Relevant Measures of Wind Turbine Capacity

Frank Kaminsky and Peter A. Morrison
(2/3/12)

Estimated Pre-installation Capacity Factor (EPCF)

When the annual energy is being estimated from wind speed data at a site, the predicted capacity factor of the wind turbine can be computed. This value is the percentage of the ***theoretical maximum*** value that could be produced by the wind turbine. For example, the 100-kilowatt machine at the high school theoretically could generate 876,000 kilowatt hours if the turbine produced 100 kilowatts during each of the 8760 hours in the year (e.g., 8760 x 100 = 876,000.) For the high school turbine, the ***estimated pre-installation*** (as distinct from ***theoretical maximum)*** amount of energy was calculated to be approximately 250,000 kilowatt hours. That calculation yields the ***estimated pre-installation capacity factor*** (EPCF) as 250,000/876,000 = 0.28. This EPCF is what is anticipated, based on what is known or estimated prior to actual operational experience.

The EPCF is computed by estimating the average annual wind speed at the hub height of the wind turbine and then calculating an estimate of the annual energy the wind turbine would produce using a probability distribution of the hourly wind speeds in the year and the power output curve of the wind turbine.

A key uncertainty here is "losses" (15.8% according to the Black and Veatch study, 10% according to SED's study). Until the modeled and observed values are reconciled with real operating data, a 45% EPCF is just that.

Actually Realized Capacity Factor (ARCF)

Upon operation for a sufficiently long period of time (say 12 or 24 months), the turbine's actually realized capacity factor (ARCF) can be measured. For example, a 900 kilowatt turbine (rated as having a theoretical maximum capacity of 7,884,000 kilowatt hours) installed at the Madaket site produced 3,000,000 kilowatt hours during 12 months of operation, then the ARCF would be 3,000,000/7,884,000 = 0.38.

Estimated Pre-installation Capacity Factor at the Nantucket Landfill

At the landfill, the average annual wind speed at a height of 71 meters was estimated by SED to be 8.56 meters per second. Using WindPRO modeling software and the power output curve (power output versus wind speed) of the [MFGR & MODEL NAME] 900-kilowatt turbine, the annual energy was estimated to be 3,939,900 kilowatt hours per year (sources shown at Madaketwind.org). This value corresponds to an EPCF of 3,939,900/7,884,000 = 0.50. Assuming a 10% value for annual losses due to interruptions in energy production, etc, this EPCF would be adjusted downward to be 3,546,000 kilowatt hours, to derive an ***anticipated*** pre-installation capacity factor (APCF) of 3,546,000/7,884,000 = 0.45. This APCF is the best (i.e., most informative) information one has to rely on prior to gaining a year's worth of actual operating experience following installation.