Evaluation of Wind Power Avoided Emissions Benefits

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It is a common belief that new wind power generation will displace coal and natural gas-fueled power plants and thereby avoid all their associated greenhouse gas (GHG) emissions such as carbon dioxide (C02), nitrous oxide (NOx) and sulfur dioxide (SO_2). These avoided emissions benefits have become a major factor in their gaining public support for siting wind projects and providing large governmental subsidies to offset wind's higher power production costs. Unfortunately, these environmental claims are built upon incorrect assumptions about how US environmental regulations actually work and the type of generation a given new wind project will displace.

Avoided air emissions benefits attributable to any given power project can be calculated as the simple difference in industry emissions between if a designated project is built versus the industry emissions if the project is not built. This simple calculation has been incorrectly done by several renewable project developers and their consultants. Their mistakes have led them to incorrectly claim large project avoid air emission benefits from building new wind facilities.

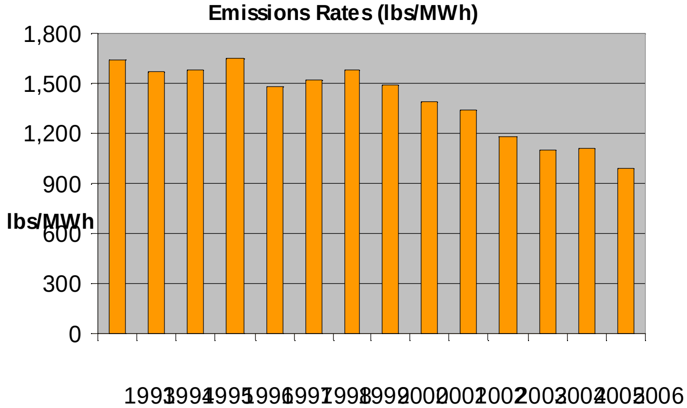
Any analysis of avoided air emissions benefits must first correctly account for existing environmental regulations and their impact on utility emissions. Much of the power industry's emissions are currently regulated under strict emission cap & trade programs. Under this framework, the government establishes an emissions tonnage cap that is enforced by issuing only the specified number of allowances that can be allocated and/or purchased by affected emission sources. All affected sources must hold sufficient allowances to cover their emissions of the regulated pollutant. Suppose a power provider is allocated credits to emit 1,000 TPY of a regulated pollutant. If they erect a wind project and assume it displaces 5 percent of fossil fuel generation, the displaced generator would not consume 50 TPY of their already-established emissions allowance. However, the source could transfer/sell the unused 50 TPY of credits to another power provider, enabling this entity to emit even more. *Therefore, any air pollutant subject to a cap & trade program may be displaced but **not** avoided*.

Currently, all powerplants in the lower 48 states are subject to an existing SO2 cap & trade program[i]. In addition, power plant NOx[ii] and CO2 emissions[iii] are also subject to existing and/or future regional cap & trade programs as shown in Exhibit 1 and 2. Therefore, no new Northeastern or Midwestern wind project can offer any incremental avoided emission benefit of CO2, NOx or SO2. If the Congress adopts a national CO2 cap & trade program as part of climate change legislation, wind projects may no longer claim any additional future incremental avoided CO2 emission benefit in the US.

Second, most studies advocating avoided emissions benefits from wind power incorrectly model the two cases (with and without the identified project). Two common mistakes are made.

(1) Most analyses compare a wind output's distribution over a prior historical year. The proper comparison is look at it over the period that the project will operate. Given that the generation mix is constantly changing with time, displaced units on the margin continue to get cleaner as stricter environmental requirements are adopted. This trend is illustrated by an annual analysis of marginal emission rates by the ISO New England to calculate benefits of energy efficiency measures (Exhibit 3). Therefore by selecting a historic year, one will tend to overestimate any displaced emissions.

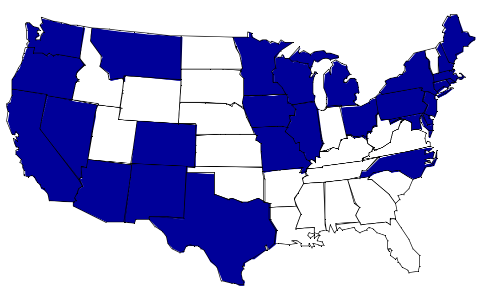
Exhibit 3
Calculated New England Generation C02 Marginal Emissions Rates (lbs/MWh)



Source: *2006 New England Marginal Emission Analysis* (Sept 2008) ISO New England Inc

(2) Developer analyses incorrectly calculate the baseline emissions (no project case). By selecting a historical year, the baseline has no new facilities so the wind project generation would be replaced with conventional fossil fuel generation sources. This assumption is incorrect for projects being built to meet a renewable portfolio standard such has been adopted in 28 states (Exhibit 4) or if a new national renewable portfolio standard is adopted by Congress.

Exhibit 4
28 States and the District of Columbia have adopted Renewable Portfolio Standards



Any analysis of wind power's potential for emissions displacement must begin with a distinction between the 28 states with Renewable Portfolio Standards (RPS) in place and those without it. RPS set aside a protected portion of the market that can be met by only qualifying renewable sources. As renewables are not yet competitive to compete in the open markets with fossil fuels, all wind projects currently being built are to meet this special set-aside market demand. In these states, the proper comparison is not to look at wind vs. coal or gas, but wind generation vs. other qualified renewable technologies competing for this special set-aside market (solar, biomass, geothermal or landfill gas, etc.) If wind were not used, utilities, in an effort to meet RPS goals, would replace it with another qualifying renewable resource. For these markets, displaced emissions for a given wind project will be the net difference between the project emissions (zero) and other competing renewable project (solar, wind, biomass, etc.) emissions (also zero[iv]). *Therefore, no avoided air emission benefit exists if wind generation displaces another renewable project generation to meet a state (or future national) renewable portfolio standard*.

Until a US carbon cap & trade program and/or a national renewable portfolio standard is adopted by Congress, only a few very selected areas remain in which wind could even compete in an open power market and create potential avoided CO2 emission benefits. In these few areas, new wind generation will displace highest incremental cost generation on the regional powerpool margin. This marginal generator constantly changes throughout the day due to continuing load fluctuations. This constantly changing market makes it extremely difficult to predict what resources would be displaced throughout a given year. Without use of a regional dispatch model in combination with the project generation profile, wind developer consultants make simplifying and often flawed assumptions. These assumptions often center on the displaced generation being either coal-fired generation or a weighted average regional blend of fossil fuel generation. Given that higher cost gas and oil can be on the margin, a weight average fossil fuel average that better reflects the dominant baseload generation resources (more heavily coal based) result in even overestimating displaced emission characteristics for their selected historical period (also an error as outlined above).

For example, Resource Systems Group's (RSG) July 2006 report for the DOE's Clean Energy/Air Quality Integration Initiative is indicative of much of flawed research that exists today regarding emissions displacement. In *Avoided Air Emissions from Electric Power Generation at Three Potential Wind Energy Projects in Virginia*[v], RSG uses 2004 EPA emissions data to analyze the aggregate avoid emissions of the three proposed wind projects in Virginia with a 160 MW capacity.

Since no site-specific data exists for the three Virginia plants, the report uses "typical performance data on comparable wind generation facilities" in the Appalachian Mountains, and determined differences there were marginal differences. Additionally, since hourly generation records from comparable fossil fuel plants are not available, the study constructs it using hourly CO2 emissions and the generation average CO2 emission rates per MWh, as reported to the EPA. The report's methodology compares typical hour by hour generation output of wind plants and fossil-fueled units in the Virginia power market. Hour-by-hour analysis proves difficult and inaccurate because the marginal generating unit changes frequently due to load fluctuations over the course of the day.

Despite the report's tendency to easily overlook the incompleteness and general inadequacy of its data, the authors leave little room for doubt in their conclusions. "When wind energy is available, it will displace generation at high operating cost fossil-fueled units." Unfortunately, their fossil fuel weighted average emission rate methodology to calculated displaced emissions does not reflect this observation. The paper simply states. "The emissions from those fossil fuel generating units are then avoided."

While wind energy may be able to displace some fossil fuel emissions, integrating it into your generation mix poses additional problems. Electrical grids require reliable power delivery to meet their grid reserve margins. Wind's intermittent and unreliable nature means it is unable to stand on its own. To compensate for wind's inadequacies, power providers are forced to build another more reliable back-up unit, usually gas-powered one, to make up for the drastic swings in wind energy output.

In *Cost and Quantity of Greenhouse Gas Emissions Avoided by Wind Generation*[vi], Peter Lang analyzes the challenges associated with using gas turbines as back-up units to meet the power shortages caused by wind's unpredictability. He details two classes of gas-powered turbines, Open cycle Gas Turbine (OCGT) and Combined Cycle Gas Turbine (CCGT) as best able to follow the load changes created by wind power. While OCGT may be well-suited to back up wind, doing so becomes more expensive and actually produces a negligible reduction in GHG emissions when compared to using a cleaner burning CCGT plant alone. "Because wind cannot be called up on demand, especially peak demand, installed wind generation does not reduce the amount of installed conventional capacity required," Lang states. "Wind is simply an additional capital investment."

To estimate wind's potential to displace emissions and its inherent costs, Lang compares CCGT plants vs. wind generation plus OCGT back-up. But for wind and OCGT to generate the same amount of power, it would only be 11% less carbon intensive and more than double the cost:

Technology	CF	Factor t C02/Mwh	Emissions t C02/Mwh	Rate$/MWh	Cost/MWH$/MWH
CCGT	45%		**0.577**		**$54**
OCGT	15%	0.751	0.250	$105	$35
Wind	30%	0.027	0.018	$90	$60
Backup for Wind	30%	0.376	0.250	$39	$26
Total Wind and OCGT	45%		**0.519**		**$121**

Finally, proponents who suggest that wind is able to entirely displace C02 overlook a fact fundamental to energy generation: wind's unpredictability means it is truly has no generating capacity value, and its construction will not displace building any new coal or natural gas generating capacity. Grid reserve margins require wind-back up, and the inefficiency of quickly firing up a natural gas unit to meet erratic wind generation output means any emissions displacement is minimal. Wind is simply an additional capital cost which proves to be more than twice as expensive for the ratepayer.

In summary, any analysis of wind power's potential to displace fossil fuel generation must first correctly reflect current environmental regulations. Any air pollutant subject to a cap & trade program (SO_2, NOx and regional CO_2) may be displaced but **not** avoided. Emission levels will remain at capped levels with or without wind project development. With the eventual implementation of a federal cap-and-trade regulating C02 emissions appearing likely, wind power will likely offer no future incremental greenhouse gas emission reduction benefit.

One must also distinguish between states with renewable portfolio standards and those states without them. Those competing in these special set aside protected markets are competing against other renewable projects and not in the open market against lower cost conventional power sources. In these states/regions, one must compare emissions between competing projects. In such closed markets the wind projects again can offer no incremental emissions benefits. Unfortunately, almost all of wind project's avoided air benefit claims are overstated.

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[i] Under Title IV of the 1990 Clean Air Act, Congress established a SO_2 cap & trade program for the electric power industry in the lower 48 states. This program implemented in 1995 has been subsequently modified by the EPA to lower allowable emissions in a 28 state region as part of its strategy to meet national ambient air quality standards for fine particulates.

[ii] Major fossil fuel fired stationary sources located within a 28 state region (See Exhibit 1) are subject to an annual cap & trade NOx program beginning in 2009 as part of EPA's program to control fine particulate air levels.

[iii] Major fossil fuel fired stationary sources located within the 10 state Regional Greenhouse Gas Initiative region became subject to a cap & trade program for greenhouse gas emissions starting in 2009. Similar programs are under development in the 6 state Midwest Greenhouse Gas accord and 7-state Western Climate Initiative. These regional programs are illustrated in Exhibit 2. States have also taken independent action and others are actively debating adopting CO_2 cap & trade programs to control greenhouse gas emissions.

[iv] Biomass combustion does emit CO_2. However, regulators consider that for closed loop biomass systems these CO_2 emissions are recycled CO_2 emissions of previously captured CO_2. Being a closed loop system means that the biomass was being grown and harvested as an energy crop.

[v] July 2006 RSG report available at: http://www.ert.net/pubs/VA-WindReportFINAL.pdf

[vi] Peter Lang Paper available at: http://www.windaction.org/documents/20052