all energy goals, is a good tool when it comes to achieving a balanced expansion of wind energy'

- Quote from Per Toppenberg

23.0 Approaches to wind energy planning in Scotland

23.1 Work has been done in the UK which in principle is a similar approach to wind energy planning in Denmark. At a strategic level, SNH have sponsored studies by Chris Blandford Associates, in relation to their Landscape Character Assessments and the capacity of the landscape to accommodate wind energy development. SNH are also producing Strategic Policy Guidance for Onshore Wind Farms in Respect of Natural Heritage policy statement 02/02. SNH are currently in the process of formulating landscape capacity for wind energy development studies at a national scale (fig 23). The work has set out to identify a planning framework for areas of search for wind energy development, with the emphasis on natural heritage and recreation interests.



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Fig. 23 SNH landscape capacity for wind energy, development information. The four plans indicate at national scale, areas of identified increasing sensitivity to wind energy development for different natural heritage issues. Note the plans should be read in the context of the overall report.

23.2 At a local level a number of local authorities have produced development plan supplements and planning guidelines for wind energy development. Borders Regional Council produced 'Wind Energy Development Guidelines' in late 1995. Dumfries and Galloway Council produced a wind energy planning document, 'Preparation of Wind Energy Diagram' in 1996, and Orkney Islands Council produced a development guidance document called 'Wind Power and Wind Turbines' in 1998.

23.3 These three reports followed a similar pattern to the Danish approach. Identifying that through the governments Scottish Renewables Obligation, and national commitments to cutting the levels of greenhouse gas emissions etc, these authorities recognised the need to positively meet the anticipated demand for renewable energy development. The three approaches to the studies followed similar patterns. It was recognised that in principle areas of search had to be identified where wind energy development of various scales would be acceptable. The reports were based on national policy and planning guidelines, including information on wind resources and close proximity of areas to the national grid. Using a map sieving technique, information on landscape, conservation and heritage interest and sensitivity were used to focus in on potential areas where wind energy development could be feasibly located. The work was carried out using a grid format, with 1 kilometre squares being used as mapping units for identifying overall sensitivity to development. Areas of social/community sensitivity, as well as heritage and historical interest were also taken into account. Issues such as radar and telecommunications were included in the studies. The resulting pattern, which emerged from the process, indicated planning zones in which the acceptability of potential wind energy development was rated in terms of sensitivity, and presented in 1 kilometre square format.

23.4 Work of this nature is ongoing in Scotland, and more recent projects are known to be under way in Argyll & Bute and The Western Isles. Studies in these areas include identifying potential areas of search and testing them out in principle by producing zones of visual influence for various potential scales of development. These studies are not an end in themselves, and the consultants emphasise the ongoing need for detail EIAs for individual sites. The studies also cannot give an indication of acceptable levels or density of development in particular areas. They give an indication of current landscape value and the likely magnitude of the effect of change to that character. Other complicating factors which have to be taken into account are social. In the Western Isles for example, there is an identified problem of population loss, and the local authority is keen to reverse this trend for the sake of local communities. Development and stimulating commercial activity is seen as a way to address this problem. It's therefore recognised that there is a balance to be struck between environmental interests and those of the local economy. Generally the benefits of renewable energy developments to local communities needs to be maximised. This issue indicates the need for a broad approach to strategic planning at a national level if all the needs of society and the environment are to be balanced and appraised in relation to wind energy development. It's inconsistent to have different local authorities evaluating the environmental impact of developments differently for non environmental reasons. Such an approach could lead to wind energy developments locating in particular districts for reasons unrelated to landscape and environmental best practice.

23.5 The studies do however potentially provide clear areas of search for developers, which is of use to the industry and local authorities. These studies are complex and all of them employ variations on a similar approach and differing methods of identifying sensitivity to development. This can only be inevitable when entire regions are forming the basis of studies, which for practical and financial reasons can only go into relatively limited research and detail. A weakness of the Argyll & Bute as well as the Western Isles approach is that information generally still tends to be of a subjective nature, based on landscape character definitions, and prescriptive policies are what the industry especially would prefer. Landscape character definitions, especially for environmentally more average locations, can depend on the judgement of the surveyor, and be open to interpretation and question. For this reason it can be difficult to be objective about sensitivity to change for some landscape character areas. One

groups understanding of acceptable development impact on one landscape character location will probably be different to another groups. This is where the Danish approach may be of benefit. However it needs to be accepted that the Danish wind energy plans are in a constant cycle of review and update, which is labour intensive, and the mistakes of the past are there to be learned from, and replaced/removed as appropriate.

23.6 The Scottish authorities mentioned are not a conclusive list. Fife, Moray and a number of other Councils are known to have worked on similar projects, or are in the process of formulating an approach to detail wind energy planning.

23.7 In principle the methodology is similar in approach to the North Jutland regional authority, but the philosophy, approach, scale and level of detail is not the same. The driving force or motivation behind the North Jutland wind energy plan was primarily to meet energy production targets, set by Danish central government and interpreted at local level by regional and municipal plans, by indicating clear areas of search/development sites for wind energy development, accompanied by prescriptive policies. Danes as far as possible, deal with specifics and create prescriptive planning information, which is reviewed and adjusted with experience.

23.8 A problem which it could be said we have in Scotland is identifying the motivating factors for development of wind energy planning frameworks at various scales. At national level, SNH are working on a landscape capacity for wind energy development framework (fig 23). Their remit is conservation of natural habitat and recreation interests. At regional/local level, local authorities are working on detail frameworks for development of renewable energy sources. Their remit is balancing the needs of society and those of commercial interests with the needs of the environment, while implementing national policies at local level. It would be an advantage if strategic frameworks were produced to directly address similar issues to those being addressed at local level.

24.0 Private developers view on wind energy planning

24.1 In the course of reviewing the various wind energy planning applications and scoping exercises, in Aberdeenshire the opportunity was taken to ask the developers to comment on what qualities they look for in a development plan. This was an appropriate line of inquiry because it's a process the Danish went through in the development of their wind energy plan. The following is a summary of the responses.

24.2 The development plan should offer clear guidance as to the preferred location/areas of search for wind energy development, preferably on a map-based format. Information regarding areas of search should fully cross reference with all relevant policies. This information could extend to preferred scale of development, in relation to different types of landscape. The plan should also clearly indicate valued aspects of the landscape/environment which need to be conserved. Aberdeenshires tiered approach to assessing sites was seen as being useful. The developers also expressed a wish to see specific energy targets established for development plan areas. Issues such as possible cumulative effects of neighbouring wind farms also needs to be addressed in the development plan.

24.3 The developers also identified conflict of interest which is emerging. Environmental groups would like to see wild land protected and wind energy development moved closer to areas of population. The planning authority however recognises the current desire to keep wind energy development away from centres of population. The wind energy developers pointed out that certain types of conservation designation, such as geological SSSI's ,may not be effected by or preclude wind energy development.

24.4 It should be emphasised that research with wind energy developers was informal, and the conclusion to be drawn from the conversations with various individuals would indicate that generally the UK is still at an early stage in terms of wind energy development. The requirement of wind energy developers is changing with the increasing scale of proposals, and the planning authorities need to be as informed as possible in relation to all relevant issues.

24.5 Areas of search in plan form will automatically attract developer interest. They will also attract criticism and objection from people living in the area identified. A balance needs to be struck between meeting developers needs and taking an impartial balanced approach to potential wind energy developers in areas where public opinion is initially against it.

25.0 Issues which require further research?

25.1 The wind energy industry is a rapidly evolving field of expertise. Recent outline enquiries from developers here in Aberdeenshire would indicate that the industry is pushing for ever larger turbines (100metres plus) to be installed. This is an area of relatively little experience here in the UK and in Denmark. The odd experimental turbine has been constructed over 100 metres high, but the environmental impact of an entire farm of turbines of this scale is unknown. The majority of recent wind farm developer scoping exercises in Scotland have been for turbines which stand at more than 100metres in height. Planning Authorities need to start the process of identifying potential impacts of structures of this scale in order to be prepared for future applications of this nature. Denmark cannot give us a great deal of assistance in terms of experience with this scale of wind farm development.

25.2 If planning applications for wind farms in Scotland are for turbines of 100 metres or higher, then further research will be required into how to assess what is appropriate for certain locations in different types of landscapes. Put simply, is there a size of structure which is simply too large, either singly or in numbers, to be located in particular landscape character types?

25.3 Research is also required into the capacity of the landscape to accommodate wind energy development. At what point do wind farms become unacceptable in terms of numbers of turbines in particular landscapes? Certain locations by their nature will be able to accommodate a higher density of wind energy development than more sensitive designations. We need to identify an objective methodology for appraising this quality.

25.4 In terms of identifying different landscape character types, suited to different types/scales of wind energy development, the planning approach to landscape character boundary areas also needs to be clarified. Different types of landscape rarely have defined boundaries, therefore there needs to be an identified transition zone where a particular planning approach needs to be identified and implemented.

25.5 Similarly, large-scale wind energy development can effect several planning authorities if located close to regional boundaries. It is therefore important that this issue is agreed between authorities and co-ordinated at a national level in terms of planning approach and policy.

26.0 Visual coalescence

26.1 Visual coalescence is an effect which is already an issue in Aberdeenshire. The Glens of Foudland development has been given planning permission. Developers have already expressed an interest in establishing a further wind farm at Clashindarroch. Clearly the planning authority needs to establish guidelines for controlling and assessing the impact of visual coalescence in terms of two or more wind farms being seen from a single viewpoint. The Danes have a great deal of experience in relation to this issue, and there is an opportunity to learn from this, but further objective study is needed, especially in relation to the Scottish landscape.

27.0 Various scales of potential development

27.1 The development plan for Aberdeenshire needs to include a range of factors, if it is to adequately address future wind energy issues. As well as large-scale development, such as wind farms, the plan needs to address the issue of small-scale development. Interest has already been shown by Aberdeenshire farmers in establishing single, or small clusters of turbines on their land. For this reason guidelines need to be formulated to control design and location of individual turbines on farms. Experience in Denmark would indicate that development of this type is different in nature to large-scale proposals. For this reason small-scale developers need clear guidelines to avoid clutter in the landscape, establish best design practice and refrain from infringement on areas which may be more suitable for large-scale development.



Fig. 24 Example of single turbine development

27.2 Detail of design best practice in highland landscapes needs also to be developed. Because of the unique nature of the highlands, it is important that the issue of design best practice, in relation to wind energy, is developed, to conserve the unique and cherished quality of Scottish hills and glens.



Fig. 25 Novar Wind Farm Scotland

27.3 The visual implications of new shapes in developing technology needs to be also assessed and

reviewed. The equipment manufacturers are currently developing tear shaped generators. The issue of how this will appear in the environment needs to be explored and assessed.

28.0 Visual impact/perception

28.1 The perception of wind energy development is a significant element of the impact of such proposals. This is inevitable given the nature of a wind farms requirement to be located in an exposed, usually rural, windy site. It is often the case that anticipated problems or impacts don't materialise with the implementation of the proposal. Many people have an emotional attachment to the landscape and any perceived change is viewed defensively and with caution. People often also have pre conceptions about the appropriate character of the landscape and how it should look. These factors all need to be borne in mind, especially when policy is being formulated and planning applications reviewed. In Denmark the issue of visual impact is regarded as being of primary importance to a planning application, hence the requirement for additional visual information for controversial sites. Development plans and planning judgements need to be as impartial and objective as possible in relation to wind energy development and the landscape.

29.0 Summary of Danish wind energy planning approach

29.1 Wind energy development first got under way in Denmark in the 1980s. The industry was at a very early stage and planning was relatively inexperienced at this point in time. The first wind energy plan was developed in 1989. In 1994, in an effort to co-ordinate planning at Danish national level guidelines were produced by central government instructing the countries regions and municipalities to formulate wind energy plans for their area. National targets were set in terms of wind energy production, and these targets had to be interpreted through the regional and municipal plans. The goal was for Denmark to produce 2000 megawatts of power from wind energy by 2005.

29.2 The wind energy plans required to identify areas which could be developed for various scales of wind energy facilities. The areas identified had to be efficient in terms of potential energy production, while the intrinsic landscape, conservation and heritage values of the Danish environment had to be conserved. The wind energy plan was based primarily on existing wind resources and patterns. Windy sites had to be identified on plan. Onto this base information, areas unsuitable for wind energy development were superimposed. Areas designated for landscape quality, conservation interest and valued heritage sites were used to build up a framework of areas which were inappropriate, and appropriate for wind energy development. Zones were produced in plan which identified, where wind turbines should be prohibited, where individual turbines would be appropriate, where small clusters of turbines would be suitable and finally areas where wind farms could be located.

29.4 The wind energy plan was produced strategically at regional level, and interpreted in detail by the municipalities at local level. The wind energy plan was accompanied by specific guidelines developed through observation and experience. These guidelines, as far as possible are prescriptive and objective. For example distances between wind farms have been set, and the minimum distance between wind turbines and nearest neighbours have also been stipulated. All aspects of the wind energy plan were developed with consultation with all interested parties, including the general public and wind energy companies.

29.5 The Danish planning system is very flexible and all cases are reviewed on their individual merit. Should an application come in for example which is out with stipulated planning parameters, then supplementary information will be required before the application is reviewed. Similar, additional information is required for proposals which are by wind energy development standards, abnormal. Turbines of more than 80 metres in height fall into this category.

29.6 The onus is on the developer to meet health and safety requirements in relation to wind energy implementation. In relation to noise for example, if a wind turbine proves to be unacceptably noisy, then the local authority, can have the turbine switched off.

29.7 The wind energy plan is reviewed and updated every 4 years, taking into account new developments and experience gained over that period. The regional plan is now recognised as having been lacking in detail in the early years. All aspects of the plan are reviewed, including detail guidelines on design and layout of wind energy development, in order to refine and improve best practice. The appropriateness of designations which limit wind energy development are also reviewed.

29.8 Because of the time Denmark has been involved with large scale wind energy development, an issue now being addressed by the energy plan is that of replacing obsolete technology, and repositioning originally poorly located turbines.

29.9 As well as protecting positive environmental qualities of the Danish landscape, improving energy production efficiency is important. Areas designated for wind energy development need to be as productive as practical. For this reason replacement turbines need to be more efficient by as much as three times, than the technology originally placed on the site,

29.10 Observation and experience has taught the Danish planners that wind farm layouts need to be simple and tie in with the existing landscape patterns/characteristics. The scale of development needs to suit the scale of landscape.

29.11 Policies have had to be formulated to give developers clear guidance on the siting of all scales of development in different types of location.

29.12 Generally the co-ordination of local and regional plans needs to be improved. This will involve ensuring that planning approaches to planning boundary zones are standardised in order to create a continuous planning approach to all areas. Planning anomalies at authority boundary areas have been a problem up until now.

30.0 Conclusion

30.1 The description of the planning process in Scotland, in relation to that of Denmark, appears to be currently more reactive, rather than proactive. The need to be proactive at planning stage was a clear objective of the Danish planning system, and this contributed to the planning policy process outlined in this report. In a situation where there is a sudden demand for development such as wind energy, with strategic and environmental implications, it is important that the planning authority is as informed as practical.

30.2 The Danes started with clear aims and objectives in terms of renewable energy production targets in the 1990s, and translated these into on the ground potential development zones. Here in Scotland we are already committed to raising 18% of the nations electricity from renewable sources by 2010. The Scottish executive is currently considering, through consultation, a target of 40% for 2020, so there is every probability that a fairly ambitious target will be set, which will also need to be translated into on the ground development.

30.3 In terms of wind energy resources, Scotland is in a comparable situation to Jutland. A recent report prepared by Garrad Hassan and Partners for The Scottish Executive indicates that Scotland has a renewable electricity potential to meet its current winter demand ten times over. With this sort of potential further demand to expand all sectors of renewable energy must be inevitable.

30.4 In Britain so far the majority of nationally strategic work has been carried out by government agencies such as SNH. The results so far is information at a fairly small scale with the emphasis on natural heritage and recreation issues. At regional level a number of Scottish structure plans are now backed up by studies specifically on wind energy potential. The information tends to evaluate the sensitivity of local landscapes, habitats and environmental qualities, in relation to potential wind energy development, and this informs the decision making process.

30.5 In Denmark the approach is much more specific, with areas of search outlined and even suitable locations for wind parks identified. Policies backing the plan information, also tend to be prescriptive with finite information provided for dimensions and scale of development. There is a degree of flexibility to this approach, with proposals which are out with the planning recommended framework being considered, usually with an increased requirement for environmental impact information.

30.6 Britain, as well as the rest of Europe, will be subject to European targets for expansion of sources of renewable energy. Some 12% of total European energy is predicted to be generated by wind by 2020. At present the market in Europe is expected to expand quickly, and for this reason development costs are expected to drop. The incentive for this sector of the energy market to develop is going to increase, both in The UK and Europe, for the foreseeable future, and in Scotland we need to be prepared for this eventuality and learn from the experience and approach of our European neighbours.

