Excerpted from ...

WORLDWATCH INSTITUTE

WORLD WATCH March/April 1999

Bull Market for Wind Energy

by Christopher Flavin

Bull Market in Wind Energy

Many countries may soon find that the cheapest way to produce electricity is to pull it out of the air.

by Christopher Flavin

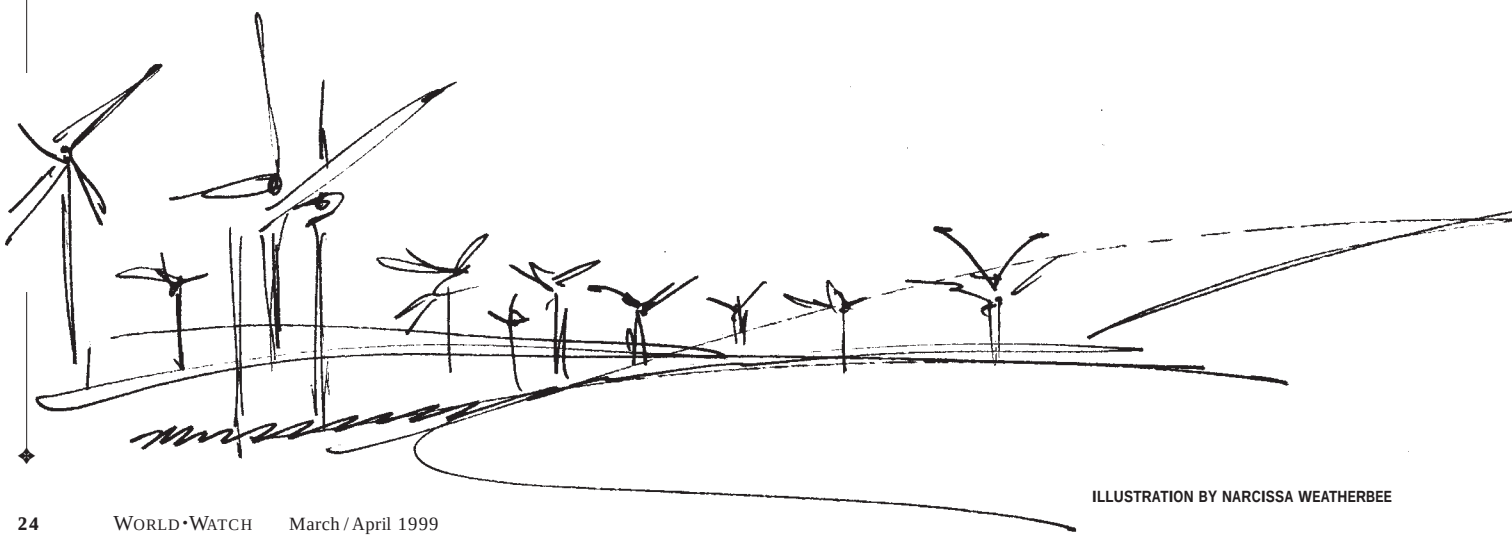
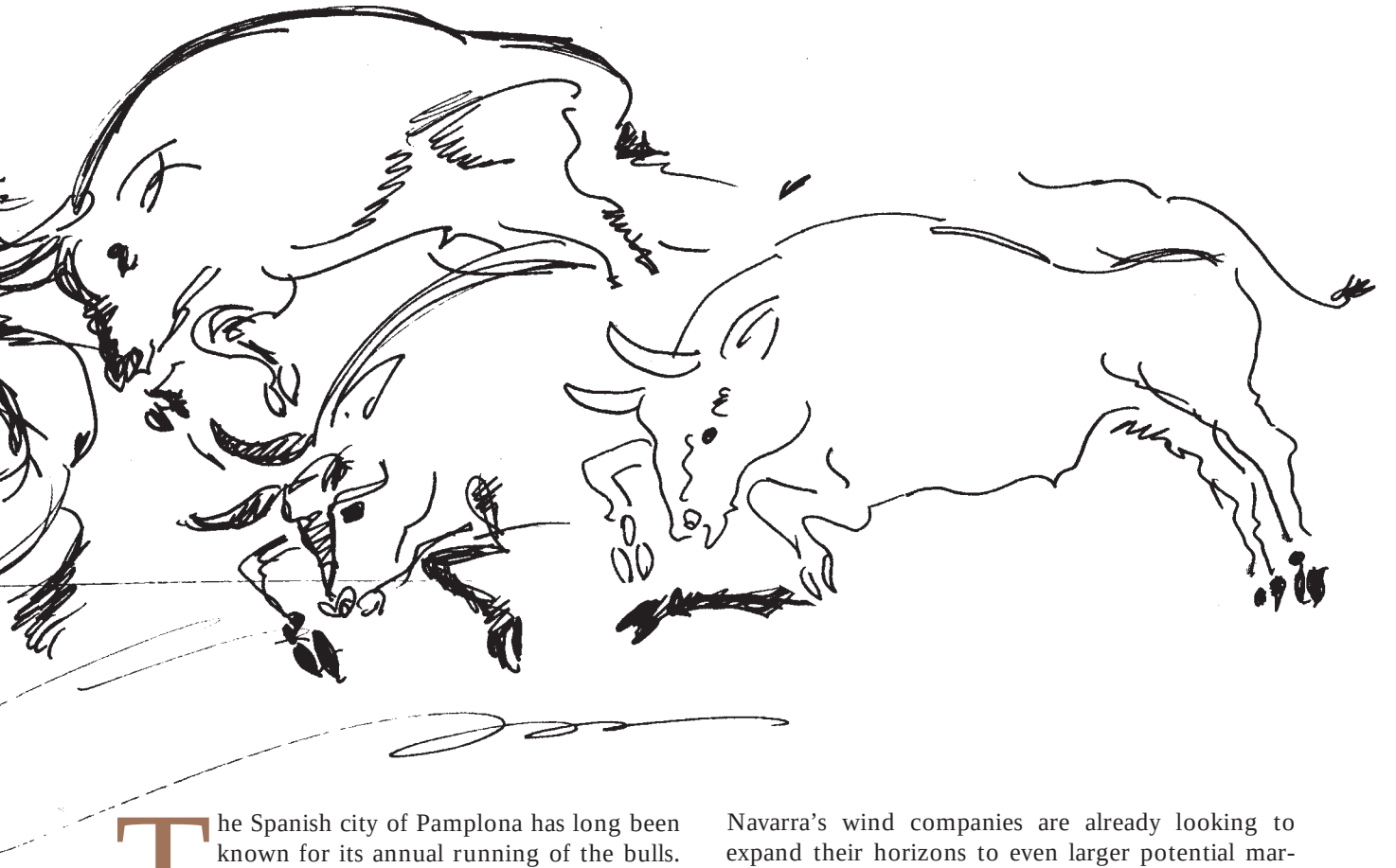


ILLUSTRATION BY NARCISSA WEATHERBEE



The Spanish city of Pamplona has long been known for its annual running of the bulls. But this mid-sized industrial center, the capital of the state of Navarra in the rugged Pyrenees region, is quickly gaining another distinction: it has the world's fastest growing wind energy industry. Starting from scratch just three years earlier, Navarra was obtaining 23 percent of its electricity from the wind by the end of 1998.

With a population of 180,000, Pamplona has an economy based heavily on manufacturing, including a sizeable car industry. But along with much of the rest of Spain, the city has had a relatively stagnant economy and a high rate of unemployment in recent years. In an effort to deal with that problem—and replace the coal and nuclear energy it imports from other parts of Spain with local power—Navarra recently introduced a set of tax incentives and other inducements for harnessing wind energy using locally manufactured turbines.

These policies paid off well beyond the dreams of the government officials who crafted them. Several wind-energy companies were quickly established in Navarra, most of them joint ventures owned in part by the Danish firms that supplied the technology. And much of the investment is coming from Energia Hidroelectrica de Navarra, the regional electric utility. These firms have provided a strong political base for the region's burgeoning wind power industry. Navarra's wind companies are already looking to expand their horizons to even larger potential markets in areas where Spain has strong historic ties, such as North Africa and South America.

The sudden transformation of Navarra's energy mix may turn out to be foreshadowing something much bigger. During the 1990s, wind power has already become the world's fastest growing energy source. Propelled by supportive new government policies—most of them motivated by environmental concerns—some 2,100 megawatts of new wind generating capacity were added in 1998, according to our preliminary estimate. That's not only a new record, but 35 percent more than the previous record set the year before.

Global wind generating capacity now stands at 9,600 megawatts—a 26 percent increase from a year earlier. (See figure on page 27.) Wind turbines will generate a projected 21 billion kilowatt-hours of electricity in 1999—enough power for 3.5 million suburban homes. And though it now provides less than 1 percent of the world's electricity, these double-digit growth rates could make the wind a major power supplier soon.

Wind power is also one of the world's most rapidly expanding industries. Valued at roughly $2 billion in 1998, the wind industry is creating thousands of jobs at a time when manufacturing employment is falling in many nations. And as a booming new industry, wind energy has become a major investment opportunity—comparable perhaps to some of the internet stocks that are now so hot on Wall Street.

Ancient Ideas, Brand New Markets

Although it has had a recent rebirth, wind power is actually an ancient source of energy. The first windmills for grinding grain appeared in Persia just over 1,000 years ago, and later spread to China, throughout the Mediterranean, and to northern Europe, where the Dutch developed the massive machines for which the country is still known. In the Middle Ages, windmills allowed peasants to grind grain without depending on watermills controlled by feudal lords.

As the fossil-fuel age emerged in the early 20th century, wind power seemed to have become a permanent footnote in the history of energy technology. But in the 1970s, Danish companies invented a machine composed of three propeller-like fiberglass blades that pointed upwind of a steel tower on which they were mounted. The latest versions, which are also manufactured by companies based in Germany, India, Spain, and the United States, have variable pitch blades whose angle of attack varies depending on the wind speed. The blades, which can be as long as 40 meters, will spin in winds of little more than 15 kilometers per hour. They maintain a relatively slow and constant speed, though a new generation of electronic variable-speed drives allow the blade speed to vary, increasing the machines' efficiency. The generator—similar in design to those connected to diesel engines—sits atop the tower, along with the transmission, brakes, and sophisticated microprocessors that coordinate all of the equipment.

The 1998 wind energy boom was led by Germany, which added 790 megawatts, pushing its capacity to 2,875 megawatts, nearly double the total capacity in the United States. Germany's wind industry is only seven years old; it grew out of a 1991 electricity reform law that was motivated in part by the Chernobyl nuclear disaster. But already, wind generators are producing as much power as two of Germany's large coal-fired power plants, or a little more than 1 percent of the country's electricity. In the northern state of Schleswig Holstein, wind now provides 15 percent of the electricity, and is on course to supplant nuclear energy as the state's leading power source. The new German government plans to shut down the nuclear plants that supply 30 percent of the country's electricity—a move that may give wind power another substantial boost.

One of the most notable developments in 1998 was the emergence of Spain as the number-two player in the industry. Spain added an estimated 395 megawatts of wind power last year. That increase pushed the country's total wind capacity up 86 percent, to 850 megawatts. Robust wind energy industries have sprung up not only in Navarra, but also in the northwest state of Galicia, and in the south near Gibraltar. With development in all of these regions accelerating steadily, Spain could soon surpass Germany as the world's leading wind energy producer.

Wind generation also expanded in the United States in 1998. Some 230 megawatts of new capacity were added, to make up the largest increase in wind power that the country has seen since 1986. The new installations are spread across 10 different states, and were spurred by the desire to take advantage of a wind energy tax credit that is currently scheduled to expire in June 1999. They include a 107-megawatt wind farm in Minnesota, a 42-megawatt farm in Wyoming, a 25-megawatt farm in Oregon, and many small projects, ranging from Maine to New Mexico.

In contrast to the erratic ups and downs of the U.S. industry, Denmark maintained its moderate, steady pace in 1998. The 235 megawatts of capacity added in the last year took Denmark's total wind capacity to 1,350 megawatts. Wind now generates over 8 percent of the country's power. Most notably, Danish wind companies utterly dominate the global export market; more than half the new wind turbines installed worldwide in 1998 were made in Denmark. The Danish companies are also involved in joint-venture manufacturing in India and Spain—an arrangement that has allowed for the rapid transfer of wind technology to the host countries. Altogether, the Danish wind industry had a turnover of just under $1 billion last year. That's roughly equal to the combined sales value of the nation's natural gas and fishing industries—two leading Danish sectors.

A Technology That Has Come of Age

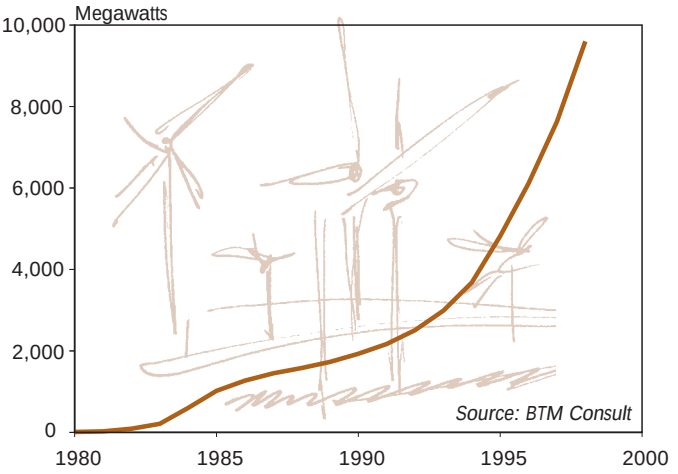
The nations that could benefit most from wind power are in the developing world, where power demand is growing rapidly and where most countries lack adequate local supplies of fossil fuels. The developing world's largest wind industry is in India, which has over 900 megawatts of wind power in place. But expansion has slowed there in the last two years, due to a suspension of the generous tax breaks that were in effect in the mid-1990s. Observers expect the new government to restore some of these incentives, which could give the industry a boost in 1999. Although wind power now provides less than 1 percent of India's electricity, its share could one day rise to 20 or 30 percent.

The wind potential of China is even greater. China has not yet established a solid legal basis for wind power, although several companies have installed small projects there in the last few years, with the help of foreign aid. But China could become a wind superpower. It has vast wind resources in several regions, including a huge stretch of Inner Mongolia that by itself could provide most of the power needed in Beijing and the rest of northern China. China's wind potential is estimated to exceed

its total current electricity use. That fact has enormous international implications, since China's coal-based economy exacts a heavy environmental toll. A Chinese wind industry could allow a significant reduction in global greenhouse gas emissions.

The dramatic growth of wind power in the 1990s stems primarily from laws that guarantee access to the grid for wind generators at a fixed price. (The price offered is usually a bit higher than the cost of fossil-fuel power—a recognition that the environmental benefits of renewable energy technologies are worth paying for.) These laws have established a stable market for the new industry, and have overcome resistance from the coal- and nuclear-dependent utilities that monopolize the market today. Some 70 percent of the global wind power market in recent years has been centered in just three countries, Germany, Spain, and Denmark—a distribution that reflects both the success of such laws where they exist, and the failure to adopt them broadly.

World Wind Energy Generating Capacity, 1980–98



Wind energy is also being spurred by steady advances in technology. Larger turbines, more efficient manufacturing, and more careful siting of the machines are among the improvements that have pushed wind power costs down precipitously—from $2,600 per kilowatt in 1981 to $800 in 1998. A typical wind turbine today produces 700 kilowatts of electricity, costs $700,000 (including installation), and provides enough power annually for 200 homes.

State-of-the-art wind turbines are highly automated and reliable; their downtime for maintenance, of less than 5 percent, is less than for fossil fuel plants, and maintenance costs are minimal. The "footprint" of a wind farm is also very small, since wind turbines blend readily with traditional uses of the rural landscape. (Farmers can either install their own wind turbines or lease the land to wind companies. The bulk of the land can still be used for grazing animals or raising crops.)

In many areas, wind power is already less expensive than electricity from coal-fired power plants. And as the technology continues to improve, further cost declines are projected. In many countries, the wind could become the most economical source of power in the next decade.

Over the past few years, wind seems to have achieved the kind of "critical mass" necessary to attract serious corporate interest. In 1996 and 1997, the largest U.S. natural gas company, Enron Corporation, purchased two wind manufacturing companies and is now developing projects around the world. Japanese trading companies have announced plans to build large wind projects, as have the German power giant Siemens and Florida Power and Light, a major U.S. electric utility. Companies in Denmark and the Netherlands are making plans for even larger offshore wind farms in the North Sea.

Continued and perhaps accelerated growth of the wind industry is likely in 1999 and beyond. Spain and the United States are projected to have particularly good years, probably exceeding 500 megawatts of new turbines each. Other countries where growth is likely include Canada, Italy, Japan, Norway, and the United Kingdom. The strongest potential developing-country markets include Argentina, Brazil, Costa Rica, Egypt, Morocco, and Turkey.

Ultimately, wind power could be a major force for transforming the global energy economy. In the United States, the states of North Dakota, South Dakota, and Texas have sufficient wind capacity to provide all U.S. electricity. In windy regions such as Patagonia, the American Great Plains, or the steppes of Central Asia, wind farms could churn out vast amounts of electricity. A study by Danish researchers in 1998 laid out a strategy for providing 10 percent of the world's electricity from the wind within the next few decades. In the longer run, wind power—both onshore and off—could easily exceed hydropower—which now supplies 20 percent of the world's electricity—as an energy source.

Wind power is still considered a laughing matter by many energy industry executives. But soon, such people may look almost as silly as those who once called the airplane an absurd idea. If that happens, Navarra may enter the history books alongside Kitty Hawk, North Carolina as the proving ground for a technology that changed the way the world lives.

Christopher Flavin is senior vice president at Worldwatch Institute, and co-author with Nicholas Lenssen of *Power Surge: Guide to the Coming Energy Revolution* (W.W. Norton, 1994).