Wind Power – Clean AND Reliable

Can We Rely on Wind Power ?

Yes. Wind power is currently supplying 48 billion kilowatt-hours (kWh) of electricity annually in the U.S., powering the equivalent of over 4.5 million homes. Wind power is an important part of electric utility generation portfolios.

Yet some question whether wind power, being a variable resource (meaning it generates electricity when the wind is blowing) can be relied upon as part of a system that provides reliable electricity to consumers without interruption. Based on a growing body of analytical and operational experience, the answer is a resounding "yes".

According to many utilities and reliability authorities, wind power can readily be accommodated into electric system operations reliably and economically.

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Other resources

www.awea.org/utility

Utility Wind Integration Group, www.uwig.org

National Renewable Energy Laboratory, www.nrel.gov/wind/

American Wind Energy Association

High Wind Penetration and Reliable Operation

In Europe, Denmark receives over 20% of its electricity from wind energy, and in 2007 Germany received around 7% of its electricity from the wind. Both Spain and Portugal had periods in 2007 when wind energy provided over 20% of their electricity. In the U.S., Minnesota and Iowa both get close to 5% of their electricity from wind energy. These examples show that high penetrations of wind power can be a valuable part of a utility generation mix that supplies reliable electrical service to consumers without interruption.

Accommodating the Variable Nature of Wind Power

When wind energy output decreases, reliable electrical service is maintained by turning up the output of other generators on the electric power system. Electric utility companies serve as "system operators" which can be thought of as air traffic controllers of the power system. System operators can control, or dispatch, generators on their system such as natural gas-fired and hydroelectric generators. They have always actively dispatched their systems in response to electrical demand, or load, which varies randomly over the course of an hour or day. Wind energy output behaves similar to load in that it is "variable," meaning its output rises and falls within hourly and daily time periods; and it is "non-dispatchable," meaning its output can be controlled only to a limited extent. Reliable electrical service can be maintained by system operators dispatching generators up and down in response to variation in load and wind generation. System operators also keep generation in reserve, called "operating reserves," which can be called on in case of a shortfall.

According to Paul Bonavia, Chief Operating Officer of Xcel Energy, one of the nation's largest electric utility companies:

> "Wind energy is an integral piece of our power supply portfolio. It provides a hedge against fuel price volatility associated with other forms of electric generation. Our studies and experiences show that wind energy integrates effectively and reliably into our power systems with regional market operations to mitigate the impact of wind variability. In these cases even with 25 percent of the electricity on our system from wind we forecast cost for operating system reserves of approximately $5 per megawatt-hour, or roughly ten percent of the cost of the wind energy. As we gain experience with wind we keep seeking ways to achieve low integration costs."

Is Energy Storage Needed?

No, while it is natural to think that batteries or other storage systems might be needed to supply steady power, they are not needed to integrate wind energy into electric power systems. The power system essentially already has storage in the form of hydroelectric reservoirs, gas pipelines, gas storage facilities, and coal piles that can provide energy when needed. Storing electricity is currently significantly more expensive than using dispatchable generation. In the future, through advances in technologies such as batteries and compressed air, energy storage may become cost-effective. The prospect of plug-in hybrid electric vehicles holds great promise because the expense of their batteries would be covered by their fuel cost savings and they could provide many megawatts of storage for the overall electrical power system. This would also allow wind power and other renewable energy resources to displace consumption of foreign oil. Still, energy storage will best be used as a resource for the overall power system. It would not be cost effective or efficient to couple energy storage resources exclusively to individual wind plants.

Is wind less "reliable" than conventional generation?

No. Conventional resources occasionally shut down with no notice, and these "forced outages" require operating reserves. For example, a power system that has a 1000 Megawatt nuclear or coal plant will typically keep 1000 Megawatts of other generation available, to be ready to quickly supply electricity if a plant unexpectedly shuts down. The power system can still be operated perfectly reliably in this fashion. Thus, "reliability" is not specific to any single generation facility, rather it is measured on a system-wide basis. Because significant generation reserves are already required to accommodate unexpected changes in electricity supply and demand, in many regions large amounts of wind power can be added to the grid without increasing the total amount of reserves that are needed.

As noted by Jon Brekke, Vice President of Member Services for Great River Energy, a utility that operates in Minnesota and Wisconsin: "Wind energy is a valuable part of our diverse and growing energy portfolio. When partnered with other traditional generation resources, wind energy is an effective way to provide reliable, clean and affordable power to our member cooperatives. Geographic diversity of wind energy helps even out the variability of wind energy in the regional market. In addition, wind farms are typically made up of many individual turbines which reduce the impact of outages. For instance, there are 67 1.5 -MW turbines at our Trimont Wind Farm, so if one is down for maintenance only 1.5% of the total wind farm's generating capacity is lost."

Changes in wind energy output are not instantaneous, as are conventional generator failures. Because of the geographic diversity inherent with large numbers of wind turbine installations, it typically takes over an hour for even a rapid change in wind speeds to shut down a large amount of wind generation. This is a significant benefit when compared with the instantaneous forced outages of conventional units. In addition, wind forecasting tools that warn system operators of upcoming wind output variations are becoming widely used and better integrated into system operations.

What is the cost of wind integration?

When large amounts of wind energy are added to the grid, modest amounts of additional generation may be required to accommodate wind energy's variability. The exact costs of these incremental reserves depend on the mix of generation on a given system and various other factors, but they are generally quite small. In a document prepared by the Utility Wind Integration Group in coordination with the trade associations of all three utility sectors (investor-owned, public, and cooperative), the studies and experiences with utility wind integration are summarized as follows:

- ✓ "Wind resources have impacts that can be managed through proper plant interconnection, integration, transmission planning and system and market operations.
- ✓ System operating cost increases arising from wind variability and uncertainty amounted to only about 10% or less of the wholesale value of the wind energy.
- ✓ A variety of means – such as commercially available wind forecasting – can be employed to reduce these costs.
- ✓ In many cases, customer payments for electricity can be decreased when wind is added to the system, because the operating-cost increases are offset by savings from displacing fossil fuel generation."

See http://www.uwig.org/UWIGIntSummary.pdf for more information.