# State of wind energy

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Over the last five or six years, we have been witnessing spectacular development in wind energy generation in the U.S., with about 200 GW being added to an already impressive wind generation capacity. It is estimated that by the end of 2003, wind generation capacity shall attain 950-960 GW.

I chose to talk about this type of energy today because it has been the subject of growing interest in the United States, a country with substantial wind energy resources. I will be looking at economic and technological factors, as well as the prospects for this type of energy.

## I. Economic factors

Wind energy generation costs have decreased considerably, most notably due to new technology, and these costs are now comparable to those of fossil fuel-based thermal plants. There have also been considerable incentives in the U.S. at the state and federal level to make the technology more attractive to developers and investors with an interest in this “green” energy.

The wind energy potential in the U.S. is substantial and all those worried about the United States’ dependence on oil see this as an additional argument in favour of wind-generated electricity.

In terms of the cost of generating electricity, a comparison with means of generation based on natural gas and coal show that wind turbines compete well with an output of 28% and 40%. Given the volatility of the price of gas and fiscal incentives that favour wind energy, this technology is a competitive alternative, even when compared to efficient combined cycle plants or coal plants that use new technologies. One of the competitive aspects of wind energy is the absence, in its cost structure, of the cost of primary energy.

Fiscal policies are one of the major factors of wind energy development. Many states have established incentive policies that are both fiscal and regulatory in nature. By regulatory incentives I am referring to real-estate assistance programs, credit assistance programs or tax credit programs for producers and end users. At the federal level, the House of Representatives and Senate have adopted legislation that guarantees, up to 2007, tax credits that can be applied for existing producers and those investing in wind energy in the future.

As for wind energy resources in the U.S., the wind chart shows only one zone without much potential: the southeastern United States. However, wind energy resources are especially abundant in coastal regions.

A review of the means of generation used in the United States reveals that in 2002 net electricity consumption totalled 38,100 TW/h, 50% of which originated from coal plants, 20% from nuclear plants, 18% from natural gas plants, 7% from electrical power plants, and only 1% from wind energy, the remainder being provided by other forms of renewable energy. Based on these figures, one can see that we are still very dependent on coal, and concerns regarding coal emissions should favour the development of renewable forms of energy. The growth of wind energy stalled in the 1980s and early 1990s, but it has taken on new life again with a remarkable rise in 2002. It still does not account for much of our 960,000-MW generating capacity, but its progression is slow and steady.

## II. Technological factors

Technological factors are related to the increase in wind turbine size, increase in output, and the capacity to optimize their implementation.

We see many wind farms springing up, such as those found in Europe, Denmark, Germany and Spain. In the U.S., this is a new form of energy and we are learning how to meet quality requirements.

In terms of wind turbine size and output, over the past 15 years there has been an increase of a few hundred kilowatts, to 2.2 or 2.3 MW for the more recent units. To obtain these impressive results, the size of the structures has been increased, including turbines, blades and masts, which is not without environmental problems, especially in

terms of aesthetics on the coastline. But there are undeniable technological advances, especially when the units are concentrated in farms.

Wind turbine implementation has become highly scientific. Not too long ago, it depended on real-estate speculators who set up wind turbines wherever they considered wind conditions to be adequate. We now have a multitude of atmospheric data and decisions are based on 10- to 15-year forecasts for a given area in order to choose suitable sites and altitudes.

At a given site, it is possible to determine the ideal number of wind turbines to be installed, and the potential prospects and revenue from the outset. It is therefore possible to know in advance a site's potential in financial terms. One must then study the distance to the grid since suitable locations are often far way from 5- and 45-kV lines. This data must be taken into consideration.

Wholesale markets are found in the U.S. Based on the prices in these local markets, it is possible to determine the cost-effectiveness of an installation at a given location based on its size. Once the data has been gathered, a loan can then be negotiated with a bank. This is more or less what combined-cycle power plant developers have been doing over the last five years.

One of the major areas which has developed considerably over the last two years is solving grid integration problems. In the past, when an operator had wind turbines in his service area, he would elect to systematically shut down all of the facilities in the event of a disturbance, incident or storm. He would not make use of the wind turbines to increase the grid's reliability or ensure continuous service. A reverse situation occurred recently: wind turbines are now not only being required to withstand disturbances but to restore the system while ensuring continuous generation. There is the example of the wind farm in New Mexico which consisted of 130 1.5-MW turbines located next to a high-voltage relay. The operator-host had required that, in the event of major voltaic disturbances or any other incident, the turbines would have to continue to operate at 100%. We were able to demonstrate through modeling that this was the case with our wind turbines, which constitutes definite progress.

## III. Outlook for wind energy in the U.S.

In terms of growth forecasts, we have the figures for the end of 2003 which were provided by the American Wind Energy Association. Europe is still ahead in terms of wind energy development. The United States is progressing but still lags behind Europe. In the coming years, the growth in the U.S. should be comparable to the rest of the world, and by the end of 2003, 36- to 37-GW wind turbines should be available. When compared to total generating facilities, these are modest figures, but for those of us who believe in the environmental advantages of wind energy, it is very promising.

As regards the type of wind generation facilities being built in the U.S., there is an increasing number of wind farms, either alone or interconnected on networks of over 200 MW. Their implementation is determined using a highly sophisticated technique which I spoke to you about that ensures optimal cost-effectiveness. These wind farms are the result of a cooperative effort between electric utilities and developers, as was done for combined-cycle plants. There are also potential off-shore sites all along the Atlantic coast. A large-scale project is under way with the Long Island Power Authority. It has a potential of 5.2 GW, but the actual installed capacity remains to be determined.

The U.S. Department of Energy is investing considerably in the development of wind energy in low-wind areas (4 to 5 m/s). In the current state of the art, wind energy is not cost-effective in these zones. We are therefore developing the technical means to make use of the areas. We have designed a wind turbine with a short mast and blades which presents an advantage from both an aesthetic and technical standpoint.

Wind forecasting is becoming increasingly reliable, which is necessary when the electrical supply must be ensured even when wind conditions are less optimal. Thanks to technologies that combine meteorological science and electrical engineering, forecasts are improving. This is crucial for wind energy to exceed 1% of total generating facilities as is currently the case.

We have also been developing hybrid materials for the masts and blades to make them sturdier in high-wind areas or lighter in areas when environmental constraints affect the size and weight of the structures. This is a crucial area for R&D.

Lastly, for developing countries with wind resources, we are working on developing hybrid wind/diesel/battery systems that make use of this renewable type of energy.