Some Basics of Wind Power

Wind power is another source of renewable energy. It could potentially satisfy a significant fraction of our demand for electricity, but it brings a number of challenges that will have to be met if it is to do so.

The wind blows everywhere, but it blows harder and more often in some places than others. The *wind density*, or the amount of power that can be harnessed from the wind, depends on the speed at which the wind blows and how reliably. In Boston, for instance, the average wind speed is 12.9 mph., while in St. Louis it is 9.6 mph.[i] In general, the wind blows more reliably and more strongly over water than land, over clear land than over land with obstructions, and in places where the topography of the land funnels the wind through a restricted channel. In general, then, the largest wind resources tend to be located near the ocean, on the Great Plains, and in passes. In most cases, the wind resource is larger the farther one goes above the surface of the earth. Local conditions vary, but as a general estimate, in Missouri wind power density at 100 meters altitude is roughly double that at 50 meters.[ii]

Air is less energy dense than water. The size of a wind turbine varies on the purpose and kind of installation. Farm and home-owner wind turbines are relatively small. For supplying power to the grid, however, the generator has to be reliable and efficient, and the power has to be conditioned to grid quality. Large turbines are the most economic means to satisfy these requirements. Generators can have a capacity as large as 3.6 mW, and their rotors can sweep a circle 340 feet in diameter.[iii] We're talking about a big windmill!

The advantage of wind power is that the wind blows for free, and it will never run out. The disadvantage is that it is fickle. We will discuss the advantages and disadvantages of wind power separately. Historically, wind power was expensive relative to traditional coal fired electrical generation. Its price has declined dramatically over the last two decades, however. The process of trying to estimate the "true" cost of energy is controversial. However, the Energy Information Administration estimates that the levelized cost of new generating capacity for coal fired power plants is $53.10 per megawatt, while for wind power it is $55.80.[iv] This estimate illustrates that the cost gap has closed significantly.

Total world theoretical wind energy potential is about 54,000 Mtoe.[v] That compares to 10,878 Mtoe of total world energy use in 2006.[vi] That estimate is theoretical, as it would involve covering the surface of the earth with wind turbines, but it illustrates that this potential resource is huge. The U.S. regions with the most wind energy are the Great Plains and the mountain regions, but locally harvestable wind resources can be found in many parts of the country.[vii] The National Renewable Energy Laboratory estimated that wind energy could provide as much as 25% of U.S. electrical power by the year 2050.[viii]

Thus, if problems associated with the fickle nature of the wind can be overcome, wind power represents a potentially significant source of relatively cost-effective clean energy.

[i] National Climate Data Center. Retrieved online at http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html.
[ii] The maps of wind power density are available from the Missouri Department of Natural Resources, retrieved online 12/28/2007 at http://www.dnr.mo.gov/energy/renewables/wind-energy.htm.
[iii] *3.6 mW series wind turbine.* General Electric Co. Retrieved online at http://www.gepower.com/prod_serv/products/wind_turbines/en/36mw/index.htm.
[iv] *International energy outlook, 2006, p. 66*. Energy Information Administration, U.S. Department of Energy. Retrieved online at http://www.eia.doe.gov/oiaf/ieo/index.html. The costs were: coal, $53.10; natural gas, $52.50; wind $55.80; and nuclear $59.30.
[v] Mtoe = the amount of energy contained in a million metric tons of oil. The estimate is from Archer, Cristina, & Jacobson, Mark. (2005). Evaluation of global wind power. *Journal of Geophysical Research – Atmospheres. 110,* (D12), D12110. Retrieved online 12/29/2007 at http://www.stanford.edu/group/efmh/winds/global_winds.html.
[vi] *BP statistical review of world energy, 2007.* Available online at http://www.bp.com/statisticalreview.
[vii] *Wind energy resource potential.* Office of Energy Efficiency and Renewable Energy, Department of Energy. Retrieved online 12/29/2007 at http://www1.eere.energy.gov/windandhydro/wind_potential.html.
[viii] Short, Walter, Blair, Nate, and Heimiller, Donna. (2003) The long-term potential of wind power in the United States. *Solar Today*. Retrieved online 12/29/2007 at www.nrel.gov/docs/gen/fy04/34871.pdf.