

RE: Availability of wind energy systems

SUBJECT: Synopsis of simple installed wind systems

As with many emerging technology sectors, the wind energy industry is littered with misnomers that lead to confusion. The term *availability* for example refers to the fraction of scheduled operation time during which the wind system is actually on-line. According to the American Wind Energy Association, modern wind turbines have an availability of 98 percent, meaning they are very rarely down for repairs.

Although wind systems have a high probability of being on-line, they do not necessarily generate energy the entire time they are in the field. Another misleading aspect of wind power arises from the industry rating turbines by their maximum power, their *rated power*. When the wind is not blowing, wind turbines produce no electricity. Also, wind systems only produce their rated power during the fraction of time when the wind is blowing just right. Hence, a second metric is used to quantify the amount of energy a wind system may produce. This term is called the *capacity factor*.

For a wind system, capacity factor is the ratio of actual energy delivered to the energy that could be generated if the turbine ran continuously at its rated power. To see this relationship more clearly it is important to note that all wind turbines have a characteristic power graph. This graph relates the wind speed a turbine experiences to the fraction of rated power actually produced. The simple wind system power graph shown in Figure 1 illustrates that simple wind systems are characterized by two points: 1) *cut-in*, the wind speed at which energy is first generated and 2) *cut-out*, the wind speed at which the turbine stops making energy to protect itself from damage.

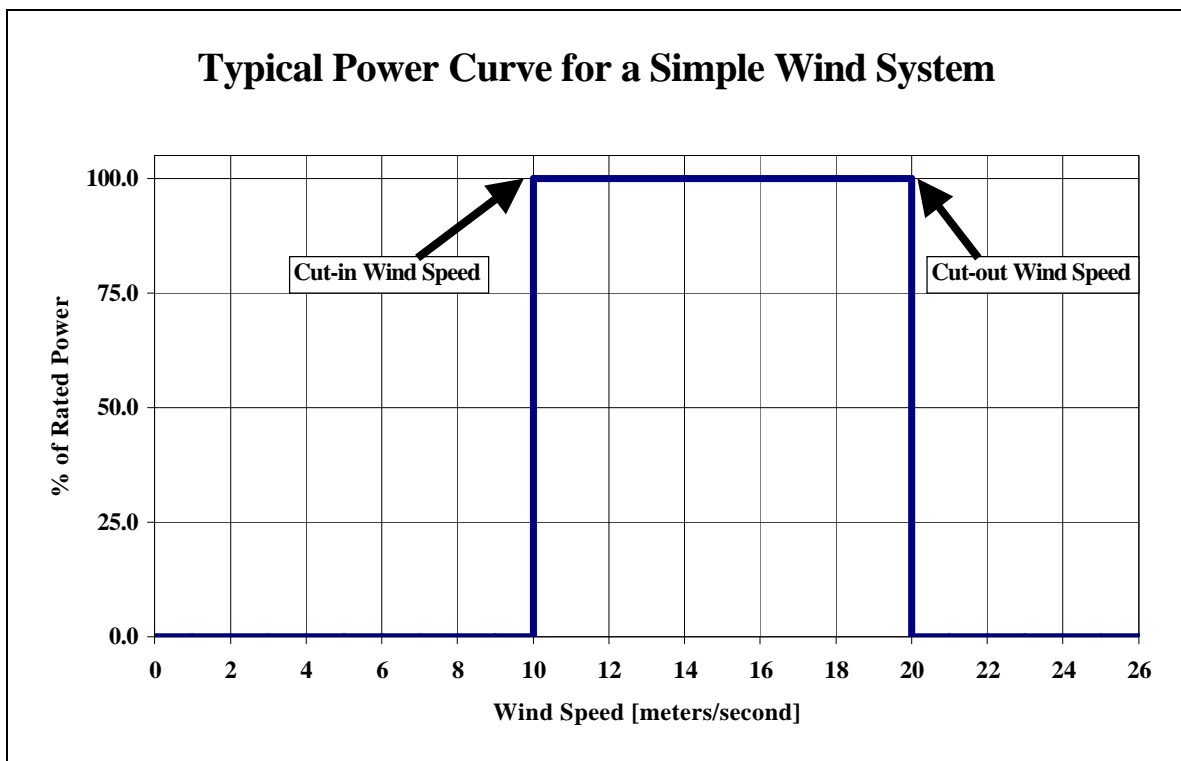


Figure 1: Once rated wind speed is met, turbines deliver constant power for wind velocities up to cut-out.

The presence of adequate wind speed at the wind system site plays an important role in capacity factor. If the wind speed at a site is most often within the range where the turbine produces energy, a simple wind system will generate more energy than if it were sited where the wind speed is outside this range.

A site's wind speed data can be combined with a turbine's power curve to make the black line in Figure 2. The energy generated by a simple wind system is represented by the blue area contained under this black line. In contrast, the dotted line in Figure 2 represents a simple wind system's performance under ideal conditions where the wind blows just right at all times. For this fictional best-case scenario, the red area contained under the dotted line represents the energy that could conceivably be generated. Capacity factor is the ratio of the smaller blue area to the larger red area.

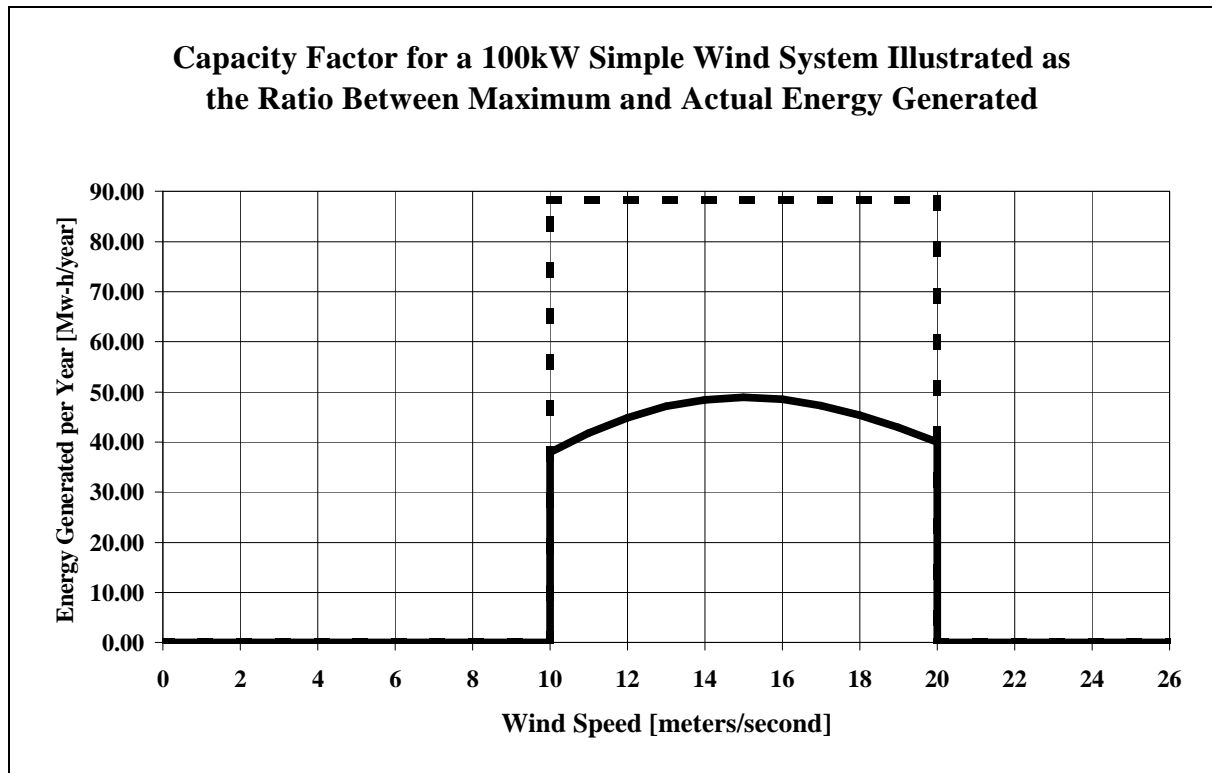


Figure 2: Capacity factor is the ratio of blue area of the turbine curve to the red area under the ideal curve.

Both individuals you spoke to in Georgetown were spinning true information to match their own interests. The renewable energy advocate said that simple installed wind systems are now operating “exactly up to specification”. This statement means that the performance of simple wind systems can be accurately predicted, as with the black line in Figure 2. This assertion is true provided data about the turbine and the wind at its site are correct. The utility lobbyist said that “even simple installed wind systems have a capacity factor of less than 20 percent”. This statement means that for a given system the ratio of the blue area to the red area in Figure 2 is smaller than 20 percent. In general, this statement understates the realistic capacity factor for wind systems, but in some cases a poorly engineered system could return capacity factor of less than 20 percent.

For future reference, also note that there is an additional definition of capacity factor in use by the wind power industry. This alternate definition states that capacity factor is the fraction of time during which a simple installed wind system delivers its rated energy.