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The following is a status report on the development of wind energy in the USA at the end of 2004 by Paul Gipe.

United States of America

Country Description

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USA Total	9,631,418	sq km
Alaska	1,530,693	sq km
USA Lower 48 (w/o Alaska)	8,100,725	sq km
Population	295,734,134	
Population Density Lower 48	36.5	persons/sq km

Electrical Energy Sector

USA Total Electricity Generation	3,883	TWh	
USA Total Generating Capacity	948,446	MW	
Coal	483,707	MW	51%
Nuclear	189,689	MW	20%
Natural Gas	161,236	MW	17%
Hydro	66,391	MW	7%
Oil	28,453	MW	3%
Other	28,453	MW	3%

Installed Wind Capacity (2004)

There is nearly 6,600 MW of wind generating capacity operational in the USA. Much of it is located in California, Texas, and other Western states. There are, however, commercial-scale wind turbines and wind power plants operating in many of the 50 states. Small wind turbines can be found in all states in applications either off-the-grid or interconnected with the grid.

Wind Energy Resource Assessments

In the late 1970s the Department of Energy directed Battelle Pacific Northwest Laboratory to assess the nation's wind-electric generation potential. The results were published in 1981. In the mid 1980s Battelle updated their earlier data with data from additional resources. The results of the revised assessment were published in 1986.

As a pioneer in national wind resource assessment, Battelle used a system of wind power classes to characterize wind resources. The classes are a shorthand for wind speed and power density at various heights above the ground. Battelle's wind resource work was eventually merged with that of the National Renewable Energy Laboratory (NREL).

In the early 1990s researchers at NREL, using Battelle's most recent Wind Resource Atlases, sorted regions by their resources and land uses. With expected advancements

in wind turbine technology, Battelle found that wind turbines could theoretically generate twice the then total consumption of electricity in the United States.

After excluding all land area with potential conflicts, NREL estimated that there is 45,000 square kilometers of land suitable for wind development or less than 0.6% of contiguous U.S. land area (that is, the lower 48 states). Based on this data NREL estimates that the United States could produce 700 TWh per year from more than 300,000 MW of wind capacity. This is enough capacity to generate 27% of total 1990 electricity consumption and nearly 10% of the total U.S. energy consumption.

Beginning in the late 1990s NREL began re-evaluating the wind resources in the USA and other countries using modern digital technology. Several states, notably Minnesota, Texas, and Wisconsin, began their own resource assessments. Private companies also began generating state wind resources maps. Much of the USA has since been re-mapped in more detail using ground truthing of digitally created wind maps.

Electrical Energy Markets

The electricity market in the USA is complex. Electricity is regulated by the states, however, the Federal Energy Regulatory Commission has jurisdiction over certain matters. To further complicate the situation, municipal utilities and rural electric cooperatives are not regulated in some states.

In most states, there is a mix of privately-owned electric utilities (IOUs or Investor-Owned Utilities), municipally-owned utilities, and rural electric cooperatives. Federally-owned power marketing agencies, such as the Bonneville Power Administration and the Tennessee Valley Authority, dominate some regions (the Pacific Northwest and the central Appalachians). Most electricity is generated, transmitted, and sold by privately-owned companies.

In the early 1990s so-called market liberalization (restructuring in American political jargon) began being introduced in state legislatures by Independent Power Producers such as Enron as well as by the electric utility industry itself. Beginning in California, deregulation swept the country. The onset of California's power crisis, due in large part to utility deregulation, derailed further liberalization. Some states have since returned to cost-of-service rate making.

The U.S. Congress also exercises authority over the electricity market and in 1978 passed the landmark Public Utility Regulatory Policies Act or PURPA. This law revolutionized the power market in the country. PURPA required utilities to permit independent power producers to connect to their lines and to pay for the electricity that was delivered. Unlike Germany's *Stromeinspeisungsgesetz*, PURPA did not specify the price only a method for determining the price. This weakness required lengthy and often unsuccessful regulatory proceedings aimed at defining the price in each state.

California was one of the first states to do so and coupled with generous federal and state tax subsidies spurred the rapid development of wind energy between 1981 and 1985.

Wind Energy Legislation

There is nearly a three decade history of state and federal legislation intended to foster renewable energy development in the USA.

Federal Programs

Most significantly, Congress has used its powers of the purse to either provide direct monetary subsidies for research and development, or tax subsidies for equipment installation. Early tax subsidies were directed at equipment capital subsidies and the abuses that this system permitted led to its abandonment with much negative fanfare in the first year of the Reagan administration.

Beginning in the late 1990s Congress introduced a tax subsidy on the production of wind-generated electricity. The availability, the expiration, and the hoped for extension of the Production Tax Credit (PTC) causes the boom and bust market that typifies wind development in the USA. Further, the PTC by its limitations has determined the shape of the wind industry in the USA and the dominance of electric utility subsidiaries, such as Florida Power & Light which alone manages nearly half of all wind-generating capacity in the country.

Congress also periodically directs federal agencies to use increasing amounts of renewable energy or otherwise aid private companies in developing wind energy. One example is the Department of Energy's Wind Powering America initiative which, among other tasks, has created Wind Working Groups in each state with a wind resource.

The single most significant federal action was passage of the Public Utility Regulatory Policies Act in 1978.

State Programs

States have periodically offered tax subsidies and other incentives for wind energy. Most notable is California and Minnesota. California offered generous tax subsidies in the early 1980s for renewable power development. The Golden State also ordered utilities to not only buy electricity from independent power generators but also directed utilities to set a price and offer standard contracts. The state's subsidies and the standard offer contracts launched the commercial wind industry in the country. By the end of 1985 nearly 1,500 MW of wind generating capacity had been installed and wind turbines in the state were producing nearly 2 TWh per year.

With electricity market liberalization, a number of states, including California, have

introduced Systems Benefit Funds or Public Goods Charges to provide a pool of money to subsidize renewable energy generation. These funds are derived from a fee on electricity sales and disbursement is often the purview of state legislatures. In addition a number of states have introduced Renewable Portfolio Standards (RPS). For most, the RPS is merely a target. However, RPS programs that are true to the market theory (or ideology) on which they are based, also include a renewable energy credit trading scheme.

Renewable Portfolio Standards in conjunction with the periodic renewal of the PTC have resulted in wind energy development booms in some states, most importantly Texas. Pennsylvania and New York are also seeing growth in wind development as a result of the introduction of RPS or more generally utility restructuring.

Wind Energy Projects

Project size has increased steadily. In 2004-2005 it is not uncommon for developers to begin construction on 150 MW to 200 MW projects comprising hundreds of multi-megawatt turbines. Texas has the most number of large projects. Cielo Wind Power's Llano Estacado Wind Ranch near White Deer, Texas is among the smaller projects at 80 MW. Florida Power & Light's King Mountain project is among the largest at 200 MW.

While project size remains more modest in states such as California with widely varying terrain, other states such as Oklahoma are seeing projects as large as 175 MW installed.

Installed Wind Capacity by State

	New Units	Total Units	MW	Total MW	GWh
Alaska	3	24	0	1	2,915
Arizona	0	1		0.66	1,452
Arkansas	0	1	0	0.108	0,216
California	72	12,049	72	2,070	3,401
Colorado	4	189	6	228	488
Hawaii		132	0	11	10
Illinois	1	65	1	71	141
Iowa	2	621	0	481	1,059
Kansas		173		114	227
Maine		2		0	0
Massachusetts	0	9	0	1	1
Michigan	0	3	0	2	5
Minnesota	23	687	33	580	1,455
Montana	0	5	0	0	1
Nebraska	0	12	0	14	31
New Mexico	62	200	61	267	452
Nevada	0	0	0	0	0
New York	0	41	0	50	101
North Dakota	0	35	0	67	146
Ohio	2	4	4	7	8
Oklahoma	0	113	0	176	353

Oregon	0	191	0	261	521
Pennsylvania	0	89	0	129	258
South Dakota		35		48	97
Tennessee	15	18	27	29	4
Texas	0	1,405	0	1,311	2,884
Utah	0	1	0	0	0
Vermont	0	12	0	6	13
Washington	0	319	0	242	532
West Virginia	0	44	0	66	145
Wisconsin	0	55	0	53	101
Wyoming	0	285	0	292	643
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Total	184	16,820	204	6,579	13,082

References

D. L. Elliott, L.L. Wendell, and G.L. Gower, "An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous United States," Battelle Pacific Northwest Laboratory, Richland, Washington, August, 1991.

Paul Gipe, Wind Energy Comes of Age, John Wiley & Sons, New York, 1995.

State wind resource maps are available at http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_maps.asp., visited June 10, 2005.

Statistics on historical development of wind in the USA are derived from the private collection of Paul Gipe and from the American Wind Energy Association at <http://www.awea.org/projects/index.html>, visited June 10, 2005.

Statistics on the electrical generating capacity of the USA are available from <http://www.eia.doe.gov/neic/quickfacts/quickelectric.htm>, visited June 10, 2005.