Subsidizing CO_2 Emissions via Windpower: The Ultimate Irony

by Kent Hawkins

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SUBSIDIZING CO2 EMISSIONS VIA WINDPOWER: THE ULTIMATE IRONY

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It is the irony of ironies. Taxpayer and ratepayer-forced subsidies for utility-scale wind-power also subsidizes emissions of carbon dioxide (CO2). The same would be true under a national renewable portfolio standard as proposed in pending federal legislation.

Such is a vivid demonstration of the perils of *unintended consequences* and, to borrow a phrase, "an inconvenient truth" about wind power.

My recent four-part Wind Integration Realities reviewed two new studies, based on actual experience, that show fossil fuel consumption and CO_2 emissions are *increased, not reduced*, with the introduction of wind. Their results were compared as well as to those of my fossil fuel and CO_2 emissions calculator for the same conditions. The brief summary in Part IV of the series is expanded upon here for clarity of this game-changing argument.

In general, the studies show that as wind penetration increases, the effect on fossil fuel and CO_2 emissions worsens. Specifically, at wind penetrations of about 3% (as is the case in the Netherlands), the savings are zero. *At 5-6% (as for Colorado and Texas) the "savings" become negative, that is, emissions actually increase due to the presence of wind power.*

DETAILS OF THE THREE JURISDICTIONS STUDIED

The two studies, covering three jurisdictions, the Netherlands, Colorado and Texas, provide a good range of electricity system size and fuel mix, and wind implementation, penetration and capacity factor. In the Netherlands gas predominates, whereas in Colorado coal does. Texas shows approximately equal contribution between the two, with gas exceeding coal by about 30% when CHP (Combined Heat and Power) plants are included.

Table 1 is an expanded version of the table provided in Part IV, summarizing the important details and the results of the three analytical approaches used, which are:

- The le Pair and de Groot study for the Netherlands
- The Bentek Energy study for Colorado and Texas
- The results from my calculator for these jurisdictions.

TABLE 1 – SUMMARY OF THE THREE APPROACHES ANALYZED IN THIS SERIES

	The Netherlands (2007)	Bentek		Comments
		PSCO (Colorado - 2008)	ERCOT (Texas - 2009)	
Total Electricity Production	105 TWh	53 TWh	405 TWh	
Wind Capacity	1,570 MW	1,064 MW	9,410 MW	
Total Wind Production	3.4 TWh	3.2 TWh	18.7 TWh	
Wind Capacity Factor	25%	35%	23%	Calculated
Wind Penetration	3.2%	6%	5% **	Calculated
Percent Coal Production	27%	66%	36%	
Percent Gas Production	58%	23% *	29% **	
Wind Curtailment	?	Small?	Up to 36% of wind capacity daily	See Technical Appendix for more details on ERCOT
Efficiency Loss (Heat Rate Penalty) in Fossil Fuel Plant Fleet	2.11%	3.3%	3.3%	Calculated
Efficiency Loss (Heat Rate Penalty) in Wind Balancing Plants	25%	35%	20-25%	Calculated - ERCOT is adjusted as explained in Part IV.
Total Electricity CO_2 Emissions	42 mt/y***	42 mt/y	252 mt/y	DOE EIA
Netherlands Study				
Netherlands Study Fossil Fuel Increase	0%			
Calculator Fossil Fuel Increase (Saving)	(0.5%)-1.7%			The range shown is for two runs (1) CCGT cycling only, (2) CCGT/OCGT cycling
Calculator CO_2 Emissions Increase	0.8%			This is run (3) which includes some coal plants
Bentek Study				
Bentek CO_2 Emissions Increase		0.1-0.15 million tons/year	0-1.1 million tons/year	Coal cycling only
Calculator CO_2 Emissions Increase		0.11 million tons/year	0.8 million tons/year	Coal cycling only

*Includes non-utility suppliers (otherwise is 9%)
** Excludes CHP plants
*** Estimated, and likely low
Sources: Except as noted, the latest available data from DOE EIA (2008) and referenced studies (2007 for the Netherlands, and 2009 for ERCOT)

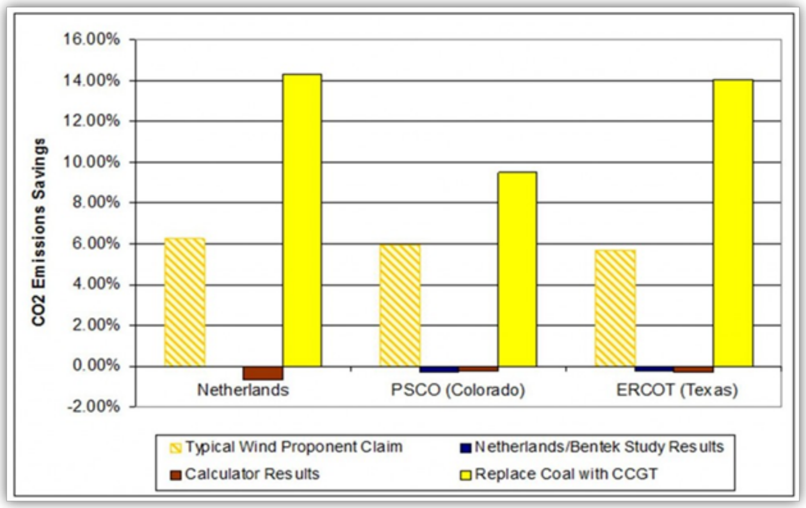
Figure 1 shows the CO_2 emissions savings based on two approaches to the replacement of a portion of the coal plants in all three jurisdictions.

1. Introduce wind plants, which produce no CO_2 emissions at the point of wind electricity generation.

2. Do not introduce wind and use efficient gas plants (CCGT) to replace coal production.

For comparison purposes, the wind plant capacity is used as a reference point. Wind production is based on the average wind production over a year. Production from other energy sources (coal and gas here) used in the comparison is the wind production at 100% of capacity minus the wind average over a year. This is a useful basis for comparison, because in real-time wind can vary over the full range of its capacity. The sum of these two is the coal plant production being displaced.

FIGURE 1 – COMPARISON OF RESULTS



The CO_2 emissions savings shown are percentages of the total emissions for the electricity system. Percentages will increase (further positively and negatively) for higher wind implementations, and in the case of replacing coal with gas for higher implementations of gas plants.

The four columns in each case represent:

- Column One – The typical wind proponent claim Their view is that the average wind production over time replaces the CO_2 emissions from the same production of the coal plant(s). This view ignores the loss in efficiency (resulting in increased fossil fuel consumption and CO_2 emissions) for the plants that are frequently cycled up and down to mirror wind's highly variable, real-time production. It is purposely shown as somewhat washed out because it is not realizable. Column two shows the reality. It is coincidental that all are at about 6% of total emissions and is due to the combination of the specific wind capacity factors and the proportion of coal and wind in each jurisdiction.

- Column Two – Study results This shows the results based on actual experience in the three jurisdictions studied. The Netherlands result is zero. The mid-points of the ranges for PSCO and ERCOT were used.

- Column Three – Calculator results

- Column Four – High efficiency gas plants only This shows the result of not implementing wind and using high efficiency gas plants to replace the same coal production. The variation in percentage reductions in column four is due to the underlying proportion of coal and gas. Colorado has the highest reliance on coal and CO_2 emissions are greater in proportion to the other two. As the result, the same level of reduction is less as a percentage.

No costs of CO_2 mitigation are calculated because at the wind penetrations studied (greater than 3%) there is no reduction.

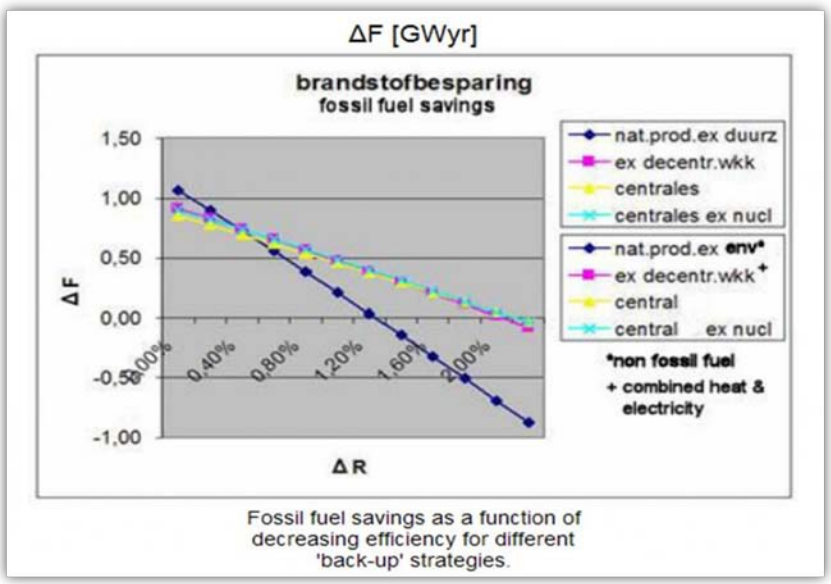
The two studies and calculator results demonstrate that claimed CO_2 emissions are not reduced, but are increased, with the introduction of wind plants, and a straight substitution of gas for coal production is a far superior strategy. This is by no means the last word, as all three analysis approaches call for comprehensive and objective studies, based on complete information, to confirm these findings.

TECHNICAL APPENDIX

Point of Zero Fossil Fuel and Emissions Savings

The Netherlands study shows that the point where CO_2 emissions overall become negative occurs at about 2% efficiency reduction across the fossil fuel fleet and corresponds to about 3% wind penetration. This is shown in Figure 2 which is reproduced from the Netherlands study. ΔF is the change in fossil fuel consumption and ΔR is the percent reduction in efficiency of the total fossil fuel fleet.

FIGURE 2 – RELATIONSHIP BETWEEN EFFICIENCY LOSS (ΔR) AND FOSSIL FUEL SAVINGS (ΔF)



If the wind proponents are right and ΔR is zero, then ΔF is approximately 1.00 GWy. Therefore the fossil fuel consumption of 18.45 GWy as shown in Table 2 of the Netherlands study would be 18.45-1.00 = 17.45 GWy. That is to say, in theory the introduction of wind saves 1.00 GWy, but at ΔR of 2% gives this back due to the inefficient operation of the fossil fuel plants. Therefore the typical wind proponent claim is that the 1.00 GWy would be saved and the percentage saving is about 1.00/17.45, or 5.7%. Compare this to the calculated wind proponent claim of 6.3% for the Netherlands in Figure 1.

However theoretically possible, this has been demonstrated by Colorado and Texas experience not to be the case. Further, increases in the efficiency loss for the fossil fuel fleet above 2% will result in increased fossil fuel consumption (negative ΔF), and hence CO_2 emissions, again as shown by the Colorado and Texas experience. Such increases in efficiency loss could be caused by:

- Increased wind penetration
- Increased wind volatility which may occur between jurisdictions and from year to year.

On the other hand decreases in efficiency loss could be caused by increased wind curtailment.

None of these considerations is supportive of the deployment of utility-scale wind plants, except in very small amounts, for whatever purpose that might serve.

ERCOT Wind Curtailment

Here is more detailed information on ERCOT wind curtailment as reported by the NREL:

Period	Curtailment	Wind Capacity
January to August 2008	Approximately 140-150 MW about 45-50% of the days	At end of 2007 – 4,400 MW At end of 1Q2008 – 5,300 MW At end of 2Q2008 – 6,200 MW
December 2008 to July 2009	Between 500 MW and 1,000 MW daily, and at times curtailing up to 3,000 MW daily	At end of 2008 – 7,200 MW 2009 – 9,410 MW

Sources for wind capacities: 2007-2008 – AWEA , 2009 – Bentek Energy

By mid-2009 (assuming the average of the year-end wind installations for 2008 and 2009) wind curtailment appears to be about 6-12% daily (500/8,420 and 1,000/8,420), and at times up to 36% daily (3,000/8,420). As wind curtailment is already widely used in Germany, and Texas has reached the same wind penetration, this is not surprising, and illustrates another "inconvenient truth" about utility-scale wind power. It is not clear why more curtailment is not reported for Colorado, given its stronger wind regime.

Source: http://www.masterresource.org/2010/06/subsidizing-co2-emissions/.

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