Chapter 21
United States

21.1 INTRODUCTION

The United States has vast wind energy resources and has been one of the leaders in wind energy research, development, and deployment (R,D&D) for more than 30 years. Today, nearly 20% of worldwide wind energy capacity is in the United States, and wind is the fastest-growing source of electricity. During the past ten years, electricity production from wind turbines has more than doubled, at a rate faster than other forms of power generation.

This report describes recent wind technology development and market trends in the United States. Emphasis in the report is on the United States Department of Energy (DOE) Wind and Hydropower Technologies Program and its role in leading the development of new wind energy technologies that can compete with other electricity sources without the need for subsidies.

21.2 NATIONAL POLICY

Strategy

The National Energy Policy (NEP), published in May 2001, contains recommendations to diversify the national energy supply, move towards clean affordable energy sources, and modernize the electricity grid and infrastructure. Renewable energy sources play a key role in this policy, including development of wind energy. Further, the policy proposed expansion of performance-based, goal-oriented research and development (R&D) focused on advanced technologies adapted to sites with lower wind speeds; extension of wind energy production tax credits; and the increased use of wind and other renewable resources on federal lands.

Consistent with NEP, the DOE Office of Energy Efficiency and Renewable Energy has as its mission: "Strengthen America's energy security, environmental quality, and economic vitality through public-private partnerships that bring clean, reliable and affordable energy production and delivery technologies to the marketplace." A goal of DOE is to increase the viability and deployment of a range of renewable technologies, including wind.

The strategy in the United States is to expand the use of wind energy through continuing wind technology R,D&D combined with market development incentives. Emphasis has shifted from government-led R,D&D to cost-shared public-private partnerships aimed at developing advanced wind turbine designs that can operate economically in broad applications and areas. The focus of financial incentives has shifted from purely federal investment incentives to a combination of national and regional/state incentive programs that will eventually become unnecessary as the cost of wind energy declines.

The DOE wind energy program supports the development of wind systems in a range of sizes for a variety of applications. For large wind energy systems with rated turbine capacity over 100 kW, the program's R,D&D activities focus on supporting U.S. industry efforts to improve low wind-speed performance to reduce the life-cycle cost of wind energy to levels that can compete in bulk electric power markets. For distributed small wind systems of less than 100 kW, R,D&D is focusing on advanced turbines designed to improve cost effectiveness for meeting a broad range of energy needs for homes,

farms, isolated communities, and distributed grid-connected generation.

Specific cost reduction and performance targets have been set to position wind as an attractive advanced-technology option for the twenty-first century. The DOE program goals follow.

- Reduce the cost of electricity from large wind systems to 0.03 USD/kWh at high-wind sites with an average wind speed of 6.7 meters per second (m/s) by 2004, and at low-wind sites with 5.8-m/s winds by 2012.
- Reduce the cost of electricity from small, distributed wind systems to 0.10 USD/kWh to 0.15 USD/kWh by 2007 in an average wind resource of 5.4 m/s.
- Wind speeds are measured at the standard height of 10 m above the ground.

For wind energy to be used in many parts of the United States, it is necessary to develop turbines that can operate efficiently in areas of lower wind speed (5.8 m/s). Generally, urban load centers are located in low-wind areas, so the new turbine technology will allow wind plants to be economically viable on land that is on average five times closer to the load center. This will help relieve power transmission constraints by placing turbines in closer proximity to consumers. It will also expand the economically viable land area for wind energy development by a factor of 20 or more.

Other considerations in the DOE program are the trends towards larger multi-megawatt turbines with their economies of scale, integration and control of much bigger wind-power plants (see Figure 21.1), and in the future assessing the potential for both land-based and offshore wind-energy installations.

The program is exploring possible linkages between wind and other renewable energy technologies. In 2002, DOE's wind energy and hydro-power programs were combined into one office. Although the two technologies will be developed independently, this organizational change provides the opportunity to explore potential synergistic operations. In many parts of the country, intermittent wind and hydro-power resources can be used together with beneficial effects. Wind energy is being considered for possible use in producing hydrogen for transportation and electric power markets.

Federal and Other Government Agencies' Use of Wind Energy

DOE and other parts of the federal government are expanding their use of energy from wind and other renewable energy sources. Through *Executive Order Number 13123* issued 3 June 1999, and through other policy

Figure 21.1 GE Wind Energy 1.5-MW turbines in 150-MW Trent Mesa wind-power plant located near Sweetwater, Texas

guidance, federal agencies are required to obtain the equivalent of 2.5% of their electricity from renewable resources by 2005.

Responding to the executive order, Dyess Air Force Base, Texas, on 1 January 2003 began purchasing 100% wind-generated electricity. The Dyess purchase of 78 million kWh of wind energy annually is the largest single purchase of wind energy in the nation. Texas-based TXU Energy, through a competitively awarded contract issued by the Defense Energy Support Center, will provide wind energy from six wind-power plants in Texas.

Earlier in 2002, DOE announced the purchase of electricity generated from renewable energy for its facilities in the Washington, D.C., area. The contract calls for an annual purchase of 6 million kWh, 25% to be provided by wind and the rest to be provided by landfill natural gas plants.

The examples set by the federal government are being replicated at state and local levels. In one case, a local school district in Montgomery County, Maryland, near Washington, D.C., recently announced plans to purchase 400,000 USD in power from wind plants annually.

Power Industry Involvement

The ongoing deregulation of the electric power industry and new independent green power marketing businesses are helping wind energy by increasing competition and allowing consumers to choose to purchase electricity from clean energy sources. However, deregulation is being implemented separately by individual states, causing many variations in procedures and adoption pace. This is one reason for regional differences in the adoption of wind.

Progress Towards National Targets

No national targets for wind energy deployment have been established by the government. However, the U.S. wind industry has a goal to generate 6% of the nation's electricity from 100,000 MW of wind systems by 2020. DOE has established specific program goals intended to support industry by encouraging wind deployment across the United States.

- Facilitate the installation of at least 20 MW in 32 of the 50 states by 2005, and of at least 100 MW in 16 states by 2010.
- Increase the use of wind energy by federal facilities to 5% of the electricity used by the federal government (equivalent to approximately 1,000 MW) by 2010.

21.3 COMMERCIAL IMPLEMENTATION

Installed Capacity

Installed wind capacity in the United States has increased continuously since 1980. Most recently, the growth rate has been increasing due to the combined effects of declining wind energy costs, available financial incentives, and high costs for competing energy sources. The installed capacity and cost trends are shown in Figure 21.2. The wind industry installed an additional 410 MW of capacity during 2002, and 27 states now host utility-scale wind-power development. At the end of 2002, installed U.S. wind capacity totaled 4,685 MW (see Figure 21.3).

Rates and Trends in Development

Wind power plant installations are continuing to expand into new regions, and projects are currently being developed and are under construction in many parts of the country. Although the 2002 growth of 410 MW was down from previous years, 2003 additions

are projected to return capacity to 2001 levels of 1,500 MW to 1,800 MW.

The recent year-to-year fluctuation in the construction of wind energy installations was caused primarily by a delay in the extension of the federal renewable energy production tax credit (PTC). Although there was strong support for the extension, the PTC expired in December 2001. In March 2002, the PTC was extended for two years, including a provision making it retroactive to the beginning of the year. This three-month delay caused many projects to be put on hold, disrupting turbine production plans and project financing. The coming year's expansion will be encouraged primarily by the PTC's extension through the end of 2003 as well as declining wind energy costs and the variety of incentives that are available in many states. Legislators are considering extending the tax credit for longer periods to reduce these fluctuations in construction.

Both wind turbines and wind power plants are growing in size, which is helping to reduce the cost of wind energy to the point that bid prices for several recent proposed land-based projects with excellent wind resources are approximately 0.03 USD/kWh, including the PTC. Most of the new large projects employ turbines rated from 600 kW to 1.5 MW. Two of the largest U.S. wind plants are the 278-MW King Mountain Wind Ranch near Odessa, Texas, built by Renewable Energy Systems, and the 300-MW Stateline Wind Plant on the Washington-Oregon border near Walla Walla, Washington, built by FPL Energy. In one of the first offshore projects, Cape Wind Company is planning to use 130 of the new, 3.6-MW GE Wind Energy turbines in a 468-MW project off the south shore of the state of Massachusetts.

Small wind turbine sales are increasing dramatically as a direct result of state incentive programs. For example, California implemented a rebate of up to 4,500 USD for the purchase of a wind turbine rated at 10 kW or less. As a result, one small turbine manufacturer, Southwest Windpower, sold more than 10,000 of its 400-W (see Figure 21.4) and 1 kW turbines in both 2001 and 2002. Another small turbine manufacturer, Bergey Windpower, is celebrating 25 years in the business of producing turbines from 1 kW to 10 kW, and it now has machines operating in all 50 states and in more than 90 countries. Bergey's sales increased 30% in 2002.

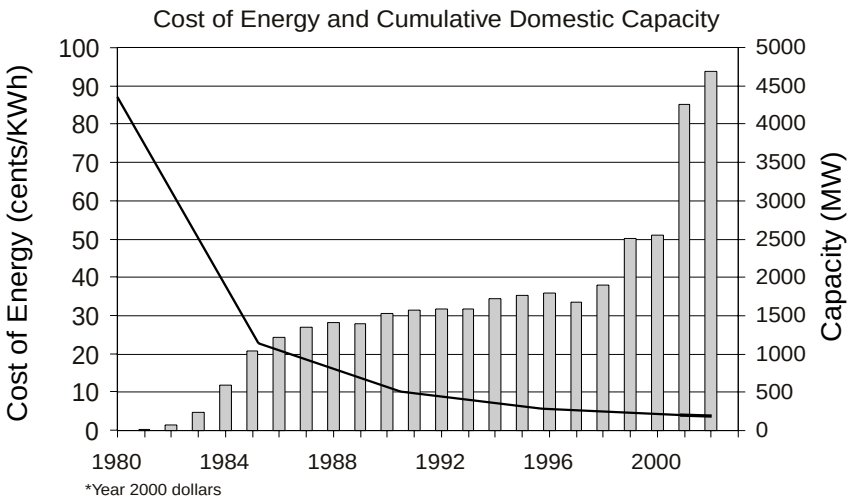

Figure 21.2 Wind energy cost and installed capacity trends since 1980

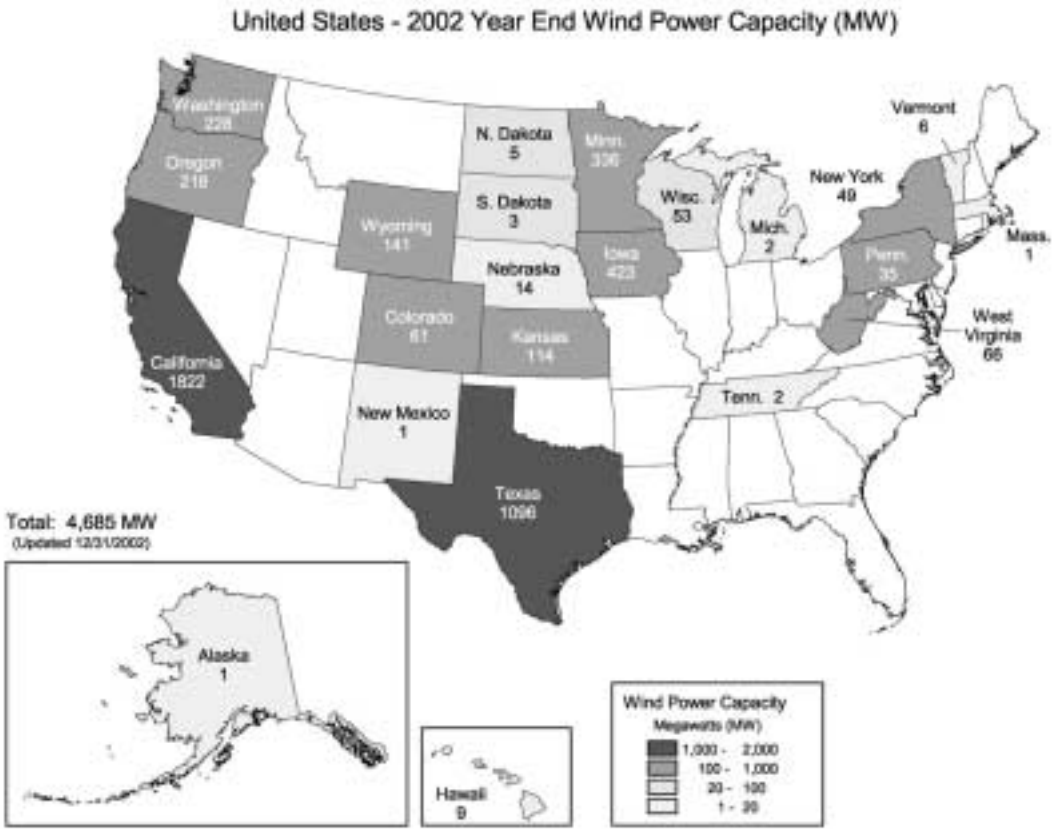

Figure 21.3 Wind-power plant installed capacity in the United States at the end of 2002

Contribution to National Energy Demand

Energy production from wind systems in the United States during 2002 is estimated to have been approximately 12 TWh, assuming that early pre-1990 turbines operate at an average capacity factor of 22%, that machines built during the 1990s operate at a 30% capacity factor, and that newer units operate at a 35% capacity factor. The aggregate capacity factor is estimated to be 29%. Currently, wind energy is only 0.3% of the national electricity supply, but its importance is growing, especially in regions with good wind resources and incentives for development. Industry's goal is for wind to supply 6% of the nation's electricity by 2020.

21.4 MARKET DEVELOPMENT AND STIMULATION

Market Support Initiatives and Market Stimulation Incentives

State policies and incentives are having an increasing influence on regional development of wind power, especially when combined with federal tax incentives. Many different programs are being developed on the state level where local conditions and needs vary. The most successful programs feature these characteristics.

- Clearly defined goals.
- Simplicity.
- Long-term (typically 10-year) benefits and/or penalties.

Figure 21.4 Southwest Windpower 400-W turbines sold 10,000 units during 2001 and again in 2002

• Flexibility that allows suppliers and consumers to choose from various renewable energy technologies.

The following examples of mechanisms that have helped to expand wind energy use are discussed in more detail in the International Energy Agency (IEA) Wind Energy Annual Report for 2001. The incentives and policies described in the following paragraphs often work together (see Figure 21.5).

1. Wind energy production tax credit:
A tax credit offered by the federal government for energy from wind and closed-loop biomass projects. Under this program, a commercial wind plant owner is allowed a tax credit of 0.018 USD for every kWh produced (rate is adjusted annually for inflation). This tax credit can be claimed for the project's first 10 years. To qualify for the credit, these plants have to be brought on line before 31 December 2003.

2. Renewable energy production incentive:
An incentive payment is available from DOE for municipal utilities that do not pay taxes to the federal government. As with the tax credit just described, applicants can receive a payment of 0.018 USD/kWh (indexed to inflation) for energy produced over a 10-year period, for plants brought on line prior to 31 December 2003. During 2002, payments totaled 3.8 million USD for solar, wind, and biomass plants with 1.3 million USD for wind plants. This payment is subject to availability of annual funding.

3. The 2002 Farm Bill:
This legislation includes a five-year, 115 million USD Renewable Energy Systems and Energy Efficiency Program that provides low-interest loans, loan guarantees, and grants to farmers, ranchers, and rural businesses to invest in wind and other renewable energy and efficiency improvement technologies. This program is implemented by the U.S. Department of Agriculture.

4. Green power purchasing prices:
In an increasing number of states, residential and commercial customers can choose to purchase electricity from environmentally benign or green power sources. An example of this were discussed in Section 21.2.

5. Renewable energy portfolio standards:
Some states are requiring that a portion of the energy sold by utilities come from renewables. This mechanism is discussed in the U.S. chapter of the IEA Wind Energy Annual Report for 2001.

6. Compatible land use and tax benefits:
Farmers and ranch owners in the United States are finding it attractive to harvest wind along with other crops. Typically, a Midwest farmer leases land to a developer under a long-term contract. In return, the farmer normally receives an annual cash payment plus a portion of the energy sales, typically 2%, amounting to annual revenue of 2,000 to 4,000 USD per large turbine. Some states also offer property tax breaks or holidays from taxes.

	Beneficiaries					
	Electric Utilities	Independent Power Producers	Public Power	Rural Electric Cooperatives	Manufacturers	Individuals/ Businesses • Customers • Farmers • Ranchers • Rural Business
Federal Incentives						
Production Tax Credit		X				X
Renewable Energy Production Incentive			X			
2002 Farm Bill —Loans and Grants						X
State and Local Incentives						
Given Power Purchasing Choices		X		X	X	
Green Tags		X		X	X	
Renewable Portfolio Standards		X			X	
Land Use and Tax Breaks • Property Tax Waivers • Sales Tax Waivers • Tax Holidays	X	X		X		X
Net Metering						X

Figure 21.5 Matrix of wind energy incentives and beneficiaries in the United States

To help facilitate the transition of wind energy technology into commercial markets, DOE started the Wind Powering America activity. This effort has five focus areas, as follows.

1. State-level support: Providing support in the form of workshops and technical analysis for local planners and regulators to include wind and other renewable energy sources in the power generation mix.

2. Outreach and technical support: Providing technical assistance on topics including wind resource assessment; wind mapping; economic analysis; environmental assessment, and other issues of interest to industry, utilities, and energy consumers in their decision-making on whether to build or buy wind generation.

3. Rural economic development: Providing educational and outreach materials to rural communities and developing new business models that employ wind development that includes land lease arrangements and other revenue-sharing approaches between developers and rural landowners, farmers, ranchers, and American Indian groups on tribal lands.

4. Power partnerships: Working with power generators and suppliers to encourage them to install clean generating capacity and providing information to large consumers of electricity that are considering the purchase of clean power.

5. Federal green power: Working with federal agencies to encourage the use of wind and other renewable energy technologies to fulfill requirements for purchasing electricity from clean energy sources for use by government-owned facilities. See Section 21.2.

The Wind Powering America program has been working successfully to remove obstacles to the introduction of wind technology in new regions and for new applications.

Turbine Cost Reduction

R&D efforts, increased turbine production volume, larger projects, and improved construction methods have all helped to reduce the cost of wind energy. Large wind plant installations are currently estimated to cost between 900 USD/kW and 1,000 USD/kW. These estimates are based on data from actual projects and include the turbines, electrical system interconnection, and substation costs. The cost depends on many things including turbine type, size, quantity, terrain, transportation access, grid-connection voltage and distance, and other variables.

21.5 DEPLOYMENT AND CONSTRAINTS

Operational data from successful projects are helping to reduce electric utility company concerns about allowing connection of large wind plants to the grid. However, transmission and distribution system constraints in regions with high-wind resources are expected to limit future wind energy growth unless new lines or system reinforcements are built. Several detailed power system studies are under way.

One study in New England analyzed high penetration of wind and biomass power plants operated in conjunction with existing hydro-power systems. Results showed that an addition of more than 800 MW of wind capacity could be accommodated in the state of Vermont without major costs for transmission and distribution system upgrades or reinforcements. Further, the value of wind power was found to be up to 22% higher if stored in hydro-power plants in the United States and Canada during their peak demand periods than if sold at local spot market prices.

In some parts of the country, transmission system capacity and integration issues have constrained wind energy development. The unbundling of the transmission function from the formerly vertically integrated monopoly electric service industry has eliminated investment in transmission upgrades and grid expansion in many states. Some transmission owners have adopted an interconnection policy that places responsibility for any network upgrades on the incremental new generator without providing clearly defined ownership rights in network capacity in return for that investment. As a result, it is rare for a new generation project to be built other than in a location where transmission capacity already exists.

The need to schedule the use of a transmission system can also be a constraint for wind plants, but solutions are being developed. Recently the California Independent System Operator (CAISO) proposed that intermittent renewable energy generators not be subject to heavy penalties for deviations from scheduled transmission line usage. The CAISO proposal allows intermittent renewable generators to forecast their output power and resulting transmission needs on an hourly

basis and for schedules of transmission usage to be based on those forecasts.

Environmental concerns can also be an issue in the planning and development of wind plants. Areas populated with protected species of birds should be avoided. Visual impact and noise are also concerns, but aesthetics and noise are becoming less of an issue as landowners realize the income potential of harvesting wind energy. Considering the large quantities of windy areas in the United States, avian and aesthetic concerns are not considered to be significant constraints. These and many other topics are covered in a report titled *Permitting Wind Energy Facilities* published by the National Wind Energy Coordinating Committee and available online at www.nationalwind.org/pubs/permit/permitting2002.pdf.

21.6 ECONOMICS

Trends in Investment

Investment patterns for wind-power projects are changing in the United States. Windpower plant projects are growing larger, driven by demand for clean energy and project economies of scale. Large companies are now becoming developers because they are better able to handle the necessary capital-raising and financial commitments. In addition, the wind energy business is becoming more profitable, attracting major new investors.

Some of the developers are subsidiaries of electric utility companies, while others are associated with other fields of the energy business or are energy equipment suppliers. Some of the major developers associated with utilities are FPL Energy, American Electric Power, Texas Utilities (TXU), Nebraska Public Power District, and Xcel Energy. Other energy sector companies that are now delving into wind projects are Chevron-Texaco, Exelon, Shell, and Zilkha Renewable Energy. In addition, about 20 small companies are developing projects across the country.

Trends in Unit Cost of Energy and Buy-Back Prices

Since 1980, the cost of electricity from wind systems without subsidies at good wind sites has been reduced from 0.80 USD/kWh (in year 2000 dollars) to between 0.04 USD/kWh and 0.06 USD/kWh. (See Figure 21.2.) In the best wind areas, project bids are approximately 0.03 USD/kWh, including available tax credits. Although costs have decreased significantly, researchers believe that further improvements could reduce costs an additional 30% or more. The DOE program goal is to advance wind energy technology so that utility-scale, grid-connected systems can produce electricity for 0.03 USD/kWh at widely available low wind-speed sites. As will be described later, DOE has launched a turbine development effort to produce concepts, components, and prototype systems that will be cost effective, without subsidies, at low-wind sites.

21.7 INDUSTRY

Nine U.S. companies are currently manufacturing wind turbines, and numerous businesses are building components, developing projects, and providing engineering services and related equipment. Currently three companies are building turbines larger than 50 kW, and six are building smaller turbines. Information about U.S. firms is available on the American Wind Energy Association web site, www.awea.org.

In May 2002, GE Power Systems announced that it had purchased some of the assets of Enron Wind Corporation. The new company is GE Wind Energy, a subsidiary of GE Power Systems. Worldwide, GE Wind Energy employs more than 1,500 people, with wind

turbine factories in Spain and Germany as well as in California. To date the company has deployed more than 5,500 wind turbines with a total rated capacity exceeding 3,100 MW.

Some of the larger European wind turbine manufacturers are establishing assembly or component manufacturing plants in the United States. The Danish firm NEG Micon has a large turbine assembly facility in Illinois. In addition, LM Glasfiber is building rotor blades in North Dakota.

21.8 GOVERNMENT-SPONSORED R,D&D

The DOE wind energy program for 2002 was composed of three elements: applied research, turbine research, and cooperative research and testing.

Applied Research

Much of the applied research directly supports the development of the low wind-speed turbine. The program includes research into wind inflow and turbulence; aerodynamics; systems and controls; materials, manufacturing, and fatigue; design codes; advanced component testing; university research; and distributed wind applications.

Significant progress was made in the applied research effort in several important areas. One area focuses on understanding the interaction between the large rotors on low wind-speed turbines operating an atmospheric phenomenon known as the low-level nocturnal jet. The nocturnal jet is a poorly understood phenomenon that occurs in the Great Plains at night as cooling allows high-level, high-velocity winds to dip close to the Earth's surface, creating violently turbulent wind regimes. Because it typically occurs at heights of 60 m to 400 m above the ground, the wind shears that occur below the jet may interact with the top portions of the turbine rotor disk -- dramatically increasing structural loads, but possibly also increasing energy production, especially during the summer.

Work continued on the National Wind Technology Center's 600-kW Controls Advanced Research Turbine (see IEA Wind Energy Annual Report for 2001) to develop control systems and approaches that improve energy capture, reduce extreme and fatigue loads, and mitigate noise. In 2002, the program collected detailed inflow and turbine data on relevant turbine parameters necessary for use as control inputs.

Other important applied research advances were made in the development and validation of models of the wind inflow and loads analysis techniques to characterize the rate of occurrence, magnitude, and sequencing of the entire spectrum of loads-producing events. In another effort responding to requests by the wind industry, several upgrades are being made to the current suite of design tools supported by the program, including the AeroDyn library of aerodynamics routines to improve the generalized dynamic wake model.

Turbine Research

Emphasis in this element is on developing new, low wind-speed turbine technology. The program encompasses four areas, as follows.

- Next-generation turbine.
- Low wind-speed technology.
- Wind partnerships for advanced component technology (WindPACT).
- Distributed wind technology

Next-generation turbine development projects with industry are nearing completion. GE Wind Energy has installed more than 1,000 of its 1.5-MW turbines worldwide, with several hundred units operating in the United States. This turbine is undergoing further development and testing to improve

and verify the design for lower wind-speed sites. The Wind Turbine Company (WTC) is developing a 500-kW turbine prototype under a next-generation turbine project, which is continuing extensive field testing in California. This turbine's flexible, hinged-rotor design has the potential to significantly reduce component weight and cost.

The low wind-speed technology project is assisting U.S. industry in developing advanced, cost-effective, low wind-speed turbines with a cost goal of 0.03/kWh USD in 5.8 m/s winds by 2012. During 2002, the first awards were made to companies under this program in three technical areas: conceptual design studies, component development, and full-scale prototype turbine development. Six development projects were selected through a competitive solicitation with industry, and these multi-year cost-shared efforts will commence in 2003.

Expected improvements from the low wind-speed research include advanced rotors and controls (flexible, low-solidity, higher-speed, hybrid carbon-glass, and advanced and innovative designs); advanced drive trains (hybrid drive trains with low-speed permanent magnet generators and other innovative designs); new tower concepts (taller, modular, field-assembled, load feedback control); improved availability and reduced losses (better controls, siting, and improved availability); manufacturing improvements (new manufacturing methods, volume production, and learning effects); and site-tailored designs.

Concept studies being pursued include independent blade pitch control strategies and tall hybrid steel-concrete wind turbine towers. Component development activities include a direct-drive permanent magnet generator; an advanced power conversion system designed for use as a subsystem in multi-megawatt-scale direct-drive, permanent magnet turbines; and a 100-m telescoping, tubular, steel monopole tower.

Prototype turbine development by Clipper Windpower on its 2.5-MW Quantum turbine includes a multiple drive train consisting of a single-stage gearbox driving multiple generators. The turbine design also incorporates advanced controls and a self-erecting tower.

The program is also supporting a research effort by GE Wind Energy to develop a 3.6-MW to 5-MW prototype turbine targeting land-based, low wind-speed sites. GE Wind Energy is currently testing a 3.6-MW prototype turbine in Spain that is designed specifically for offshore applications.

Under the WindPACT effort, studies have been completed on composite blades, turbine rotor and blade logistics, self-erecting tower and nacelle feasibility, balance of station costs, turbine rotor designs, and blade systems designs. In addition, WindPACT is sponsoring hardware development efforts that include a 1.5-MW drive train using a

Figure 21.6 Northern Power Systems' 100-kW cold weather turbine undergoing field tests at the National Wind Technology Center in Colorado and operational tests in Kotzebue, Alaska

single-stage gearbox with a medium-speed permanent magnet generator and an innovative power conversion system, a 1.5-MW direct-drive permanent magnet drive train, and advanced carbon-fiber blade designs.

Under the distributed wind technology area, Southwest Windpower is pursuing a 1.5-kW turbine design that would be mass-produced in ways similar to those used by the household appliance industry. Bergey Windpower continued to test its 50-kW prototype furling wind turbine design for distributed generation applications. Northern Power Systems completed the development of a direct-drive 100-kW turbine designed specifically for cold climates. The first prototype turbine is being field tested for certification at the National Wind Technology Center in Colorado (see Figure 21.6). A second unit was installed in Kotzebue, Alaska, in May 2002, and has performed well in field performance verification tests.

Cooperative Research and Testing

Cooperative research and testing activities address opportunities and barriers to the use of wind energy. Under this element of the program, researchers work with industry partners and utility system stakeholders to help remove market and institutional barriers to wind turbine deployment. Sponsored efforts include electrical system integration studies on voltage stability, power regulation, and other performance issues; turbine field

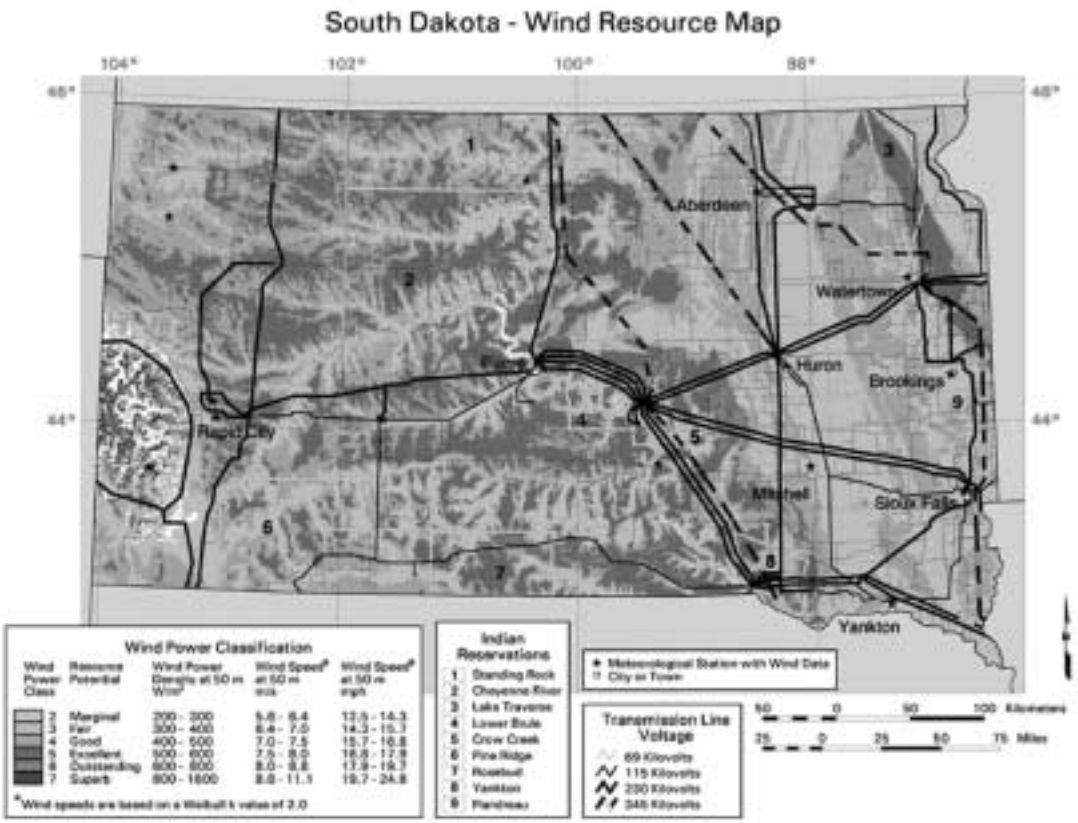

Figure 21.7 Wind resource map of South Dakota with 1-km resolution and overlay of power transmission system maps of most other parts of the country are available through the National Renewable Energy Laboratory at www.eere.energy.gov/windpoweringamerica

verification projects; and support for turbine certification testing and standards development.

New, high-resolution wind resource mapping is being done through cooperative efforts with the states. These maps are based on improved atmospheric flow models and have resource estimates with 1 km resolution compared with about 25 km in prior wind atlases dating back to the 1980s. Overlays showing power lines and key geographic features are shown on the wind maps. (See Figure 21.7.)

The Wind Powering America outreach activity continues to focus on reaching a broad base of stakeholder groups to help overcome informational and institutional barriers to wind's greater use. States are an important focus of this effort because of the important role that state policy can play in facilitating deployment. Important stakeholder groups being targeted include farmers and Native Americans because of the potential for wind to contribute to local economic development. This outreach effort is also targeting U.S. governmental entities, to increase the rate at which the government uses wind-produced electricity.

Offshore Siting

During the past year, there has been increasing interest in offshore wind energy development along the east coast of the United States. Developers have recognized the resource potential of offshore locations, combined with the value of locating projects near the urban load centers. As a result, numerous permit applications have been submitted for commercial projects in the relatively shallow waters located within 12 miles of the east coast. Several offshore wind projects have entered the permitting and wind resource measurement stage of development. In addition to the Cape Wind project mentioned previously, Long Island Power Authority has invited proposals for an offshore wind plant located along the south shore of Long Island in New York state. It is seeking an experienced developer to build, own, operate, and maintain a plant consisting of 25 to 50 offshore wind turbines that would produce approximately 100 MW to 140 MW and that could be operational by late 2007.

Despite the growing interest, several important issues are slowing offshore wind project development. Technical issues relate to the water depths along the continental shelf and sea conditions in the exposed North Atlantic. In addition, concerns from local residents focus on environmental issues, namely possible impacts on navigation safety, noise, fishing and recreation, birds, and visual impact. DOE is assessing possible efforts aimed at better understanding the technical, environmental, and regulatory issues affecting offshore installations; assessing the R&D needs for offshore wind technology; and expanding offshore wind resource assessment and mapping in shallow and deep water.

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