Restless Power of the Wind: Wind Electricity

Wind is an inexpensive source of electricity now - able to provide variable electricity at a levelized cost of ~5 cents per kWh[271].

Wind potential could provide virtually any amount of electricity we would need considering only class 5 and better wind power available year round[272]. Economically viable sources worldwide could supply many times world demand[273]; economically viable sources within the U.S. could supply several times U.S. demand[273].
Of course wind is a variable source (not intermittent – power curves from wind are fairly predictable – but variable). Further, most energy is consumed at a fair distance from areas where class 5 and higher winds blow all year round. (Constant high winds don't head most lists of preferred climates.) Even in those places the wind occasionally stops blowing.

The variable nature of wind is not as difficult to deal with as most people think. The problem with wind power without storage is that you need backups for when the wind does not blow - so you end up spending capital twice, once for the wind generator and once for the backup plant. But all power plants need some spinning and operating reserves. (Spinning reserves are reserves that are already on line or can come on line in less than a second – to compensate for failures where there is no notice. Operating reserves are off-line plants that can be brought on-line in a normal step by step manner for a planned or predicted reduction in production from another source.) There is a level of wind utilization at which operating and spinning reserves are no greater than those needed for any other source.

The DOE says that level is 10%. But studies, (and actual experience), suggests that that clever grid management can let you gain 20% of your power from wind and still not need a significant increase in spinning and operating reserves. If a large percent of your electricity is extremely reliable base generation - say hydroelectricity or geothermal energy, wind power without storage or extra backup may provide more than that[274].
But it turns out that wind could supply much higher percentages of a grid than previously realized if we used HVDC electric transmission lines to connect wind farms hundreds (or even thousands) of miles apart. Because wind tends to rise and fall at different locations at different times, low and no power periods grow shorter and less frequent. With sufficient interconnections, around a third of wind energy generated can compete with coal plants for baseload needs[275]. (Baseload is the demand for electricity a utility must meet all the time, as opposed to the additional loads the vary from hour to hour above that base.)

However we also need to consider than once you have all these interconnections, storage needs to turn a greater percent of power generated in into base or peak loads decreases. In March of 2006, Windtech International magazine published an article on Vehicle to Grid interconnection[276], which included a chart based on unpublished wind data from a study covering eight sites dispersed hundreds of kilometers apart[277]. It found that with such interconnected wind farms, most periods of low wind lasted three hours or fewer for the combination of interconnected farms (as opposed to a single farm). Thus the ability to store only a few hours worth of power would allow a much higher percent of power produced as firm or baseload capacity.

This still does not allow wind to meet demand above that consistent base; if you want to do that you would need to be able time shift some of your output by more than three hours. Ten hours of average production for the series of wind farms would seem a reasonable guess. At this point almost all the power produced could be used for base, load following, and even (to some extent) peak. That amount of reliability would let wind replace 80% or 90% of electrical use.

Average production for a wind generator represents about 30% maximum capacity. (That is: over the course of a year, a single generator will produce about 30% of the electricity it could create if it spun at maximum speed 24 hours per day.) So ten hours of average production represents three hours of peak production; and peak production is how capital expenditures for wind are measured. In other words, to calculate capital costs for the additional storage, we should price three hours of capacity compared to the power all the farms could produce if all the generators on all of them spun at maximum speed at the same time.

End Notes

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