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INFLUENCE OF WIND ENERGY ON THE ENVIRONMENT

WPŁYW ROZWOJU ENERGETYKI WIATROWEJ NA STAN ŚRODOWISKA PRZYRODNICZEGO

Abstract

In the 1970s, oil shortages pushed the development of alternative energy sources. In the 1990s, the push came from a renewed concern for the environment in response to scientific studies indicating potential changes to the global climate if the use of fossil fuels continued to increase. Wind energy is an economical power resource in many areas of the country. Wind is a clean fuel, wind farms produce no air or water pollution because no fuel is burned. Growing concern about emissions from fossil fuel generation, increased government support, and higher costs for fossil fuels have helped wind power capacity grow substantially over the last 10 years. The state and perspectives of the wind energy development in Poland, Europe and the world is shown in the paper.

Keywords: wind energy, ecological effects

Streszczenie

Kryzys energetyczny lat siedemdziesiątych przyspieszył rozwój alternatywnych źródeł energii. W latach 90. nastąpił rozwój tych źródeł energii wywołany zaobserwowanym globalnym ociepleniem klimatu, którego przyczyną jest wykorzystanie konwencjonalnych źródeł energii. W artykule przedstawiono stan i perspektywy rozwoju energetyki wiatrowej w świecie, Europie i Polsce oraz wpływ na środowisko przyrodnicze. Wskazano, że energetyka wiatrowa w minimalnym stopniu negatywnie wpływa na środowisko, wywierając duży wpływ na zmniejszenie emisji szkodliwych substancji.

Słowa kluczowe: energia wiatru, efekty ekologiczne

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1. Introduction

The European Commission's White Paper for a Community Strategy sets out a strategy to double the share of renewable energies in gross domestic energy consumption in the European Union by 2010 (from the present 6% to 12%) including a timetable of actions to achieve this objective in the form of an Action Plan. The main features of the Action Plan include internal market measures in the regulatory and fiscal spheres; reinforcement of those Community policies which have a bearing on increased penetration by renewable energies; proposals for strengthening co-operation between Member States; and support measures to facilitate investment and enhance dissemination and information in the renewables field.

2. World wind energy supplies

Wind power available in the atmosphere is much greater than current world energy consumption. The most comprehensive study to date found the potential of wind power on land and near-shore to be 72 TW, equivalent to 54,000 MToE (million tons of oil equivalent) per year, or over five times the world's current energy use in all forms. The potential takes into account only locations with mean annual wind speeds ≥ 6.9 m/s at 80 m. It assumes 6 turbines per square km for 77 m diameter, 1.5 MW-turbines on roughly 13% of the total global land area (though that land would also be available for other compatible uses such as farming).

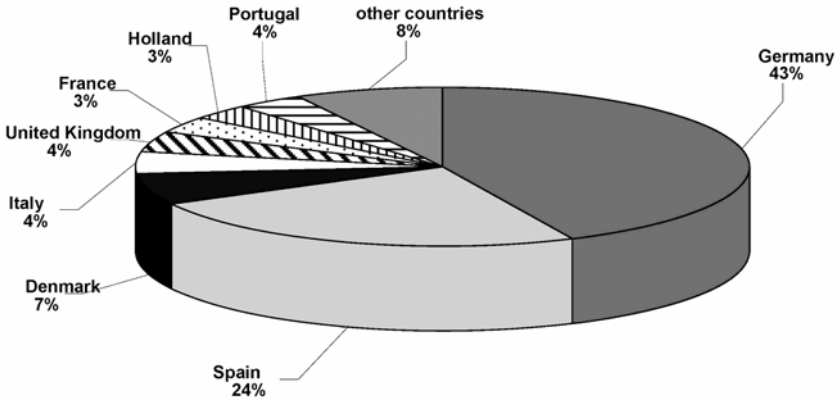
The practical limit to exploitation of wind power will be set by economic and environmental factors (there are many others barriers which need to be overcome to reach this theoretical capacity), since the resource available is far larger than any practical means to develop it.

Table 1

Total installed capacity (in MW) for the 10 largest markets

Country	2001	2002	2003	2004	2005	2006	2007
	[MW]						
Germany	8743	11968	14612	16649	18428	20622	22247
USA	4245	4674	6361	6750	9149	11603	16818
Spain	3550	5043	6420	8263	10027	11615	15145
India	1456	1702	2125	3000	4430	6270	8000
China	406	473	571	769	1267	2604	6050
Denmark	2456	2880	3076	3083	3122	3136	3125
Italy	700	806	922	1261	1717	2123	2726
Japan	357	486	761	991	–	1431	–
UK	525	570	759	889	1353	1963	2389
Holland	523	727	938	1081	1219	1560	1746

Source: [7, 13]



Source: [7]

Fig 1. Share of EU countries in total wind energy capacity in 2006

Rys. 1. Udział poszczególnych krajów w całkowitej mocy zainstalowanej w energetyce wiatrowej na terenie UE w 2006 r.

As of April 2008, worldwide wind energy capacity was about 100 GW, and wind power produced some 1.3% of global electricity consumption, accounting for approximately 19% of electricity use in Denmark, 9% in Spain and Portugal, and 6% in Germany. Status by the end of 2007 shows that year it was a year with the highest installation ever. There was installed 19,860 MW.

The European wind energy market still grew in the end of 2007, there was installed about 57 GW. In an average wind year this will produce approximately 114 TWh of electricity, equal to 3.5% of total EU electricity consumption. Currently more than 25,000 wind farms are operating throughout Europe, and capacity is expected to double by 2015. According to the European Wind Energy Association, the industry will be worth 109 USD billion by 2020. Table 1 shows total capacity of wind power in some countries and Figure 1 shows the share of EU countries in wind energy power stations in 2006.

3. Prognosis of wind energy development

In its revised 5-year forecast till 2012 a significant growth is expected. In the past five years the average growth in annual new installation was 22.3% per year. In the forecast until 2012 an annual growth rate of 20.7% per year is expected. The group of Top – ten suppliers in the world covers around 95% of the total supply in the year 2007. An interesting development on the supply side is that Asian manufacturers of wind turbines are improving their share of the global market. The fastest growing markets in the past three years have been China, France and the US. In the coming five years the highest growth in installed capacity is expected in US and China. However the Asian and American shares of the global market will improve significantly by the end of the forecast period. Annual installation of capacity will still grow. Cumulative capacity by end of 2010 will reach around 150 GW and in 2025 year about 1,103 GW (Tab. 2).

Table 2

Forecast for power installed for regions and world for 2010 and 2025 [MW]

Region	Power installed December 2005	Forecast For total Power installed [MW]	
		2010	2025
Europe	41,044	87,694	359,300
America	10,062	29,562	312,200
Asia	5,618	20,918	273,500
OECD Pacific	3,132	7,257	52,700
Other regions	407	3,362	105,600
Total	**59,264**	**148,794**	**1,103,000**

Source: [6, 10]

4. Polish wind energy sector

Although the rate of wind energy market growth in Poland has been very high in the last few years, the total installed capacity is still rather modest at about 276 MW, especially when compared to the country's potential. Poland is one of the most promising wind energy markets in Europe, there are some areas of the country with favorable conditions for wind power generation. Given the consistent elimination of barriers to wind energy development and stable long-term supporting scheme, the perspectives for the sector are quite positive. In 2007, Poland's wind energy market experienced 81% growth with 123 MW of new installed capacity. Three wind parks were constructed in 2007 in Kisielice, Kamieńsk and Jagniątkowo and several single turbines or groups of small turbines were erected throughout the country. In Table 3 the localization of biggest wind farms in Poland is shown. The amount of electricity produced by wind turbines during the 2007 can reach about

Table 3

The biggest wind farms localization in Poland

Date of activate	Localization	Installed power [kW]	Type
2007	Jagniątkowo	30 600	–
2007	Kamieńsk	30 000	Enercon
2007	Kisielice	40 500	–
2006	Gniewino n/Żarnowiec and Lisewo	8 400	Enercon
2006	Gnieżdzewo n/Puck	22 000	Vestas
2006	Tymień	50 000	Vestas V80
2003	Zagórze n/Wolin	30 000	Vestas V 80
2001	Cisowo n/Darłowo	18 000	Vestas
2001	Barzowice	4 980	Vestas
2000	Wiżajny n/Suwałki	1800	WindMaster

Source: [4]

552 GWh (in standard wind condition). There are some wind parks under construction that will be completed in 2008/2009. Additionally, construction of several new projects is expected to start in next years. Projects are being developed not only along the coast, but also in central and southern Poland.

5. Environmental impacts of wind power

Wind energy is one of ideal renewable energy because: it is a pollution-free, infinitely sustainable form of energy, it does not require fuel, it does not create greenhouse gasses, it does not produce toxic or radioactive waste. So the main effect of influence on the natural environment of wind turbine is decrease of emission of harmful substances. Utilization of wind energy (wind turbines are installed on farmland) required only about 2% of the land area and the rest is available for farming, livestock, and other uses.

Ownership of wind turbine generators by individuals and the community allows people to participate directly in the preservation of our environment.

Wind power plants, like all other energy technologies, have some environmental impacts. However, unlike most conventional technologies (which have regional and even global impacts due to their emissions and fuel imports), the impacts of wind energy systems are rather minimal and local. This makes them easier for local communities to monitor and, if necessary, mitigate.

The negative results of the using of wind turbine are:

- noise, which accompanies the work of the wind turbine,
- introduction to the natural scenery of technical units (visual effect),
- possible animals migrations from the areas of the location of the power station,
- threat for fowls resulting from the possibility of crash with the whirling blades of wind turbine,
- the stroboscopic effect (flicker).

Present manufactures proceed to the limitation the noise emits through turbines to about 45 dB. If we think about the remaining results of the influence on the environment many autorities work out many acts of the relating with wind turbine location, however special conditions for wind turbine were not foreseen in Polish legislation. The building of wind turbine be subject to building law and protection law, so now the qualification of minimum distance from the areas of the residence and natural areas legally protected (national parks, the reserves of the nature) and also the values of aesthetical power stations is the important problem to solution.

Most forms of energy production create some form of negative externality: costs that are not paid by the producer or consumer of the good. For electricity production, the most significant externality is pollution, which imposes social costs in increased health expenses, reduced agricultural productivity, and other problems. In addition, carbon dioxide, a greenhouse gas produced when fossil fuels are burned, may impose even greater costs in the form of global warming. Few mechanisms currently exist to *internalise* these costs, and the total cost is highly uncertain. Other significant externalities can include military expenditures to ensure access to fossil fuels, remediation of polluted sites, destruction of wild habitat, loss of scenery/tourism, etc.

If the external costs are taken into account, wind energy may be competitive in more cases. Wind energy costs have generally decreased due to technology development and scale enlargement. Wind energy supporters argue that, once external costs and subsidies to other forms of electrical production are accounted for, wind energy is amongst the least costly forms of electrical production. Critics argue that the level of required subsidies, the small amount of energy needs met, and the uncertain financial returns to wind projects make it inferior to other energy sources. Intermittency and other characteristics of wind energy also have costs that may rise with higher levels of penetration, and may change the cost-benefit ratio.

Wind energy contributes towards a significant reduction in CO_2 emissions. It is safe, clean, and abundant. Wind energy is a massive indigenous power source permanently available in virtually all parts of the world. It delivers the energy security benefits of avoiding fuel costs and price risks. Wind power also rules out the economic and supply risks associated with reliance on imported fuels and political dependence on other countries. Wind energy decisively contributes towards reduction in CO_2 emissions. Wind power installed in Europe (end 2006) prevents the emission of around 80 million tones of CO_2 every year.

So using wind energy has a lot of positive ecological. The ecological aspects of utilization of wind turbine and the methodology of marking the ecological effect were introduced in [9]. According to the document *Extern E*, the lowest external cost from all kind energy (fossil fuels and renewable energy sources) has wind (only 0.0005–0.0025 $/ kWh – 0.05–0.25 cent / kWh), that is more less than 2% of external cost producing electric energy from the coal.

Assume that in 2010 will be installed 148,794 MW (prognosis in the Table 3), for average wind condition it is possible to produce about 298 TWh of electric energy. However for the year 2025 (power installed 1,103,000 MW), producing electric energy obtain about 2,203 TWh on the year. The results of this prognosis can avoid about 250 millions tons CO_2 in 2010 and 1 854 millions tons CO_2 annually in 2025 in the world. Making the same calculations for Europe we receive the following sizes of the avoided emission CO_2 annually: 147 millions tons for of 2010 and 268 millions tons for 2025. For the comparison the German economy emits to atmosphere about 800 millions tones of CO_2 annually, Poland about 284 millions tons.

It is obvious that with developing wind energy sector simultaneously follows reduction of other harmful substances such as: SO_2, CO_2, dusts and uniform wastes – what will cause the gain of the ecological effect.

6. Summary

Wind energy is one of the cleanest and most environmentally neutral energy sources in the world today. Compared to conventional fossil fuel energy sources, wind energy generation does not degrade the quality of our air and water, and can make important contributions to reducing climate change effects and meeting national energy security goals. In addition, it avoids environmental effects from the mining, drilling and hazardous waste storage associated with using fossil fuels. Wind energy offers many ecosystems

benefits, especially compared with other forms of electricity production but of course can also, negatively affect on environment, as shown in paper.

Development of wind energy is one of the way of reduction greenhouse gasses and other harmful substances such as: SO_2, CO_2, dusts and uniform wastes.

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