5. Wind Energy Profile

Overview

The worldwide capacity of installed wind power was 4,900 megawatts in 1995.[70] Outside the United States, significant wind capacity is installed or proposed for near-term installation in Germany, Denmark, India, the Netherlands, Spain, and China. Sales of wind technologies to Europe are becoming increasingly important, while the U.S. share of worldwide windpower capacity continues to decline. In 1993, 80 percent of the worldwide wind power industry sales were to Europe, and in 1994 Germany accounted for almost one-half of the new capacity installed worldwide. The U.S. share of the world's installed wind capacity fell from 92 percent in 1988 to less than 50 percent in 1994[71] and 35 percent in 1995.[72] While new installed wind turbine capacity worldwide reached its single-year high in 1995, the U.S. share was less than 10 percent.

In the United States, the country with the most installed wind power, capacity was 1,731 megawatts at the end of 1995.[73,74] Wind-powered electricity generation in the U.S. electric utility sector increased significantly in 1995 to 11,000 megawatthours. A significant project in the utility sector, the 6.8-megawatt Solano Wind Project of the Sacramento Municipal Utility District, began operation in 1994 and generated nearly 11,000 megawatthours in 1995. In addition, two plants began operating in Texas in 1995: a 6.6-megawatt facility (12 Zond turbines) operated by West Texas Utilities, and a 35-megawatt facility operated by Kenetech Windpower (see footnote 74).

Although most of the on-line wind energy projects in the United States are located in California, recent installations have broadened the geographical distribution of wind power capacity. With the help of legislation encouraging the utilization of alternative energy sources, wind power plants are already finding homes in States such as Texas and Minnesota (with 42 megawatts and 26 megawatts of installed capacity, respectively).[75] Additionally, Minnesota has mandated that Northern States Power Company acquire 425 megawatts of wind generation capacity by 2002, and Iowa now requires investor-owned utilities to spend 2 percent of their funds for power from alternative energy sources[76] (see box on page 42).

The breakdown of U.S. wind capacity as of September 1996, by State, is shown in Table 15. California has 95 percent of the operational wind capacity in the country, while Minnesota has 61 percent of the planned capacity. Of the total 659 megawatts of planned capacity, 15 megawatts is under construction, 140 megawatts is

Table 15. U.S. Wind Electricity Generation Nameplate Capacity by State as of September 1996

(Megawatts)

State	Online	Planned
California	1,635	9
Texas	42	40
Minnesota	26	400
Hawaii	12	0
Iowa	2	32
Michigan	1	0
Wyoming	0	68
Washington	0	56
Oregon	0	25
Maine	0	10
Wisconsin	0	10
Vermont	0	6
Massachusetts	0	3
U.S. Total	**1,718**	**659**

Note: Planned capacity includes additions through 2003 and consists of 15 megawatts under construction, 140 megawatts under contract, 68 megawatts under agreement, 289 megawatts mandated but not yet under contract, and 147 megawatts proposed.

Source: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Wind Energy Data: Monthly Summary Report" (September 1996).

[70]International Energy Agency, *Wind Energy Annual Report 1995* (Paris, France, March 1996), p. 20.

[71]S. Williams and B.G. Bateman, *Power Plays* (Washington, DC: Investor Responsibility Research Center, 1995), p. 255.

[72]International Energy Agency, *Wind Energy Annual Report 1995*, p. 20; and Energy Information Administration, *Electric Power Annual 1995*, Vol. 2, DOE/EIA-0348(95/2) (Washington, DC, December 1996), pp. 15-16.

[73]Energy Information Administration, *Electric Power Annual 1995*, Vol. 2, pp. 15-16.

[74]Excludes 6.6 megawatts of utility capacity and 35 megawatts of nonutility capacity that were not captured by EIA sources.

[75]U.S. Department of Energy, Office of Energy Efficiency, "Wind Energy Data: Monthly Summary Report" (September 1996), p. 7.

[76]U.S. Department of Energy, *Wind Energy Program Overview: Fiscal Year 1994*, DOE/G0-10095-071 (Washington, DC, 1995), p. 1.

Northern States Power Co.

In the early 1990s, Northern States Power Co. (NSP) negotiated an agreement with the State of Minnesota requiring the utility to install 425 megawatts of wind capacity and 125 megawatts of biomass capacity by the end of 2002, in return for permission to expand on-site storage of spent nuclear fuel at its nuclear power plants.* Currently, NSP buys power from a 25-megawatt wind facility consisting of 73 Kenetech turbines. The facility operates at a 33 percent capacity factor with no mechanical difficulties.** This capacity factor is largely dependent on resource availability (wind is an intermittent resource) and not on mechanical reliability. The utility is planning to expand the Buffalo Ridge project by 100 megawatts with 143 700-kilowatt Zond Systems, Inc. wind turbines. Zond was the successful bidder at a levelized cost of energy close to 3 cents per kilowatthour. Extending transmission lines to the Buffalo Ridge project is estimated to cost about $100 per kilowatt. Many landowners in the area have sold NSP perpetual rights to the wind energy on their land. The company expects to spend $5.15 million for the rights to the energy associated with the 100-megawatt facility. The Buffalo Ridge area has average wind speeds of about 16.1 mph.***

*L. Lamarre, "Renewables in a Competitive World," *EPRI Journal*, Vol. 20, No. 6 (November/December 1995), web site www.epri.com.

**"Wind Energy Firm Flounders," *Engineering News Record*, December 25, 1995, p. 16.

***Northern States Power, "Proposed 100 MW Wind Energy Generating Facility," Docket No. E-002/CN-94-795 (September 23, 1994).

under contract, 68 megawatts agreed upon, 289 megawatts mandated, and 147 megawatts proposed.

The Role of Government

Funding for wind programs by the U.S. Government began in the 1970s, peaking at $60 million in 1980. During the 1980s those resources declined, bottoming out at less than $10 million per year from 1988 through 1990. The 1990s have again seen a reversal, with a funding level of $45 million in 1995.[77] The program budget has declined again, however, in fiscal years 1996 ($31.5 million) and 1997 ($29 million).

The Energy Policy Act of 1992 (EPACT) established the following tax incentives for wind energy: a 10-year production tax credit of 1.5 cents per kilowatthour for projects brought on line between 1994 and 1999, and a production incentive payment of 1.5 cents per kilowatthour for publicly owned (non-taxpaying) entities unable to use the tax credits.[78] These positive factors have been tempered by the uncertainty of the continuation of the credits and payments. At present, utility-scale wind energy projects produce electricity at a cost of 5 to 7 cents per kilowatthour.[79]

The Federal Government provides technical assistance in the development of wind energy through the U.S. Department of Energy (DOE) Wind Energy Program, the National Renewable Energy Laboratory's (NREL) National Wind Technology Center (NWTC), and Sandia National Laboratories (SNL). NREL is the primary player in the Advanced Wind Turbine Program, the Value Engineered Turbine Program, and the wind characterization program that originated at Pacific Northwest Laboratories.

DOE's Wind Energy Program, in conjunction with industry, supports the development and testing of wind turbine technology at both the individual component and full system levels. The purpose of this activity is to decrease costs through increased operating efficiency from improvements in variable speed characteristics, large rotor design, and weight reduction. Machines of proven configuration developed under this program and nearing completion include:[80]

- Atlantic Orient Corporation—AOC 15/50 (50 kilowatts capacity)
- FloWind Corporation—AWT-27 (275 kilowatts), EHD (300 kilowatts)
- New World Power Corporation—North Wind 250 (250 kilowatts)
- Zond Energy Systems—Z-40 (500 kilowatts).

The next generation of turbines, now under development, includes:

- Wind Turbine Company—WTC-1000 (1,000 kilowatts)
- Zond Energy Systems—Z-56 (1,078 kilowatts)
- Cannon Wind Eagle.

The program also supports development of innovative subsystems, such as power conditioning and controls,

[77]S. Williams and B.G. Bateman, *Power Plays*, p. 271.

[78]S. Williams and B.G. Bateman, *Power Plays*, p. 266.

[79]D.F. Ancona, P.R. Goldman, and R.W. Thresher, "Wind Program Technological Developments in the United States," paper presented to the World Renewable Energy Congress (Denver, CO, June 18, 1996), p. 1.

[80]D.F. Ancona, P.R. Goldman, and R.W. Thresher, "Wind Program Technological Developments in the United States," p. 5.

trailing edge aerodynamic brakes, and multi-blade flexible rotors.[81] A blade manufacturing project by SNL supports attempts to improve the cost, quality, and reliability of wind turbine blades. World market sales of turbines developed under this program have exceeded $300 million.[82]

In 1994, the NWTC was designated and dedicated near Golden, Colorado. It features laboratories, computer facilities, and testing facilities to assist in the design, testing, and evaluation of new turbines. Sixteen turbine test pads are available to test systems up to 1 megawatt in capacity, and a turbine with special instrumentation is in place for studies of aerodynamic and structural responses to turbulence. NWTC's location is ideal for testing turbines under a variety of conditions. In the fall and winter, strong, turbulent winds from the west mimic winds in California; in the spring, stable (laminar) easterly winds mimic the U.S. Great Plains and much of Europe.[83] These conditions allow testing under both extreme conditions and those typical of the Great Plains, where nearly 50 percent of U.S. wind resources are located.

NWTC also houses NREL's Wind Technology Division, which operates five 80-meter (262-foot) meteorological towers on the eastern and western boundaries of the site. The towers are used to develop and test instruments and procedures for evaluating wind characteristics, including seasonal patterns and turbulence of the local wind resource. Currently, three commercial turbines are installed at the site: Atlantic Orient Corporation's AOC 15/50, Advanced Wind Turbines' AWT-26 (both developed under DOE's Wind Turbine Development Program), and a 10-kilowatt turbine developed by Bergey Windpower Company.[84] Installation of a fourth commercial turbine (Wind Eagle) is underway. In addition, there are two installed research turbines (15 kilowatts).

An Industrial User Facility is operational at NWTC. It is designed to encourage collaboration between Government and industry in technology innovation, through cooperative research and development agreements. To that end, the testing facilities are partitioned into three separate, secure areas to protect the intellectual property of the participating commercial firms. Capabilities are also being developed to support certification testing, which is emerging as a requirement for the export of wind energy systems to many overseas markets.

The National Wind Coordinating Committee (NWCC) was formed in 1994 as a result of efforts by the American Wind Energy Association (AWEA), Electric Power Research Institute (EPRI),[85] Edison Electric Institute (EEI), American Public Power Association (APPA), and DOE.[86] Its members include utilities, environmental groups, utility consumer advocates, utility regulators, other State and Federal government officials, and the wind industry. The purpose of the committee is to plot an orderly path for the development of wind power into a self-sustaining commercial market. Its mission is to identify key issues, facilitate dialogue between the affected parties, and formulate appropriate responses. Immediate issues of concern are regulatory and environmental barriers to renewable energy, transmission access and pricing, and accurate wind resource assessment.

The Utility Wind Resource Assessment Program provides assistance to utilities in evaluating the wind resources in their service areas. Monitoring of wind speeds at proposed turbine heights is conducted for at least 1 year to verify that economical wind resources exist at the proposed site. The program, initiated by the NWCC with the support of DOE, is managed by the Utility Wind Interest Group.[87]

The Utility Wind Interest Group, a consortium of 16 utilities and industry organizations, was formed in 1989 with the support of DOE and EPRI to exchange experience and information on wind power. It currently includes the following members:[88]

- Alaska Village Electric Cooperative, Inc.
- Central and Southwest Services
- Conservation and Renewable Energy Systems (CARES)
- Green Mountain Power Corporation
- Edison Electric Institute
- Kansas City Power & Light Company

[81]A *trailing edge aerodynamic brake* is a movable flap, known as a "spoiler flap," mounted on the downwind edge of a wind turbine blade, which rotates up or down to control turbine rotor speed. *Vortex generators* are small protrusions on wind turbine blades that help to keep airflow attached to the blades. *Multi-blade flexible rotors* are rotors with three or more turbine blades constructed of a lightweight, highly flexible material.

[82]D.F. Ancona, P.R. Goldman, and R.W. Thresher, "Wind Program Technological Developments in the United States," p. 4.

[83]U.S. Department of Energy, *Wind Energy Program Overview: Fiscal Year 1994*, p. 6.

[84]U.S. Department of Energy, *Wind Energy Program Overview: Fiscal Year 1994*, p. 7.

[85]EPRI's wind budget doubled from $1.1 million in 1994 to $2.2 million in 1995.

[86]S. Williams and B.G. Bateman, *Power Plays*, p. 267.

[87]U.S. Department of Energy, *Wind Energy Program Overview: Fiscal Year 1994*, p. 10.

[88]S. Williams and B.G. Bateman, *Power Plays* p. 269.

- Electric Power Research Institute
- Kotzebue (Alaska) Electric Association
- Niagara Mohawk Power Corp.
- Northeast Utilities Service Company
- Northern States Power Company
- Public Service Company of Colorado
- Sacramento Municipal Utility District
- Southwestern Public Service Company
- TU Electric
- Waverly Light & Power
- Wisconsin Electric Power Company.

The Utility Wind Turbine Performance Verification Program was started in 1992 by DOE and EPRI to accelerate the commercialization of wind power. Its goal is to reduce the risk of testing and evaluating advanced wind energy technology for utility use. Participating utilities will be subsidized to build and operate wind power plants of at least 6 megawatts capacity, using the latest technology.[89] Each utility will select a site, solicit bids from U.S. vendors, and purchase the turbines. The utilities will also be responsible for power plant design, construction, startup, and 3 years of testing, evaluation, and documentation. The experience is intended to allow utilities to make more informed decisions about the latest turbines. In 1993, Green Mountain Power Corporation was awarded $2 million for 11 Zond Z-40 turbines, each rated at 550 kilowatts. Central and Southwest Services, Inc. was awarded $2 million for 12 Zond Z-40 turbines, each rated at 550 kilowatts. These turbines became operational in September 1995.

Executive Order 12902 (March 1994) requires the U.S. Department of Defense (DOD) to increase its use of renewable energy. DOD is the Government's largest consumer of energy. Potentially, thousands of diesel generators could be replaced by wind turbines at U.S. military installations with good wind resources. NREL is now working with the U.S. Navy to design and build a wind generation system of up to 1-megawatt on San Clemente Island. Also, NREL has collected wind data for assessment of a potential project on San Nicholas Island off the California coast between San Diego and Los Angeles. The Wind Turbine Development Program is working with industry to develop small (20 to 40 kilowatts) advanced turbines.

The Commercial Industry

The major wind energy equipment manufacturers in the United States are Atlantic Orient Corporation, Bergey Windpower Company, Cannon Power Corporation, FloWind Corporation, Kenetech Windpower, Wind Eagle Corporation, Wind Turbine Company, and Zond Systems, Inc. Kenetech Windpower, FloWind, Zond, and Cannon are vertically integrated—in addition to designing complete wind turbine systems, the companies also provide leadership in wind farm project development and work in partnership with research consortia and Government agencies to design, test, and develop new wind turbine components. Kenetech Windpower (a subsidiary of the Kenetech Corporation) is the only large-volume manufacturer among the companies and one of the few dedicated wind energy system manufacturers that is publicly owned; however, Windpower is currently under Chapter 11 corporate reorganization.

New World and SeaWest do not manufacture wind turbines, but instead develop and operate wind power plants. Both companies consider their independence from a particular piece of technology as an advantage, allowing them flexibility to choose the turbine design most appropriate for a given project. In the early years of the wind industry, large companies, such as Boeing, General Electric, Westinghouse, Bendix, and Alcoa, were involved in the government-sponsored development of multi-megawatt turbines. When those machines proved to be uneconomical under the conditions of the 1980s, the companies dropped out. More recently, however, improvements in cost efficiency have started to draw large companies back into the business, including Westinghouse, Dow Chemical, United Technologies, Teledyne, and Bechtel. Atlantic Orient Corporation is also a U.S. turbine manufacturer, but it is not involved in power plant construction or electricity generation.

The following are the larger operators of U.S. wind energy power plants:[90]

- Cannon Power: 703 units, 82.2 megawatts capacity in 1994
- FloWind: 864 units, 139.9 megawatts capacity, $9.44 million in revenue in 1993
- Kenetech Windpower: 4,334 units, 494.7 megawatts capacity in 1994, $236 million in revenue in 1993
- New World Power: 450 units, 44.4 megawatts capacity, $7.66 million in revenue in 1993
- SeaWest Energy: 2,641 units, 327.7 megawatts capacity in 1993
- Zond Systems: 2,459 units, 258.9 megawatts capacity in 1994.

[89]U.S. Department of Energy, *Wind Energy Program Overview: Fiscal Year 1994*, pp. 9-10.
[90]S. Williams and B.G. Bateman, *Power Plays* pp. 277-309.

Much of the installed wind capacity in the United States was manufactured overseas. Major foreign wind energy companies are Vestas/DWT, Nordtank, Bonus, Micon, and Wind World of Denmark; Nedwind and Windmaster of the Netherlands; Enercon and Tacke of Germany; Wind Energy Group of the United Kingdom; and Mitsubishi of Japan.

Many wind energy system manufacturers are also power generators. This circumstance is characteristic of the early days of the industry, when risk factors dissuaded larger, well-established corporations from participating in wind energy projects. As utilities increase their direct role in the wind industry, however, this situation should change.

In 1994, the Sacramento Municipal Utility District became the first utility to own a large-scale wind project in the United States. Other utilities with outright or joint ownership of wind farms include Lower Colorado River Authority, Central and South West Corporation, and Hawaiian Electric Industries. Northern States Power, Minnesota's largest utility, has been mandated by the State Senate to install 425 megawatts of wind capacity over the next 7 years (see box on page 42). In addition, a consortium of Washington State utilities, known as CARES (the Conservation and Renewable Energy System), intends to install 25 megawatts in 1997.[91]

Technology and Ownership Issues

Wind turbine technology began with small turbines, with generating capacities of 50 kilowatts or less. As the technology has matured, the focus of production, research, and development has shifted to significantly larger turbines. Today, 70 percent of the world's wind turbines are in the 50- to 150-kilowatt range.[92] Several international manufacturers have produced turbines with capacities greater than 1 megawatt; however, research has shown that economies of scale (increased efficiency of power production with greater capacity) associated with larger turbines do not increase in proportion to their cost. Therefore, it is likely that the next generation of wind farms will be powered by turbines with capacities of 300 kilowatts to 1 megawatt (1,000 kilowatts).

Since no combustion occurs in wind projects, there are no emissions. Every megawatthour (thousand kilowatthours) of electricity generated by a wind turbine offsets the equivalent of 0.5 to 1 kilogram of carbon dioxide, up to 7 kilograms of sulfur and nitrogen oxides and particulates, 0.1 kilogram of trace metals (e.g., mercury), and more than 0.2 kilograms of solid waste from fossil-fueled generation.[93]

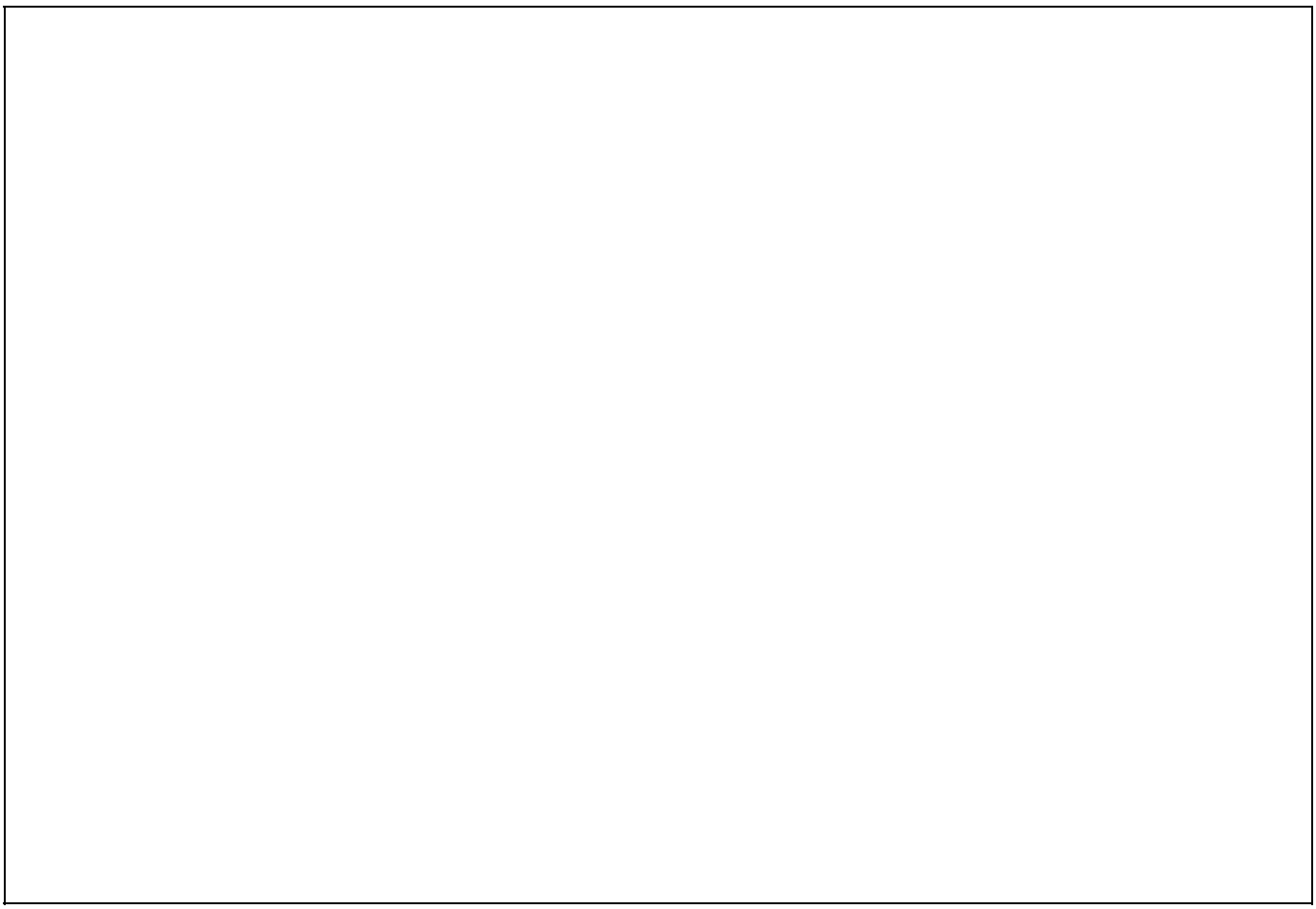
Most wind energy projects are financed by the manufacturer, institutional investors, or investment brokers. Potential investors require a rate of return higher than average because of the perceived risk and uncertainty of wind projects in the United States, which restricts the cost competitiveness of wind energy projects relative to other types of power. Continuing increases in cost efficiency and technological capability, however, are beginning to attract greater attention from utilities. The utilities will likely shift the structure of wind energy development and ownership away from independent, or nonutility, power producers, which dominated the early years of the industry by their willingness to assume greater financial risk.

Changes in Technology, Industry Structure, and Project Management

The modern wind industry began in 1981, following the enactment of the Public Utility Regulatory Policies Act of 1978 (PURPA). More than 1,000 megawatts of capacity was installed by 1985, far exceeding the goal of 800 megawatts by 1988, as set forth in the 1980 Wind Energy Systems Act.[94] Incentives during the 1980-1985 period included a 15-percent renewable energy tax credit, a 10-percent investment tax credit, and accelerated 5-year depreciation. In California, incentives included State tax credits, an attractive utility buyback rate, and a favorable political climate.

The tax credits of the early 1980s, government funding, and support for research and development were critical in overcoming the technological design and manufacturing problems of early wind turbines. However, the value of the tax credits was based on the installed cost of a project, which caused problems, as some turbines were installed with only minimal testing in order to qualify before the tax credits expired.[95] Today's credits are based on performance criteria, not merely on the amount of capital invested. One emphasis in applied wind technology is on replacing existing capacity with the latest turbine designs, which are less costly to maintain and more efficient to operate.[96] In California, this will occur as the interim Standard Offer No. 4 contracts,

[91]U.S. Department of Energy, *Wind Energy Program Overview: Fiscal Year 1994,* p. 1.
[92]J. Loyola, *Wind Performance Reporting System: 1991 Annual Report* (Sacramento, CA: California Energy Commission, December 1992).
[93]Paul Gipe & Associates, *1996 Overview of Wind Generation Worldwide* (Tehachapi, CA, July 31, 1996), p. 4.
[94]S. Williams and B.G. Bateman, *Power Plays,* p. 255.
[95]S. Williams and B.G. Bateman, *Power Plays,* p. 257.
[96]S. Williams and B.G. Bateman, *Power Plays,* p. 258.



Horizontal-axis wind turbines, developed by Enertech Corp. and the U.S. Department of Energy, located in Altamont Pass, CA.

which specify a generous fixed price for power generated, expire (about 140 megawatts had expired by 1994, another 540 megawatts in 1995, and 200 megawatts in 1996).

During the period 1980-1985, almost all wind energy development was third-party financed—that is, tax-advantaged limited partnerships of individual investors or even individual purchases of wind turbines as personal property.[97] Although new installation of wind systems dropped after 1985 (except for a brief resurgence during 1990-1991), generation has increased in every year.

Before 1993, all the utility-scale wind power plants in the United States were installed in California, with the exception of approximately 20 megawatts in Hawaii. In 1994, Minnesota joined this group, and there are now projects under development in 10 other States.[98] Through the early 1990s, virtually all wind energy plants were owned by independent power producers (IPPs). Today, the drop in prices and financial risk, the rise in technical efficiency and reliability, and legislative mandates have increased the involvement of major utilities in wind power development and investment.[99]

The average cost of electricity from wind energy has dropped from 50 cents per kilowatthour in 1980 to approximately 5 cents per kilowatthour in 1993.[100] The reliability of wind turbines has increased from 60 percent availability for machines built in the early 1980s to approximately 98 percent for the newest turbine models.[101] Productivity of turbines, as measured by annual generation per unit area swept by the rotor

[97]S. Williams and B.G. Bateman, *Power Plays*, p. 256.
[98]U.S. Department of Energy, Office of Energy Efficiency, "Wind Energy Data: Monthly Summary Report" (September 1996), p. 7.
[99]D.F. Ancona, P.R. Goldman, and R.W. Thresher, "Wind Program Technological Developments in the United States," p. 2.
[100]Energy Information Administration, *Monthly Energy Review* DOE/EIA-0035(95/02) (Washington, DC, February 1995), pp. viii, ix.
[101]U.S. Department of Energy, *Wind Energy Program Overview: Fiscal Year 1994*, p. 2.

blades, has risen from 500 kilowatthours per year per square meter to 800 (the average for California's turbines).[102] The installed cost for a medium-sized turbine has decreased from $4,000 per kilowatt in 1980 to $1,250 per kilowatt in 1996.[103] Additionally, operating and maintenance costs have decreased by a factor of 3, from 3 cents to 1 cent per kilowatthour. Generation costs are also down by a factor of 2, to between 5 and 7 cents per kilowatthour, and are expected to fall to 4 cents per kilowatthour for the next generation of turbines.[104] (The levelized cost of energy goal of the DOE Wind Energy Program is 2.5 cents per kilowatthour in 15 mph winds by 2000.[105]) In terms of net energy use, wind turbines typically repay the energy consumed in their construction in less than a year and, at good sites, in as little as 3 months.[106]

The advance in technological characteristics of wind turbines can be summarized as follows.[107]

Pre-1975: Operating life 1 to 5 years, average capacity factor 10 percent, availability 60 to 70 percent, size range less than 20 kilowatts

Present: Operating life 20 years, average capacity factor 20 to 25 percent, availability 95 percent, size range 200 to 500 kilowatts

Post-2000: Operating life 30 years, average capacity factor 30 percent, availability greater than 95 percent, size range 300 to 1,000 kilowatts.

Conclusion

Good wind resources are not a constraint to wind power development. Using moderately constraining land use and environmental restriction assumptions, and a 10-mile proximity to existing transmission line assumption, a recent study reported the U.S. potential for over 734,000 average megawatts of wind energy generation capability.[108] The U.S. share of worldwide wind capacity is declining; however, the domestic market has remained stable even as market uncertainty increases with deregulation and restructuring. Costs continue to decline, and wind energy projects continue to extend into a number of new States.

[102]Paul Gipe & Associates, *1996 Overview of Wind Generation Worldwide*, p. 3.
[103]Paul Gipe & Associates, *1996 Overview of Wind Generation Worldwide*, p. 3.
[104]S. Williams and B.G. Bateman, *Power Plays*, p. 262.
[105]U.S. Department of Energy, Office of Photovoltaic and Wind Technologies, 1996.
[106]Paul Gipe & Associates, *1996 Overview of Wind Generation Worldwide* (July 31, 1996), p. 3.
[107]U.S. Department of Energy, *Wind Energy Program Overview: Fiscal Year 1994*, p. 2.
[108]Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(95/02) (Washington, DC, February 1995), p. xii.