How and Why Wind Power Works – The Scientific Facts

Last year, wind generated power in the United States was enough to supply 1.6 million families with their total electric power needs. **A single 750-kilowatt wind turbine operating for a year can be expected to displace 2.7 million pounds of carbon dioxide, 14,000 pounds of sulfur dioxide, and 8600 pounds of nitrogen oxides.** Yet opponents of wind power argue that wind power is a fraud because a) wind fails to produce significant power at economical rates, and b) wind power is unreliable. Let's consider these claims.

Wind energy is economical and competitive with fossil fuel generation. Wind turbines produce electric power by converting wind energy into rotation of turbine blades, which then turn a mechanical generator. With modern aerodynamic blades, this process is nearly 100% efficient for all wind speeds within designed wind speed range. Because wind speed varies, over, say a year's time, wind plants operate as an average around 30% of maximum rated capacity. That is their availability factor is around 30%. Depending on the site, some may have a much higher availability factor. Fossil fuel power generation is a two-step process. First, chemical energy is converted to heat (usually in the form of hot gas) through the combustion of hydrocarbon fuels. While the combustion itself is very efficient, conservation of matter requires that there be products of the combustion; a major product of combustion is carbon dioxide gas, a greenhouse gas. The second step is the extraction of the heat produced by combustion, and conversion of that heat into electrical energy. The conversion often is done by generating steam, and using steam turbines to run electric generators. This second step is accomplished at efficiencies of about 30% to 40%. (This is a limitation imposed by the Second Law of Thermodynamics.) **In effect, burning one pound of fossil fuel will result in about one pound of emission gas, but only 30% to 40% of the heat of combustion will actually be used to produce power; the rest of the heat is wasted.** Also, fossil fuel plants are subject to an availability factor because of maintenance, etc. This factor is around 80%. Both forms of power generation have a similar overall performance factor (efficiency times availability factor), and are economically competitive.

Misunderstandings about how electric power generation is managed have led opponents of wind power in recent letters to the flawed conclusion that because wind is variable, wind power is unreliable. What they fail to grasp is the fact that all electric power, regardless of the mode of its generation, is managed and distributed through regional networks or 'grids'. Power distribution is managed by control systems that employ highly complex mathematical algorithms to determine when and where to generate power in response to fluctuating demand. In fact, a very important **variable** in power generation is the variability of demand. as a component in a managed grid, wind generated power can be used whenever it is produced and, depending on the demand at the time, other power generating facilities in the grid can reduce their production. The grid management algorithms are very flexible and can be fine-tuned to adapt quickly as conditions change. On any given day, the power you use can be coming from a fossil fuel, hydroelectric, nuclear, or wind generator.

So, how does this help us understand the role of wind power? Simply this: While wind at any given location is variable, it is not by that fact, unreliable. Wind farms are sited at their locations only after several years of data have been collected to determine the pattern of variability**.** Not every windy place is a good candidate for investment in the development of a 'wind farm'- a system of wind turbines delivering electricity into a power grid. The details of what goes into site determination for such an installation can be found at the the US Dept. of Interior, Bureau of Land Management web site, http://www.windeis.anl.gov/documents/dpeis

Wind plants produce power but by converting kinetic energy of wind into power with no fuel cost; fossil fuel plants convert chemical energy into power but have high and unpredictable fuel cost, as well as producing waste heat and pollution. The wind plant can replace significant fossil fuel produced power with no fuel cost and no pollution. No one is claiming wind power will replace all fossil fuel power in the near future. The two forms of power generation are complimentary. The bottom line is that a wind plant is competitive with an

equivalent capacity fossil fuel plant, and can offset significant fossil fuel generated energy and do so with no fuel cost and no pollution. While there may be numerous reasons for concern about, and perhaps opposition to, a specific wind turbine site project, opposition based on attacking wind power in general is unlikely to be very credible. For information on the many technical aspects of wind power go to: http://www.windeis.anl.gov/documents/dpeis/