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SMALL TURBINE COLUMN:

The Environmental Benefits of Your Wind System

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Popular press articles and Web sites about the greenhouse gas emissions of various electrical generating technologies or electrical use by appliances often leave readers confused. Many such pieces are written by authors with either a paid or vested interest in getting a particular view across to the public. Other writers attempt to discredit those whom they see as the opposition—whether they are pro- or anti- on the subject of global climate change. Different sources cite wildly diverse numbers for the amount of carbon dioxide (CO_2) produced by a given coal-fired power plant. Who can you believe?

The first thing to realize is that there are no absolutes in figuring out how much greenhouse gas your household 'generates' while consuming a given quantity of electricity. This is 'fuzzy mathematics' at its worst, as there are so many variables involved. Keep in mind, that the case laid out below is quite conservative in estimating your CO_2 footprint.

Electricity can be produced by your utility from any combination of nuclear, natural gas, petroleum (although infrequently), coal, and refuse derived fuel, plus an array of renewables including wind, solar, hydro, biomass, methane, and geothermal. Since your utility probably uses a continuously varying mix of these fuels, it's easy to see how determining the greenhouse gas effect of your electricity consumption can get quite muddled. Unfortunately, few writers make any such distinction, using instead a 'national average,' whatever that is.

In addition, there are no standard or set measures for gauging the environmental impacts and greenhouse gas emissions and pollutants of extracting and refining the fuels used to generate electricity. But the process can be simplified.

Let's assume that you have installed a wind turbine to generate all of your own electricity. For the purposes of simplicity, let's also assume that your local utility generates its electricity with 100% coal. (Again, though, keep in mind that depending on the utility and the region, utilities generate their power from a variety sources and varying

ratios.) If you were to buy power from the utility rather than generate it yourself, how much pollution would you be responsible for?

Average Coal consumption by Electricity Users

Coal has a heat range of 8,100 to 13,000 British thermal units (Btu) per pound, depending on the quality of the coal being burned. If we take the midpoint, or average, of these two numbers, we get 10,550 Btu. It may become apparent now why there is such a wide range of greenhouse gas claims in news magazines about such emissions, depending upon who wrote the article and which extreme of the 'range' they favor.

The conversion process of burning coal to generate electricity is about 33% efficient when using pulverized coal in a new fluidized bed combustion system with emission scrubbers, a process that definitely can be considered cleaner 'brown' electricity relative to other coal systems. This efficiency estimate takes into account transmission and distribution losses, as well as the inefficiencies of the combustion process. So 33% represents the actual amount of a pound of coal that, once delivered to your utility, actually makes it to the electrical outlets in your house in the form of electricity, on average. It does not address the environmental cost of mining, processing, or transporting the coal to the utility.

If we multiply our average 10,550 Btu by 33%, we find that only 3,517 Btu in our pound of coal are actually converted to electricity and delivered to your home. Since there are 3,413 Btu in a kilowatt-hour (kWh) of electricity, it's pretty safe to say that you are responsible for the burning of roughly one pound of coal for every kilowatt-hour of electricity you purchase from your utility, on average.

The average household in the U.S buys, on average, 900 kWh of electricity per month, roughly every 30 days. If we multiply 30 days times 24 hours, we find that there are 720 hours in a month. The average household, therefore, is responsible for consuming 1.25 pounds of coal per hour (900 kWh = 900 pounds divided by 720 hours). (Note: your mileage may vary, as we are assuming an 'average' house here. Check your utility bill for the past 12 months for your actual kilowatt-hour usage.) There are 8,760 hours in a year, so if we multiply 1.25 pounds by 8,760, we find that the 'average' house using 100% coal-generated electricity is responsible for the burning of 10,950 pounds of coal for the electricity they consume per year. That's nearly 5.5 tons!

Greenhouse Gas and other Emissions Due to Burning Coal

Now, what about greenhouse gas emissions? The same problem of 'range' exists, depending on the quality of coal your utility burns to generate electricity. The burning of a pound of coal releases between 1.75 to 2.24 pounds of CO_2, a primary culprit behind global warming. The midpoint for this range is 2.0 pounds and is what most people use to determine CO_2 generation. It is safe to say that you are responsible for producing about two pounds of CO_2 for every kilowatt-hour of electricity you buy from your utility.

Multiplying two pounds of CO_2 by the calculated average (from above) of 10,950 pounds of coal consumed per year reveals that you are responsible for 21,900 pounds, or nearly 11 tons, of CO_2 released into the atmosphere every year that you consume the 'average' amount of coal-generated electricity.

CO_2 isn't the only kind of emission produced by coal plants. Nitrogen oxide (NOx) and sulfur dioxide (SO_2) are two byproducts of the coal-to-electricity conversion process. NOx is a key component of smog, while SO_2 combines with atmospheric water vapor to form acid rain. Burning a pound of coal results in the release of about .01 pounds of NOx and about .0086 pound of SO_2 (again, these are the averages of a range). If we multiply these numbers by the 'average' consumption of 10,950 pounds of coal per year, the average annual release of NOx is 109.5 pounds and 94 pounds of SO_2.

In addition to greenhouse gases, burning coal to generate electricity has many other negative impacts on our lives as well. For example, in Wisconsin where I live, we have thousands of small- to medium-sized lakes that draw millions of tourists annually. Every single one of these lakes has a mercury advisory posted on them, including our two largest lakes, Lake Superior and Lake Michigan. In fact, nearly half of the mercury in the bodies of Wisconsin residents comes directly from the burning of coal to generate electricity for the state.

The bottom line

Remember, it takes about 1 pound of coal to generate a kilowatt-hour of electricity. Curious as to what a pound of coal might look like? Make a fist—a pound of good, hard coal is about the size of one and a half of your fists (an average fist). That, by the way, will light a 100-watt incandescent light bulb for a mere 10 hours. That's all. Or a 25-watt equivalent compact florescent light bulb for 40 hours.

Remember, added up, the 'average' house using 100% coal-generated electricity consumes about 5.5 tons of coal per year in the form of electricity. A railroad coal car holds about 60 tons of coal, meaning that the 'average' house consumes one rail car of coal in just under 11 years.

So, if you generate your own electricity rather than purchase it from a utility that generates electricity from 100% coal, what are you doing for the environment? Plenty! If you use the 'average' of 900 kWh per month, you are preventing the release of 21,900 pounds, or nearly 11 tons, of CO_2, 109.5 pounds of NOx, and 94 pounds of SO_2. On average. Oh, and don't forget mercury.

These figures are all based on the 'average' house using 100% coal-generated electricity. But what about where you live and your fuel mix? A really great Web site to calculate the CO_2 generated by your utility is hosted by the Environmental Protection Agency. Go to http://www.epa.gov/cleanenergy/powerprofiler.htm Enter your zip code, and the program calculates your CO_2 emissions based on your utility's electrical generation fuel mix.

An example

I'll use our situation as an example of how to figure out the environmental benefits of a wind turbine. I live in Wisconsin, where about 75% of my electricity comes from coal.

We recently installed an Abundant Renewable Energy 442 10-kW wind generator. It is calculated to generate 20,400 kilowatt hours per year atop its 112-foot tower, where the average annual wind speed is about 13 miles per hours. Those 20,400 kilowatt-hours will offset the burning of 75% x 20,400 pounds, or 15,300 pounds or 7.65 tons of coal per year in Wisconsin, eliminating the release of 30,600 pounds or 15.3 tons of CO_2 every year. In the 20 year minimum life of this wind turbine, it will offset the burning of 306,000 pounds, or 153 tons, of coal in Wisconsin, keeping 612,000 pounds or 306 tons of CO_2 out of the Earth's atmosphere. In addition, this wind turbine will keep 3060 pounds of NOx and 2632 pounds of SO_2 out of Wisconsin over the next 20 years.

That's over 2.5 rail cars of coal in 20 years!

(Note that the above calculation does not include the CO_2 and other greenhouse gases and pollutants resulting from the other 25% of the fuel that is used to generate my electricity. It may now become apparent where the 'fuzzy math' problem comes from.)

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Editor's note: The opinions expressed in this column are those of the author and may not reflect those of AWEA's staff or board.