The Low Benefit of Industrial Wind

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Driving the desire for industrial wind power is the conviction that its development is necessary to reduce the effects of fossil and/or nuclear fuel use. Thus the local impacts of large wind turbine installations are justified by a greater good of healthier air and water, reduction of global warming, and moving away from harmful mining and fuel wars. These are all without question important goals.

While the wind power industry tends to downplay its negative effects, many conservation groups call for careful siting and ongoing study to minimize them. There is debate, therefore, about the actual impacts, but there is none about the actual benefits. Even the most cautious of advocates do not doubt, for example, that "every kilowatt-hour generated by wind is a kilowatt-hour not generated by a dirty fuel."

That may be true for a small home turbine with substantial battery storage, but such a formula is, at best, overly simplistic for large turbines meant to supply the grid. The evidence from countries that already have a large proportion of wind power suggests that it has no effect on the use of other sources. This is not surprising when one learns how the grid works: A rise in wind power simply causes a thermal plant to switch from generation to standby, in which mode it continues to burn fuel.

Documents

"Impact of Wind Power Generation in Ireland on the Operation of Conventional Plant and the Economic Implications," ESB National Grid, February 2004, available at: www.eirgrid.com/EirGridPortal/uploads/Publications/Wind%20Impact%20Study%20-%20main%20report.pdf

This study by the Irish grid manager finds that the benefits of wind-generated power are small and that they decrease as more wind power is added to the system and as the system itself grew. Their model assumes that all energy produced from wind facilities would be used and did not consider output fluctuations within a time period of less than an hour.

They describe three problems that mitigate the benefits of wind power:

- large amount of extra energy required to start up thermal generators that would otherwise not have been turned off
- mechanical stresses of more frequent ramping of production levels up and down
- increased prices of energy necessary to pay for any lower usage of thermal plants.

They notice that there is very little possibility of closing any non-wind facilities, because their capacity would still be needed to respond to periods of peak demand. Wind plants add more capacity (requiring more infrastructure) with almost no reduction of non-wind capacity, the latter of which must be used more inefficiently than otherwise.

As for CO_2 reduction — the primary argument for wind-generated power — the study concludes,

> The cost of CO_2 abatement arising from using large levels of wind energy penetration appears high relative to other alternatives.

"Wind Report 2004," E.ON Netz, available at: www.eon-energie.de/bestellsystem/frameset_eng.php?choosenBu=eonenergie&choosenId=405

E.ON Netz manages the transmission grid in Schleswig-Holstein and Lower Saxony, about a third of Germany, hosting 6,250 MW of Germany's 14,250 MW installed wind-generating capacity at the end of 2003. The total production in their system was 8.5 TW-h, representing an average feed of 969 MW (15.5% of capacity).

> In order to cover electricity demands, traditional power station capacities must be maintained as so-called "shadow power stations" at a total level of more than 80% of the installed wind energy capacity [equal to a little more than the maximum historical wind power infeed]. ...

Half of the time, wind power infeed is less than two-thirds of its annual average. It is greater than its annual average only a third of the time. This power vs. time curve applies to all wind power facilities, whether their annual average output in relation to rated capacity is higher or lower. The 11-turbine facility in Searsburg, Vermont, produces no power at all more than a third of the time.

> The wind power infeed changes can occur in a relatively short time. ... On 19th November, the wind power infeed dropped very sharply – by 3,640 MW within six hours, with an average value of 10 MW per minute. ...
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> The experience of the past year has shown that whenever electricity consumption was comparatively high because of the weather, namely during cold wintry or hot summer periods, wind power plants could make only a minor contribution towards covering consumption. ...
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> The increased use of wind power in Germany has resulted in uncontrollable fluctuations occurring on the generation side due to the stochastic character of wind power infeed, thereby increasing the demands placed on control and bringing about rising grid costs.
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> The massive increase in the construction of new wind power plants in recent years has greatly increased the need for wind-related reserve capacity.

That is, wind power construction must be accompanied by construction of new conventional power plants.

"Danish Wind: Too Good to be True?" David J. White, *The Utilities Journal,* July 2004, available at: www.aweo.org/White-DenmarkTooGood.pdf

> Denmark has installed 3,100 MW of wind turbine capacity to date, which is in theory capable of generating 20% of the country's electricity demand. Of that capacity, 2,374 MW is located in western Denmark (Jutland and Funen). The statistic is misleading because it implies that 20% of Denmark's power is supplied continuously from its wind capacity, but the figure appears to be a promotional statistic rather than a factual representation of the supply pattern.
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> Jutland has cable connections to Norway, Sweden and Germany with a capacity of 2,750 MW. In other words, it has the means of exporting all of its wind production. The 2003 annual report of Eltra, the western Denmark transmission company, suggests an export figure of 84% of total wind production to these countries in 2003, with figures that ramped up rapidly over previous years as Denmark found that it could not absorb wind output into the domestic system."
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> There is no CO_2 saving in Danish exchange with Norway and Sweden because wind power only displaces CO_2-free generated power. When the power is consumed in Denmark itself, fluctuations in wind output have to be managed by the operation of fossil-fired capacity below optimum efficiency in order to stabilise the grid (ie, spinning reserve). Elsam, the Jutland power generator, stated as recently as May 27th at a meeting of the Danish Wind Energy Association with the Danish government that increasing wind power does not decrease CO_2 emissions. Ireland has drawn similar conclusions based on its experience that the rate of change of wind speed can drop faster than the rate at which fossil-fuelled capacity can be started up. Hence spinning reserve is essential, although it leads to a minimal CO_2 saving on the system. Innogy made the same observation about the operation of the UK system [D. Tolley, presentation to Institute of Mechanical Engineers, January 2003].
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> The result is that, while wind-generated power itself is CO_2-free, the saving to the whole power system is not proportional to the amount of fossil-fuelled power that it displaces. The operation of fossil-fired capacity as spinning reserve emits more CO_2/kWh than if the use of that plant were optimised, thus offsetting much of the benefit of wind.

Flemming Nissen, head of development, Elsam (operating 404 MW of wind power in Denmark), presentation to "Vind eller forsvind" conference, Copenhagen, May 27, 2004

> Increased development of wind turbines does not reduce Danish CO_2 emissions.

"Windfarms provide no useful electricity," Richard S. Courtney, presentation to conference of Groups Opposed to Windfarms in the UK, 2004, available at: www.aweo.org/windCourtney1.html

> A [thermal] power station takes days to start producing electricity from a cold start. ...
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> Electricity is wanted all the time but the demand for electricity varies from hour to hour, day to day, and month to month. The electricity grid has to match the supply of electricity to the demand for it at all times. This is difficult because power stations cannot be switched on and off as demand varies.

The problem of matching electricity supply to varying demand is overcome by operating power stations in three modes called "base load," "generation," and "spinning standby."

Some power stations operate all the time providing electricity to the grid, and they are said to provide "base load."

Other power stations also operate all the time but do not provide electricity all the time. They burn (or fission) their fuel to boil water and superheat the resulting steam which is fed to the steam turbines that are thus kept hot and spinning all the time. Of course, they emit all the emissions from use of their fuel all the time. But some of this time they dump heat from their cooling towers instead of generating electricity, and they are then said to be operating "spinning standby."

One or more power stations can be instantly switched from spinning standby to provide electricity to match an increase to demand for electricity. It is said to be operating 'generation' when it is providing electricity. Power stations are switched between spinning standby and generation as demand for electricity changes. ...

Windfarms only provide electricity when the wind is strong enough and not too strong. As they suddenly provide electricity when the wind changes, the grid operator must match this changed supply of electricity to the existing demand for electricity. This is achieved by switching a power station to spinning standby mode. That power station continues to operate in this mode so it can provide electricity when the windfarm stops supplying electricity because the wind has changed again.

Windfarms only force power stations to operate more spinning standby. They provide no useful electricity and make no reduction to emissions from power generation. Indeed, the windfarm is the cause of emissions from a power station operating spinning standby in support of the windfarm.

Summary

¶ The addition of industrial wind power, which is nondispatchable and varies according to the wind, requires corresponding addition of back-up conventional power, along with expansion of transmission capacity.

¶ Spinning standby power must be kept burning to cover the fluctuations of wind power. Thus, while wind power may displace generation of power from such plants, it does not displace the burning of fuel in them — the heat is simply diverted.

¶ The accommodation of wind power causes thermal plants to run less efficiently, adding to financial costs and increasing emissions.

The cost of big wind is the industrial development of rural and wild areas, which inarguably degrades rather than improves our common environment. That is impossible to justify if the benefits claimed by the industry's sales material are in fact an illusion.

Addendum

Why then do utilities generally support wind as a renewable power source? With the movement away from vehicles such as the Clean Air Act, which actually reduced emissions, to so-called market solutions such as renewable portfolio standards (RPS) with tradable "green credits," utilities must buy a specified proportion of their power from renewable sources or buy credits equal to their shortfall. As long as they can say that, for example, 20% of their power comes from wind, it doesn't matter if they're burning as much nonrenewable fuel as ever to back it up. Green credits are "generated" in addition to actual electricity. That is, they are a token of renewable energy already sold — an echo that is given as much value, or even more, than the real thing. So besides being required to buy renewable energy, utilities want to be a part of wind power development so they can share in the lucrative sale of the "green credits." Ironically, as analyses for New Jersey utilities and by the U.S. Energy Information Agency have shown, the only effect on emissions that an RPS might have is to drive down the cost of the credits that allow exceeding emissions caps or missing renewables targets.

This paper is available at: www.aweo.org/LowBenefit.pdf.

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