Contemplating excess wind

June 16 2009

How much usable energy do wind turbines produce? It is a question that perplexes engineers and frustrates potential users, especially on windless days. A study published this month in the *International Journal of Energy* provides a formula for answering this vexing question.

Abolfazl Ahmadi and Mehdi Ali Ehyaei of the Department of Mechanical Engineering, at Iran University of Science and Technology-Arak Branch, in Arak, have investigated the "exergy" of wind power. Exergy is a term from thermodynamics that measures that the energy a system that is available to do work.

Wind is one of the oldest renewable energy resources. Fan blades atop a tall capture the wind's energy and convert it to useful power at ground level. Modern turbines, of course, take this notion of wind power one stage further and produce electricity to drive equipment elsewhere. A single wind turbine can vary in size from a few kilowatts for small residential applications to more than 5 megawatts for industrial scale electricity generation.

Ahmadi and Ehyaei point out that wind turbines have to compete with many other energy sources, primarily fossil fuels but also other renewable energy sources such as solar and biomass technology. As such, a wind turbine has to be cost effective in order to be environmentally effective.

Turbine design must meet load requirements and produce energy at a minimal per dollar cost. In order to address this cost issue, performance

characteristics such as power output versus wind speed or versus rotor angular velocity must be optimized. Exergy analysis looks at the "quality" of the energy produced by a system. To be viable, there is little point in producing intermittent power at wildly varying levels, as this feeds only low-quality energy into the power supply system.

Usually, wind speeds of above 9 meters per second are considered irrelevant in exergy calculations of wind turbines and previous research has not taken all factors that are required for a holistic analysis into account, the Iranian team believes.

They have now developed an improved exergy analysis for wind turbines, which considers the kinetic exergy of the wind in much greater detail. Their approach gives them a model of how the turbine's potential for work can be lost. This then offers a way to optimize a wind turbine's three main parameters, cut-in, rated, and furling wind speeds, so that usable energy is maximized at any given wind speed from the gentlest breeze to a roaring gale; within the safe working parameters of the turbine.

They have carried out an exergy analysis of turbines sited in two cities in Iran, Tehran and Manjil, where wind speeds are very different. Tehran has low average wind, whereas Manjil is a windy city. Their formula offers optimized values for wind turbine rotation speed, which can be altered depending on wind speed. The results are a theoretical boost of 20% efficiency at both sites and a decrease in "wasted" energy of 80%.

Source: Inderscience Publishers (news : web)