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Some Cautionary Thoughts about Wind

Posted by Gail the Actuary on June 1, 2009 - 9:57am
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This story has been edited to make it clearer that the analysis relates to US wind rather than European wind and to clarify the problem with excess generation at night. I also added an Item 10.

I think we think we know more about wind-power than we do. These are a few things that I have recently discovered about wind that make me think that plunging headlong into electricity is not necessarily a good idea. At this point, we don't seem to have a plan that does much more than address wind turbines themselves.

I should make it clear that this discussion relates to US wind power, not European wind power. Many of the issues directly or indirectly relate to the fact the US is facing a multi-faceted problem--lack of wind turbines, needed grid upgrades, and lack of electrical storage. In a time of financial problems, the price of such a big change makes it difficult to tackle all these problems on the necessary scale at once. If we only add wind turbines, and make minimal upgrades in storage and transmission, the change is still likely to still be expensive and will likely leave us with the need for large subsidies. Without extensive grid upgrades and electrical storage changes, wind generated electricity will continue to play only a supporting role, acting mostly as a fuel substitute.

Europe has been dealing with this issue longer and has better addressed the wind transmission and storage issue, so it is in better shape in this regard. Jerome Guillet has prepared a write-up focusing more on the European perspective.

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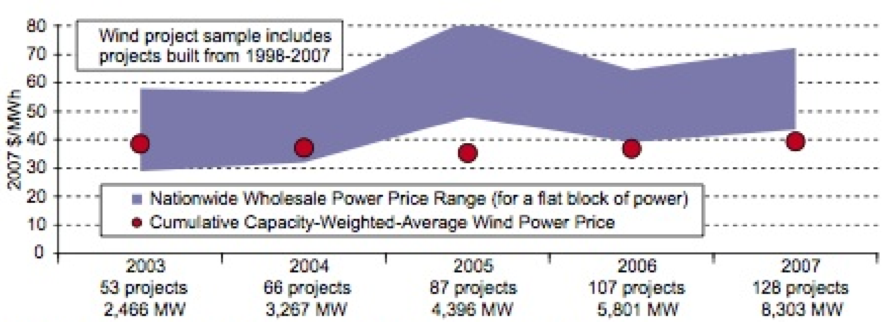
1. Without mandates or feed-in tariffs, the selling price for wind is generally lower than that for other wholesale electricity.

A Department of Energy publication shows this graphic:



Source: FERC 2006 and 2004 "State of the Market" reports, Berkeley Lab database, Ventyx.

Figure 17. Average Cumulative Wind and Wholesale Power Prices Over Time

The red dots indicate that on average, the selling price for wind had been between $35 and $40 per MWk. (This is equivalent to $.035 to $.040 per kWh, while the band of wholesale prices of electricity has floated above it).

2. Sometimes the selling price of wind is even negative.

There are times when there is an oversupply of electricity. Often, this is as night, because usage is lower at that time, and base generation is not easily reduced. Adding wind can provide at night can provide more electricity than is needed.

When there is an over-supply, there is a question of what to do with it. According to this article, the usual procedure in the past in West Texas was for grid operator to ask the wind farms to reduce production, to balance supply with demand. The wind farms objected to this procedure, and requested an economic solution.

The solution was negative rates. Wind farms are now *paying for* the privilege of dumping the wind-generated electricity on the grid. This occurred for 23% of the hours in April.

3. Wind substitutes not for *electricity*, but for the *fuels that power electrical generation* (coal and natural gas).

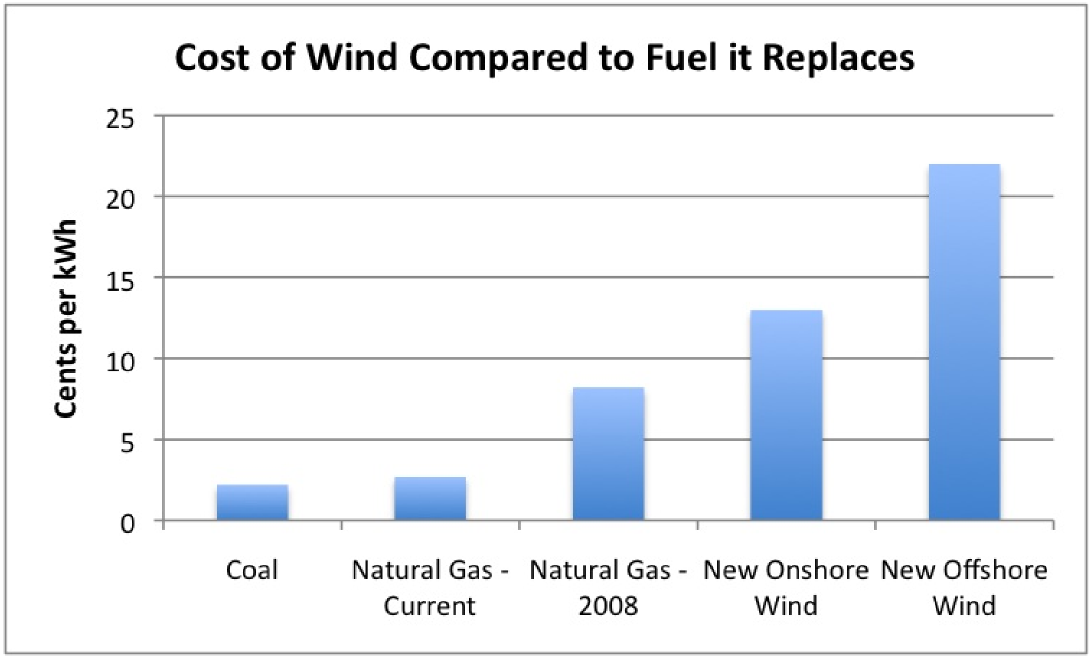
Chris Namoviz, who is in charge of renewable energy forecasting at the EIA, recently told me the following:

> Because of its relatively low “capacity value” (a result of usually not blowing very regularly during peak load hours), wind largely competes as a “fuel saver” resource, and can generally be compared against the fuel cost of what ever mix of fuel it is displacing (whether from existing capacity or from alternative investments in future capacity). In the U.S., this is typically some mix of relatively inexpensive coal and somewhat expensive natural gas, depending on the location of the wind plant, and the resulting seasonal/daily wind and load profiles (note that nuclear has relatively low operating costs, and typically does not act as a “marginal” or price-setting fuel). In gas-dominated regions like Texas, wind is relatively more competitive than in coal-dominated regions like the Mid-west, although recent growth patterns in the U.S. suggest a large role for state and Federal mandates and incentives as well.

The savings in fuel costs will vary. For 2008, the average cost of coal for electricity generation, including delivery costs, was $.022 per kWh, based on a calculation I made using EIA data. The average cost of delivered natural gas was $.082 per kWh in 2008, also based on EIA data. This year, natural gas prices are way down. One calculation by Oil Drum reader Steve Piper suggests that at current natural gas prices, the price of natural gas for electrical production may be under $.030 per kWh.

4. Currently, wind generated electricity, in the absence of subsidies, is much more expensive than the fossil fuels it is replacing.

According to this chart prepared by the Institute for Energy Reserach based on EIA forecasts, the expected levelized cost of wind in 2016 is expected to be about $.130 per kWh for onshore wind, and about $.220 per kWh for offshore wind. The amounts are in 2007 dollars, and without subsidies. I would expect costs of new production begun now would be not too different from this, because EIA is unlikely to be forecasting an increase in costs apart from inflation. (More likely, they are forecasting that costs will decrease, as we learn better to make wind turbines.)



The problem is that the price of wind is vastly higher than the price of the fuel it is replacing. With delivered coal and natural gas in the $.020 to $.030 range, while the cost of new wind production is $.130 to $.220 per kWh, new wind production is four to ten times as expensive as the cost of the fuel it is replacing.

5. At this time, it is not entirely clear that we need any new electrical production capacity.

Since mid 2008, the use of electricity in the US has been decreasing, but electric utilities made plans for new capacity, as if demand would be increasing. A similar situation is being reported around the world.

It is easy to think that a decrease in oil use could be offset by an increase in electricity use, but a pretty good argument can be also made in the other direction: a reduction in oil use may have such a squeezing impact on the economy, that electricity use declines as well. If fewer factories are operating, they use less electricity. If people are moving in with relatives, they use less electricity in the combined quarters. If they also are replacing light bulbs with CFLs, this reduces electrical use further.

The lack of growth in the use of electricity is another reason that the cost of new wind production is really comparable, at least in the short term, to the cost of the fuels it replaces.

6. The combination of low selling prices for wind and high cost of generation means that wind is likely to need large subsidies for years in the future.

Wind will be expensive, not just now, but when the price of fuel is several times what it is today. It is even possible that the price of fuel can completely bring down the economy, before wind-generated electricity becomes competitive with the fuel it replaces.

7. The cost of wind turbines depends a great deal on the financing available.

Because of the lack of cheap debt, the cost of wind may even be higher than what the EIA is forecasting.

Per hour of electricity generated, the up-front cost of wind is more expensive than the cost of nuclear energy. The following are approximate cost estimates per hour of annual electricity generated. These amounts are for 1 kW of generation throughout a year which equals 8,760 kWh:

> **Nuclear**: Costs about 3,000 to 4,000 euros per kW of capacity; operates at 90% of capacity; cost for 1.1 kW capacity would be **3,300 - 4,400 euros**
>
> **Onshore wind**: Costs about 1,500 euros per kW of capacity; operates at 30% of capacity; cost for 3.3 kW capacity would be **5,000 euros**
>
> **Offshore wind**: Costs about 3,000 euros per kW of capacity; operates at 40% of capacity; cost for 2.5 kW capacity would be **7,500 euros**

Financing these big amounts up front will be difficult, if debt financing is less available. Companies are not likely to want to part with equity for returns of 5% to 10%.

8. There are a lot of reasons that the EROI calculations may be misleadingly high.

Having looked at a few EROI calculations, I can see several issues:

a. When coal is transformed to electricity, there is a quality factor (of three to five) that the amount of energy is multiplied by to reflect the transformation to the higher quality fuel. In the wind EROI calculations, an "electricity in" -- "electricity out" calculation is used. I would argue that there should be a step-down factor, to correspond to the fact that the electricity from wind that is generated is of much lower quality than the electricity that went in. In fact, we are talking using wind-generated electricity as a substitute for coal.

b. There is a great deal of problem with the representations of manufacturers regarding how much wind turbines will generate, as a percentage of capacity, being vastly overstated. This is the abstract of a paper published this month in Energy Policy:

Capacity factor of wind power realized values vs. estimates
Nicolas Boccard, Departament d'Economia, Universitat de Girona, 17071 Girona, Spain

> For two decades now, the capacity factor of wind power measuring the average energy delivered has been assumed in the 30–35% range of the name plate capacity. Yet, the mean realized value for Europe over the last five years is below 21%; accordingly private cost is two-third higher and the reduction of carbon emissions is 40% less than previously expected. We document this discrepancy and offer rationalizations that emphasize the long term variations of wind speeds, the behavior of the wind power industry, political interference and the mode of finance. We conclude with the consequences of the capacity factor miscalculation and some policy recommendations.

c. Wind turbines evaluated in EROI studies are not necessarily representative of what one might find in this country. For example, if a wind turbine is manufactured in Brazil using electricity generated by burning sugar cane bagasse and by hydroelectric power, the EROI will be very high, because the sources of electricity use little fossil fuel. This is not representative of wind turbines being manufactured in the United States or Europe, however.

There are other issues as well. How does one handle the excess generating capacity at night (and some other times), when there is no use for it? It seems to me that if all of these issues are sorted out, EROIs for US and European produced wind turbines are likely under 10, and quite possibly under 5.

9. Wind-generated electricity cannot be used on a stand-alone basis to substitute for fossil fuel-generated electricity, without a lot of electrical storage.

Wind on a stand-alone basis does have uses. It can be used to pump water and probably to make nitrogen fertilizer. It can also be used to operate desalination plants.

I think some people have the idea in the backs of their minds that if other electrical generation fails, wind can substitute. This might be the case if a lot of electrical storage is built, and a lot of transmission lines, but I don't see it to be the case otherwise. Wind-generated electricity is just too variable. I don't think that the electrical transformers could stand having the electricity supply constantly turned on and off for very long. I am not sure our electrical appliances in homes and businesses would work very well either. If we really want an idea like this to work, we would need to plan for it very specifically, not just let it fall out accidentally as a by-product.

10. If we want to follow the European model, and upgrade the grid and add more storage, wind-generated electricity will act more like other electricity, but it will be a very big undertaking.

In a time of financial difficulty, it will be difficult to do whole job that would be needed. In many ways, this would be the ideal, but with limited resources, it is not clear that all of these things can be done simultaneously.

If all of these changes were made, one might argue that EROI calculations would not need a step down. But it seems like some of the energy expenditures related to the additional infrastructure should be charged back to wind in the EROI calculation.