How many wind turbines is a region able to tolerate?

Balance between supporting sustainability objectives and the assessment of environmental effects

Sabine Mayer[1], *Umweltbundesamt GmbH (Federal Environment Agency Ltd.) Vienna, Austria*[2]

Outline

This paper attempts to review the fast growing wind energy industry in Austria and the challenge in assessing an energy source that is expected to make a considerable contribution to the target share of EU internal energy consumption from renewable energy sources. Having in mind that wind power is already the fastest-growing branch of electricity generation in the EU, nobody will deny that even a green power technology like wind energy production impacts the environment in some way.

Beginning with a quick overview of the spatial context and the status of wind energy development in Austria taking the legal framework into account it will raise the question, whether EIA or SEA come into effect to value impacts of multiple wind farms. Furthermore it presents the approaches of two federal countries towards spatial policies to deal with the authorisation procedures.

Global Status and potentials of renewables

Presently, renewable energy provides about 14 % of global primary energy consumption, mostly through traditional biomass usage. Large-scale hydropower supplies about 20 % of global electricity. Its scope for expansion is limited in the industrialised world, where it has nearly reached its economic capacity. In the developing world, considerable potential still exists, but large hydropower projects often face financial, environmental, and social constraints.

However, 'new' renewables (modern biomass energy, geothermal heat and electricity, small-scale hydropower, low-temperature solar heat, wind electricity, solar photovoltaic and thermal electricity, and marine energy) contribute only 2 % of the world's primary energy use. Such renewable energy sources that use indigenous resources have the potential to provide energy services with zero or almost zero emissions of both air pollutants and greenhouse gases.

[1] Sabine Mayer holds a Master's degree in Landscape Ecology and Planning. Within the department 'Environmental Impact Assessment and Biosafety' her major focus of work covers reviewing EIS, operating the national EIA database, collaboration on studies and guidelines concerning EIA and technical assistance for the Federal Ministry of Agriculture, Forestry, Environment and Water Management regarding EIA Legislation and trans-boundary EIA projects. She is also responsible for providing information on SEA pilot studies as well as the organisation of a workshop focused on the practical application of SEA. Furthermore, she is a member of a working group for implementing SEA in Spatial Planning Instruments and Member of the Austrian Council for Sustainable Development.

[2] The Federal Environment Agency Austria is the environmental institution of the Federal Government and provides expertise on the condition of the environment and environmental changes. This covers environmental monitoring, assessment and evaluation for the Austrian Minister of the Environment, support in the implementation of federal environmental laws, EU directives and regulations, as well as providing national environmental databases.

About 8200 MW were installed by the global wind energy industry last year, bringing the world`s total wind power generating capacity to nearly 40,000 MW. The countries with the most wind power capacity in 2003 are Germany, followed by the United States, Spain, India and Austria. In 2003, Austria had the largest global growth of wind energy, at nearly 200 %.

The following table shows that - globally - the use of renewable energy resources is still quite low compared to the theoretical potential. The appraisal of technical potential therefore takes into account engineering and technological criteria. Even if one only looks at wind energy the potentials are immense.

Resource	Current use[3]	Technical potential	Theoretical potential
Hydropower	10.0	50	150
Biomass energy	50.0	>250	2,900
Solar energy	0.2	>1,600	3,900,000
Wind energy	**0.2**	**600**	**6,000**
Geothermal energy	2.0	5,000	140,000,000
Ocean energy	-	-	7,400
TOTAL	**62.4**	**>7,500**	**>143,000,00**

Table 1: Global renewable resource base (Exajoules per year)

Towards sustainable development

Under the threat of climate change and on the road to achieving a sustainable energy system EU wide, there is a strong trend to substantially increase the share of renewable energy sources within the next several years. The EU input to the World Conference for renewable energies (*renewables* 2004) in Bonn in June 2004 will include new ambitious targets for 2020 (a share of renewables in primary energy up to 20 % is aimed for). Furthermore, the EU - Member States are also committed to a strong policy framework, which includes

- support for the Kyoto Protocol,
- goals and targets set out in the Green Paper on the Security of Energy Supply,
- the White Paper 'Energy for the Future: Renewable Sources of Energy", and
- a growing package of Community legislation including the Directives on electricity supplied from renewable energy sources, biofuels, the energy performance of buildings and cogeneration.

[3] The current use of secondary energy carriers (electricity, heat and fuels) is converted to primary energy using conversion factors involved.

Adapted from: Goldemberg, J. (ed) 2000. World Energy Assessment: Energy and the Challenge of Sustainability. New York: UNDP.

Wind energy has come of age

To focus on wind energy there has been gradual growth in the unit size of commercial machines, from 30 kilowatts of generating capacity in the 1970s (rotor diameter 10 metres) to 5 megawatts (110 to 120 metres diameter) and more at present. Market demands have driven the trend towards larger machines through economies of scale, less visual impacts on the landscape per unit of installed power, and expectations that offshore potential will soon be developed. Modern wind turbines also have fewer components. In fact, electricity production from grid-connected wind turbines has been growing at an impressive rate of over 35 % over the past five years in Europe. With the booming wind energy business, the costs were brought down and are now competitive with e.g. new coal-fired plants.

Environmental and social aspects come into play in several phases of a wind turbine project including building and manufacturing, normal operation, and decommissioning. Negative environmental aspects connected to the use of wind turbines include acoustic noise emission, visual impact on the landscape, impact on bird behaviour, moving shadows caused by the rotor, and electromagnetic interference with radio, television, and radar signals. In practice the noise and visual impact cause the most problems for development of wind farms.

Renewables in Austria

To give an impression of why assessing these impacts and dealing with authorisation likely causes different problems compared to North America, the following offers a brief overview of Austria. Located in Central Europe, Austria has common borders with eight other countries (Germany, the Czech Republic, Slovakia, Hungary, Slovenia, Italy, Switzerland and Liechtenstein). It has a land surface of about 84 000 km^2 (33 000 square miles) and about eight million inhabitants. On account of its topography – the Eastern Alps cover some two thirds of its surface area - only about 37 % of Austria's national territory is suitable for permanent settlement. If one only takes our permanent settlement area into account, a population density of 260 inhabitants/km^2 is achieved. Added to this, very few regions in the eastern part of Austria offer good conditions for wind power. Having our population density in mind, one can imagine that project citing in these small regions is not only environmentally sensitive.

Luckily 70 % of Austria´s electricity is already produced by renewables, namely hydropower, but the potential is now more or less exhausted. Under the RES-E directive Austria committed to raise the share of renewable energy sources up to 78.1 % until 2010. To comply with this EU directive the Austrian Parliament adopted the 'eco-electricity' law, which was passed in July 2002 and came into effect on January 1, 2003. The law requires 4% of the country´s electricity to come from these eligible renewable energy sources (not including hydro power) by January 1, 2008. Furthermore it sets the tariff for wind power at a certain flat rate and guarantees this tariff for 13 years. Passing the 'eco-electricity' law was actually the catalyst of the wind energy boom in Austria. Within one year the amount of wind turbines has been tripled and Austria came into the top five wind energy markets world wide.

Currently the total installed power from wind energy in Austria amounts to 415 MW from 318 wind turbines. In relation, Canada had only 317 MW by the end of 2003, although many regions in Canada have apparently areas with good wind resources.

Austria comparatively, does not have much suitable space, with only a few regions where high productivity can be expected.

Assessment instruments

So how do we deal with all these wind farm planning applications. Presently, only projects with a total installed power of at least 20 MW or with more than 20 converters, if not in a protected area, require an EIA. If applicants stay under this threshold they have to obtain different permissions, such as the electricity act, protection of landscape, regional development plan, security of aviation from several authorities, etc. Regardless, which authorisation procedures are required, it is clear, that an investigation at the project level can not provide an adequate overview to measure likely environmental effects of multiple wind farms, even when cumulative effects are comprehensively described, which is nearly never the case.

Although the State governments who are in charge of the authorisation procedures developed different concepts to deal with assessing multiple wind farms, the current planning system does not provide for legal site planning at a regional level where in SEA could become obligatory.

Zoning approach

Therefore, to provide a better basis for decision-making in valuing impacts of multiple wind farms together, State governments initiated case studies for selected regions with suitable wind resources. These studies follow the simple mechanism of the 'zoning out' approach, which means the exclusion of areas where the planning authority would not favour wind farms. The zoning is determined by certain distances to roads and dwellings overlaid with criteria of landscape amenity and wildlife disturbance, especially focused on birds. Within the zones, where site planning is favoured, the mapping also defines certain height maximums. This approach however, does not offer enough guidance to planning authorities in assessing cumulative effects.

For example, one province in the east of Austria performed a zoning study on an area of 200 km^2 with excellent wind resources. At present there are already 130 wind turbines installed and another 30 to 50 are designed for this year. Within one year the State government was accordingly confronted with applications for about 150 wind turbines in several wind farms. The zoning approach only led to an exclusion of small strips, where siting is not favoured. Regarding the size of this region, you can imagine, that dealing with the amount of turbines applied, there is no way to sensibly assess visual impacts such as effects on birds by only looking at one project. Furthermore, the projects are not submitted at once and a description of cumulative effects by the proponent can only be requested for either already existing wind farms or wind farms at a certain planning stage.

Recommendation

Concerning the lack of a strategic planning policy for wind energy and the difficulty in having to make recommendation on individual proposals in the absence of such a

strategic framework, the ALTENER[4] Project 'Wind potential and spatial planning requirements for wind energy development in County Cork, Ireland' aims to provide a basis of such a spatial policy. As a research result, the suggested concept of 'strategic development zones' appears to be recommendable. These zones should be designated at a national level and aim to safeguard significant development potential for national strategic reasons. Within these zones a simplified planning process should be possible once the strategic site has been designated. If such strategic development zones for wind farms can be identified, they would encourage the concentration of wind farms, which would allow for shared connection to the national grid, thus reducing the development cost. It can also be argued that a concentrated development pattern would reduce the visual impact vis-à-vis a more dispersed one. This could be one step towards the use of SEA, if it would be passed as national law within the spatial planning case law.

Concluding remarks

In all respects, maintaining the balance between supporting wind energy as a clean, renewable and cost-effective energy option for reducing global warming and having a critical view on the environmental effects, constitutes a challenge for assessing the rapid development of the wind energy sector.

There is an obvious need for collecting more basic data, especially regarding bird behaviour, effects on small mammals and criteria for assessing cumulative visual impacts. Based on this data, mapping of 'strategic development zones' could provide for more controlled growth of the wind industry. This can certainly only be accomplished hand in hand with an adaptation of the legal framework.

Literature and legal framework:

Wind & Spatial Planning Altener AL/98//542: Analysis of Wind potential and spatial planning requirements for wind energy development in County Cork, Ireland.

Johansson, T.B., McCormick K., Neij L., Turkenburg W. (2004): The Potentials of Renewable Energy, Thematic Background Paper. Secretariat of for the Conference for Renewable Energies, Bonn.

European Commission (2001): Green Paper - Towards a European strategy for the security of energy supply (COM(2000) 769 final). Office for Official Publications of the European Communities, Luxembourg. http://europa.eu.int/comm/energy_transport/doc-principal/pubfinal_en.pdf.

European Commission (1997): Energy for the Future: Renewable Sources of Energy, White Paper for a Community Strategy and Action Plan (COM(97)599 final). http://europa.eu.int/comm/energy/library/599fi_en.pdf.

Directive 2001/77/EC of the European Parliament and of the Council of September 27, 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market [Official Journal L 283 , 27/10/2001 P. 0033 - 0040].

[4] ALTENER, Alternative Energy Programme of the European Commission, is an EU programme with the goal of supporting renewable energy projects.

Links:

AWEA, American Wind Energy Association: http://www.awea.org
EWEA, European Wind Energy Association: http://www.ewea.org
EREC, European Renewable Energy Council: http://www.erec-renewables.org/
IG Windkraft: http://www.igwindkraft.at/aktuell/a_english.htm
International Conference for Renewable Energies, Bonn 2004 : http://www.renewables2004.de

Contact: Sabine Mayer
Environmental Impact Assessment & Biosafety
phone: +43-1-31304/3311
fax: +43-1-31304/3700
email: sabine.mayer@umweltbundesamt.at

Umweltbundesamt GmbH
Federal Environment Agency Austria
Spittelauer Lände 5
1090 Vienna
Austria
http://www.umweltbundesamt.at/