The Facts About Wind Energy and Emissions

By Michael Goggin, AWEA
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Anti-wind groups are attempting to defy the laws of physics with their claims.

Washington, DC, United States -- Recent data and analyses have made it clear that the emissions savings from adding wind energy to the grid are even larger than had been commonly thought. In addition to each kilowatt-hour (kWh) of wind energy directly offsetting a kWh that would have been produced by a fossil-fired power plant, new analyses show that wind plants further reduce emissions by forcing the most polluting and inflexible power plants offline and causing them to be replaced by more efficient and flexible types of generation.

At the same time, and in spite of the overwhelming evidence to the contrary, the fossil fuel industry has launched an increasingly desperate misinformation campaign to convince the American public that wind energy does not actually reduce carbon dioxide emissions. As a result, we feel compelled to set the record straight on the matter, once and for all.

Fossil Fuel's Desperate War against Facts

Not to be deterred by indisputable data, numerous refutations, or the laws of physics, the fossil fuel lobby has doubled down on their desperate effort to muddy the waters about one of the universally recognized and uncontestable benefits of wind energy: that it reduces the use of fossil fuels as well as the emissions and other environmental damage associated with producing and using these fuels.

For those who have not been following this misinformation campaign by the fossil fuel industry, here is a brief synopsis. Back in March 2010, AWEA heard public reports that the Independent Petroleum Association of Mountain States (IPAMS), a lobby group representing the oil and natural gas industry, was working on a report that would attempt to claim that adding wind energy to the grid had somehow increased power plant emissions in Colorado.

Perplexed at how anyone would attempt to make that claim, AWEA decided to take a look at the relevant data, namely the U.S. Department of Energy's data tracking emissions from Colorado's power plants over time. The government's data, reproduced in the table below, show that as wind energy jumped from providing 2.5% of Colorado's electricity in 2007 to 6.1% of the state's electricity in 2008, carbon dioxide emissions fell by 4.4%, nitrogen oxide and sulfur dioxide emissions fell by 6%, coal use fell by 3% (571,000 tons), and electric-sector natural gas use fell by 14%. (Thorough DOE citations for each data point are listed here: [http://www.awea.org/newsroom/pdf/04_05_2010_Colorado_emissions_response.pdf]
Two conclusions were apparent from looking at this data: 1. the claim the fossil fuel

industry was planning to make had no basis in fact, and 2. the fossil industry was understandably frustrated that they were losing market share to wind energy.

Change in Colorado Power Plant Fossil Fuel Use and Emissions from 2007-2008, as Wind Jumped from Providing 2.5% to 6.1% of Colorado Electricity

CO2 emissions	SO2 emissions	NOx emissions	Coal use	Natural gas use
Down 4.4%	Down 6%	Down 6%	Down 3%	Down 14%

In early April, AWEA publicly presented this government data, and when the fossil fuel lobbyists released their report later that month it was greeted with the skepticism it deserved and largely ignored. Case closed, right? We thought so, too.

After the initial release of the report fell flat, the fossil fuel industry tried again a month later. John Andrews, founder of the Independence Institute, a group that has received hundreds of thousands of dollars in funding from the fossil fuel industry, penned an opinion article in the *Denver Post* [http://www.denverpost.com/andrews/ci_15081808] parroting the claims of the original report. Fortunately, Frank Prager, a vice president with Xcel Energy, the owner of the Colorado power plants in question, responded with an article entitled "Setting the record straight on wind energy" [http://www.denverpost.com/opinion/ci_15177817] that pointed out the flaws in the fossil industry's study and reconfirmed that wind in fact has significantly reduced fossil fuel use and emissions on their power system. Having been shot down twice, we thought that the fossil industry would surely put their report out to pasture.

Yet just a month later the report resurfaced, this time in Congressional testimony by the Institute for Energy Research, a DC-based group that receives a large amount of funding from many of the same fossil fuel companies that fund the Independence Institute. The group has continued trumpeting the report's myths at public events around the country and on their website, and these myths are now beginning to spread through the pro-fossil fuel blogosphere. In recent days, these myths have re-appeared in columns by Robert Bryce [http://online.wsj.com/article/SB10001424052748703792704575366700528078676.html], a senior fellow at the fossil-funded Manhattan Institute [http://www.awea.org/newsroom/pdf/07-02-10_Bryce_Book_Response.pdf].

The fossil fuel industry's desperate persistence and deep pockets make for a dangerous combination when it comes to distorting reality, so we'd like to once and for all clarify the facts about how wind energy reduces fossil fuel use and emissions.

The Truth about Wind and Emissions

The electricity produced by a wind plant must be matched by an equivalent decrease in electricity production at another power plant, as the laws of physics dictate that utility system operators must balance the total supply of electricity with the total demand for electricity at all times. Adding wind energy to the grid typically displaces output from the

power plant with the highest marginal operating cost that is online at that time, which is almost always a fossil-fired plant because of their high fuel costs. Wind energy is also occasionally used to reduce the output of hydroelectric dams, which can store water to be used later to replace more expensive fossil fuel generation.

Let's call this direct reduction in fossil fuel use and emissions Factor A. Factor A is by far the largest impact of adding wind energy to the power system, and the emissions reductions associated with Factor A are indisputable because they are dictated by the laws of physics.

In some instances, there may also be two other factors at play: a smaller one that can slightly increase emissions (let's call it Factor B), and a counteracting much larger one that, when netted with B, will further add to the emissions reductions achieved under Factor A (let's call this third one Factor C).

Factor B was discussed at length in an AWEA fact sheet (PDF) published several years ago [http://www.awea.org/pubs/factsheets/Backup_Power.pdf]. This factor accounts for the fact that, in some instances, reducing the output of a fossil-powered plant to respond to the addition of wind energy to the grid can cause a very small reduction in the efficiency of that fossil-fueled power plant. It is important to note that this reduction in efficiency is on a per-unit-of-output basis, so because total output from the fossil plant has decreased the net effect is to decrease emissions.

As a conservative hypothetical example, adding 100 MW of wind energy output to the grid might cause a fossil plant to go from producing 500 MW at 1000 pounds of CO2 per megawatt-hour (MWh) (250 tons of CO2 per hour) to producing 400 MW at 1010 pounds of CO2/MWh (202 tons of CO2 per hour), so the net impact on emissions from adding 100 MW of wind would be CO2 emissions reductions of 48 tons per hour. Unfortunately, fossil-funded groups have focused nearly all of their attention on Factor B, which in this example accounts for 2 tons, while completely ignoring the 50 tons of initial emissions reductions associated with Factor A. **(See Footnote 1.)** A conservative estimate is that the impact of Factor B is at most a few percent of the emissions reductions achieved through factor A.

Factor C is rarely included in discussions of wind's impact on the power system and emissions, but the impact of Factor C is far larger than that of Factor B, so that it completely negates any emissions increase associated with Factor B. Factor C is the decrease in emissions that occurs as utilities and grid operators respond to the addition of wind energy by decreasing their reliance on inflexible coal power plants and instead increase their use of more flexible – and less polluting – natural gas power plants. This occurs because coal plants are poorly suited for accommodating the incremental increase in overall power system variability associated with adding wind energy to the grid, while natural gas plants tend to be far more flexible. **(Footnote 2)**

To summarize, the net effect of Factors A, B, and C is to reduce emissions by even more than is directly offset from wind generation displacing fossil generation (Factor A).

Study after Study

Unsurprisingly, government studies and grid operator data show that this is exactly what has happened to the power system as wind energy has been added. A study by the National Renewable Energy Laboratory (NREL) released in January 2010 found drastic reductions in both fossil fuel use and carbon dioxide emissions as wind energy is added to the grid. The Eastern Wind Integration and Transmission Study (EWITS) used in-depth power system modeling to examine the impacts of integrating 20% or 30% wind power into the Eastern U.S. power grid.

The EWITS study [http://www.nrel.gov/wind/systemsintegration/ewits.html] found that carbon dioxide emissions would decrease by more than 25% in the 20% wind energy scenario and 37% in the 30% wind energy scenario, compared to a scenario in which our current generation mix was used to meet increasing electricity demand. The study also found that wind energy will drastically reduce coal generation, which declined by around 23% from the business-as-usual case to the 20% wind cases, and by 35% in the 30% wind case. These results were corroborated by the DOE's 2008 technical report, "20% Wind Energy by 2030," [http://www1.eere.energy.gov/windandhydro/wind_2030.html] which also found that obtaining 20% of the nation's electricity from wind energy would reduce carbon dioxide emissions by 25%.

The fact that this study found emissions savings to be even larger than the amount directly offset by adding wind energy is a powerful testament to the role of Factor C in producing bonus emissions savings. By running scenarios in which wind energy's variability and uncertainty were removed, NREL's EWITS study was able to determine that it was in fact these attributes of wind energy that were causing coal plants to be replaced by more flexible natural gas plants. (See page 174 of the study.)[http://www.nrel.gov/wind/systemsintegration/ewits.html]

As further evidence, four of the seven major independent grid operators in the U.S. have studied the emissions impact of adding wind energy to their power grids, and all four have found that adding wind energy drastically reduces emissions of carbon dioxide and other harmful pollutants. While the emissions savings depend somewhat on the existing share of coal-fired versus gas-fired generation in the region, as one would expect, it is impossible to dispute the findings of these four independent grid operators that adding wind energy to their grids has significantly reduced emissions. The results of these studies are summarized below.

Independent Grid Operators' Calculations of Wind's Emissions Savings

Grid Operator	Texas[12] (ERCOT)	Midwest[13] (MISO)	Mid-Atlantic[14] (PJM)	New England[15]
Pounds of CO2 saved per MWh of wind energy	1,241	1,277	1,628	1,036

It is even more difficult to argue with empirical Department of Energy data showing that emissions have decreased in lockstep as various states have added wind energy to their grids. In addition and in almost perfect parallel to the Colorado data presented earlier, DOE data for the state of Texas show the same lockstep decrease when wind was added to its grid. This directly contradicts the Independent Petroleum Association of Mountain States report when it attempts to claim that wind has not in fact decreased emissions in Texas.

Specifically, DOE data show that wind and other renewables' share of Texas's electric mix increased from 1.3% in 2005 to 4.4% in 2008, an increase in share of 3.1 percentage points. During that period, electric sector carbon dioxide emissions declined by 3.3%, even though electricity use actually increased by 2% during that time. Because of wind energy, the state of Texas was able to turn what would have been a carbon emissions increase into a decrease of 8,690,000 metric tons per year, equal to the emissions savings of taking around 1.5 million cars off the road.

A Time for Change

The fossil fuel industry's latest misinformation campaign is reminiscent of scenes that played out in Washington in previous decades, as tobacco company lobbyists and their paid "experts" stubbornly stood before Congress and insisted that there was no causal link between tobacco use and cancer, despite reams of government data and peer-reviewed studies to the contrary. It's time we enacted the strong policies we need to put our country's tremendous wind energy resources to use, creating jobs, protecting our environment, savings consumers money, and improving our energy security, even if it means leaving a few fossil fuel lobbyists behind.

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Footnotes:

1 Mr. Bryce's recent Wall Street Journal article [http://online.wsj.com/article/%20SB10001424052748703792704575366700528078676.html] is the most creative in its effort to exaggerate Factor B and downplay factor A. In his article, Bryce exclaims about the "94,000 more pounds of carbon dioxide" that the IPAMS study claimed were emitted in Colorado due to Factor B. To be clear, 94,000 pounds is equivalent to the far less impressive-sounding 47 tons of carbon dioxide, or the amount emitted annually on average by two U.S. citizens. Yet just a few paragraphs later, Mr. Bryce speaks dismissively when noting a DOE report that found that, on net, wind energy would "only" reduce carbon dioxide by 306 million tons (enough to offset the emissions of about 15 million U.S. citizens).

2 It is important to keep in mind that the supply of and demand for electricity on the power system have always been highly variable and uncertain, and that adding wind energy only marginally adds to that variability and uncertainty. Electric demand already varies greatly according to the weather and major fluctuations in power use at factories,

while electricity supply can drop by 1000 MW or more in a fraction of a second when a large coal or nuclear plant experiences a “forced outage” and goes offline unexpectedly, as they all do from time to time. In contrast, wind output changes slowly and often predictably.

[Editor's note: Footnotes 3-11 are embedded as links into the text above.]

Chart Footnotes:

12 Texas ERCOT Study (PDF):
http://www.ercot.com/content/news/presentations/2009/Carbon_Study_Report.pdf

13 Transmission Expansion Plan, Vision Exploratory Study, Midwest ISO (2006):
http://www.midwestiso.org/page/Expansion+Planning

14 Mid-Atlantic Study (PDF):
http://www.state.nj.us/dep/cleanair/hearings/pdf/09_potential_effects.pdf

15 New England Study (PDF):
http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/reports/2010/economicstudyreportfinal_022610.pdf

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