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THE ENERGY CHALLENGE

It's Free, Plentiful and Fickle

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Wind, almost everybody's best hope for big supplies of clean, affordable electricity, is turning out to have complications.

Engineers have cut the price of electricity derived from wind by about 80 percent in the last 20 years, setting up this renewable technology for a major share of the electricity market. But for all its promise, wind also generates a big problem: because it is unpredictable and often fails to blow when electricity is most needed, wind is not reliable enough to assure supplies for an electric grid that must be prepared to deliver power to everybody who wants it — even when it is in greatest demand.

In Texas, as in many other parts of the country, power companies are scrambling to build generating stations to meet growing peak demands, generally driven by air-conditioning for new homes and businesses. But power plants that run on coal or gas must "be built along with every megawatt of wind capacity," said William Bojorquez, director of system planning at the Electric Reliability Council of Texas.

The reason is that in Texas, and most of the United States, the hottest days are the least windy. As a result, wind turns out to be a good way to save fuel, but not a good way to avoid building plants that burn coal. A wind machine is a bit like a bicycle that a commuter keeps in the garage for sunny days. It saves gasoline, but the commuter has to own a car anyway.

Xcel Energy, which serves eight states from North Dakota to Texas and says it is the nation's largest retailer of wind energy, is eager to have more. Wind is "abundant and popular," said Richard C. Kelly, the chairman, president and chief executive, speaking at a recent conference on renewable energy.

But Frank P. Prager, managing director of environmental policy at the company, said that the higher the reliance on wind, the more an electricity transmission grid would need to keep conventional generators on standby — generally low-efficiency plants that run on natural gas and can be started and stopped quickly.

He said that in one of the states the company serves, Colorado, planners calculate that if wind machines reach 20 percent of total generating capacity, the cost of standby generators will reach $8 a megawatt-hour of wind. That is on top of a generating cost of $50 or $60 a megawatt-hour, after including a federal tax credit of $18 a megawatt-hour.

By contrast, electricity from a new coal plant currently costs in the range of $33 to $41 a megawatt-hour, according to experts. That price, however, would rise if the carbon dioxide produced in burning coal were

taxed, a distinct possibility over the life of a new coal plant. (A megawatt-hour is the amount of power that a large hospital or a Super Wal-Mart would use in an hour.)

Without major advances in ways to store large quantities of electricity or big changes in the way regional power grids are organized, wind may run up against its practical limits sooner than expected.

At a recent discussion of clean energy technologies held at General Electric's research center in Niskayuna, N.Y, Dan W. Reicher, a former assistant secretary of energy for conservation and renewable energy, predicted that renewables, led by wind, could reach 20 percent of demand in the next decade or two. President Bush has also said that wind could supply 20 percent of the nation's electricity.

But Mr. Reicher drew a quick response from James E. Rogers, chief executive of Cinergy, one of the nation's largest utilities, and chairman of the Edison Electric Institute, the industry's trade association. "I love his optimism," Mr. Rogers said. "But unfortunately, I have to deliver electricity every day."

Mr. Rogers said that wind and another big renewable source that is available only when nature cooperates, solar power, will be necessary because the government would eventually regulate carbon emissions from coal-fired power plants. He later said that his reply to Mr. Reicher had been a "cheap shot," but he and others are still wondering how much wind the nation can absorb.

General Electric, a major maker of wind machines, says that along with lowering the price for a megawatt-hour, engineers have made other improvements in wind machines. With better electronic controls, many of them now help stabilize voltage on the grid, and have been cured of their tendency to shut off when detecting a voltage fluctuation, a problem that can escalate into a blackout.

Juan de Bedout, manager of the electric power and propulsion systems lab at G.E., said this was more important now because wind machines had grown from a few hundred kilowatts to 1.5 gigawatts, and his company was exploring machines four times bigger than that. "That's ginormous," he said.

In many places, wind tends to blow best on winter nights, when demand is low. When it is available, power from wind always displaces the most expensive power plant in use at that moment. If wind blew in summer, it would displace expensive natural gas. But in periods of low demand, it is displacing cheap coal.

And in places where suppliers enter bids each day to supply power on the next day, on an hour-by-hour basis, wind is at a disadvantage. Wider use of wind requires the invention of a new kind of weather forecasting, according to the Electric Power Research Institute, a nonprofit consortium based in Palo Alto, Calif., sponsored by the utility industry and its suppliers. Rather than forecasting from temperature or rainfall, what is needed is a focus on almost minute-by-minute predictions of wind in small areas where the turbines are.

The economics of wind would change radically if the carbon dioxide emitted by coal were assigned a cash value, but in the United States it has none. Coal plants produce about a ton of carbon dioxide each megawatt hour, on average, so a price of $10 a ton would have a major impact on utility economics.

Another possibility is energy storage, although this presents other difficulties.

In May, Xcel and the Energy Department announced a research program to use surplus, off-peak electricity from wind to split water molecules into hydrogen and oxygen. The hydrogen could be burned or run through a fuel cell to make electricity when it was needed most. Xcel plans to invest $1.25 million, and the government $750,000. But storage imposes a high cost: about half the energy put into the system is lost.

The Electric Power Research Institute said that existing hydroelectric dams could be used as storage; they can increase and decrease their generation quickly, and each watt generated in a wind machine means water need not be run through the dam's turbines; it can be kept in storage, ready for use later, when it is most needed.

The institute listed another possibility, still in the exploratory stage: using surplus electricity made from wind to pump air, under pressure, into underground caverns. At peak hours, the compressed air could be withdrawn and injected into generators fired by natural gas. Natural-gas turbines usually compress their own air; compression from wind would cut gas consumption by 40 percent, the institute said.

That would help with an important goal, reducing consumption of natural gas, which is increasingly scarce and costly in North America. But not everyone is so sanguine that wind will do that.

Paul Wilkinson, vice president for policy analysis at the American Gas Association, the trade group for the utilities that deliver natural gas, said that wind, while helpful in making more gas available for home heating and industrial use, would still need a gas generator to back it up. And the units used as backup are generally chosen for low purchase price, not efficient use of fuel.

At the American Wind Energy Association, Robert E. Gramlich, the policy director, said that one solution would be to organize control of the electric grid into bigger geographic areas, so that a drop-off in wind in one place would be balanced by an increase somewhere else, reducing the need for conventional backup. That is among several changes the wind industry would like in the electric system; another is easier construction of new power lines, because many of the best wind sites are in prairies or mountain ranges far from where the electricity is needed.

A problem for new power lines is that they would be fully loaded for only some of the year, since the amount of energy that the average wind turbine produces over 12 months is equal to just 30 to 40 percent of the amount that would result from year-round operation at capacity. That number runs closer to 90 percent at a nuclear or coal plant.

Thus a 1,000-megawatt nuclear plant will produce nearly three times as much electricity as 1,000 megawatts of wind turbines. But operating costs at the wind farm are lower, and the fuel is, of course, free.