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5.8.6 Wind Energy

Wind energy may be the biggest success story in the arena of alternative or renewable energy systems. Worldwide, wind energy capacity more than tripled over the past 10 years to exceed 10,000 MW by the end of 1999. About 2,500 MW of that capacity is installed in the United States. Over the past 20 years, the cost of producing wind energy has come down from 40 cents per kWh to approximately 3 to 5 cents per kWh for bulk power. The National Renewable Energy Laboratory's National Wind Technology Center (NWTC), located near Boulder, Colorado, supports the research and development of wind energy through a collaborative effort among industry, utilities, environmental groups, and others. NREL researchers predict that near-future design improvements will lower production costs to as little as 2.5 cents per kWh, making wind energy cost-competitive with conventional fuels. Many people are forecasting that wind energy will be the cheapest electricity available from any source within the next 10 to 15 years.

Opportunities

In mid-1999, the U.S. Government made a firm commitment to:

- Use wind power to supply at least 5% of the nation's electricity needs by the year 2020;
- Double the number of states that have more than 20 MW of wind capacity by 2005; and
- Increase to 5% the Federal Government's use of wind-generated electricity by 2010.

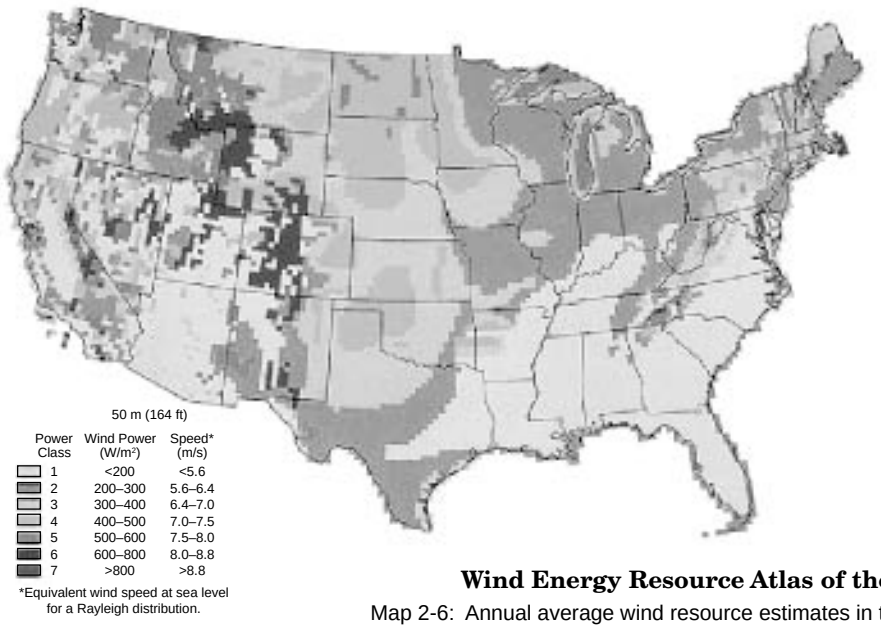
Today's wind turbines are versatile, modular sources of electricity. Small turbines—500 watts to 100 kW—can supply enough electricity to power remote sites, small homes, or business. Large, utility-scale turbines—250 kW and larger—can provide enough electricity to power hundreds of homes and businesses.

Wind energy may be an excellent choice for providing power to facilities if:

- Renewable energy incentives (rebates, tax credits, etc.) are offered;
- The power producer can participate in a production tax credit for renewable energy, established under the Energy Policy Act of 1992;
- Net metering is available in the state or utility district;
- Electricity costs in the area exceed 8 to 12 cents per kWh;
- Diesel or other fossil fuels have to be transported to the site for remote power production;
- The facility is not in compliance with air-pollution regulations; or
- The facility is attempting to meet clean energy goals.

Technical Information

Since earliest recorded history, wind power has been used to move ships, grind grain, and pump water. Today, wind power is also being used to provide electricity to homes, schools, businesses, and entire communities.



Wind Energy Resource Atlas of the United States

Map 2-6: Annual average wind resource estimates in the contiguous United States.

A year of data collection may be necessary to obtain accurate information on wind speeds in a given location or to increase the confidence level in wind data before beginning a project. Equipment to accomplish this can be installed in one day and costs $1,500 to $3,000. FEMP also has a CD-ROM containing wind speeds throughout the United States.

This 6-MW wind farm at Searsburg, Vermont, provides emission-free, renewable energy to more than 2,000 households. This installation was funded by the DOE Turbine Development Program. Photo: Green Mountain Power Corp.

More than half the United States has wind resources that could support the development of utility-scale wind power plants, and most states have enough wind to at least support small-scale wind systems. An annual average wind speed in excess of 8 miles per hour (12.9 km/h) is required for small-scale systems to be economical, and annual average wind speeds of at least 11.5 to 12.5 miles per hour (18.5 to 20 km/h) are required for utility-scale turbines.

The power available from wind is proportional to the cube of its speed. At double the wind speed, power generated increases by a factor of 8. Therefore, a wind turbine operating in 11.8 mph (19 km/h) wind can generate 29% more electricity than one operating in 11.2 mph (18 km/h) wind.

Most wind turbines are horizontal-axis machines, with turning blades that resemble propellers. Utility-scale turbines are often grouped together to form a single wind power plant, or *wind farm*, to generate bulk electrical power. Wind turbines are available in a variety of sizes and power ratings. A small home-sized wind machine has blades between 3 and 25 feet (0.9–7.6 m) in diameter and stands upwards of 30 feet (9 m) high. The largest machine stands 20 stories high and has blades that span the length of a football field.

Approximately 50 acres (20 hectares) of land are required per MW for each utility-scale turbine. However, much of the land is actually unoccupied and can be used for farming, ranching, and other activities.

Hybrid wind/diesel systems that combine a wind turbine with a diesel generator provide reliable, economical power. A more sophisticated hybrid system combining wind turbines, photovoltaic (solar electric) panels, and diesel generators provides backup power during low-wind periods, has the ability to supply peak loads under any conditions, and has lower diesel fuel consumption than simpler wind/diesel systems.

Wind energy systems help the U.S. economy by avoiding the external or societal costs associated with conventional energy sources—namely, the trade deficit from importing foreign oil and other fuels, the health and environmental costs of pollution, and the cost of depleted resources. Wind energy is a reliable domestic resource that provides more jobs per dollar invested than any other conventional power technology—more than five times that from coal or nuclear power. Wind turbine and component manufacturers contribute directly to the economies of most states, creating thousands of jobs for Americans.

A wind energy production tax credit was established under the Energy Policy Act of 1992 as a means of stimulating wind energy development and making wind energy more competitive with conventional energy sources. The tax credit amounts to 1.5 cents per kWh (adjusted for inflation) for electricity produced using wind resources. It therefore rewards actual electricity generation, rather than equipment installation, and is an important factor in setting the price of long-term wind energy contracts. The credit applies to the first 10 years of production for wind turbines installed between December 31, 1993, and December 31, 2001.

The downsides of wind-turbine-generated electricity include negative visual impacts and occasional bird fatalities. Efforts are being made to mitigate both of these effects. Using turbines of the same size with uniform spacing and analyzing visual impacts with computer simulations can greatly improve the appearance of a wind farm. The National Audubon Society and others are working with the American Wind Energy Association, DOE, and NREL to minimize bird fatalities.

Although wind turbines generate some noise, a 300 kW turbine creates only 45 dB of noise at a distance of about 650 feet (200 m). This noise is usually masked completely by background noise or the natural sound of the wind.

Contacts

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Wind Program, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy; www.eren.doe.gov/wind/.

Wind Powering America, U.S. Department of Energy; www.eren.doe.gov/windpoweringamerica/.