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Electric Industry Terms Important in Understanding Two Critically Important Limitations of Electricity from Wind Energy

- First, wind turbines have little or no "capacity value"; i.e., they are unlikely to be producing electricity at the time of peak electricity demand. Therefore, wind turbines are not a substitute for reliable generating capacity needed to provide reliable electric service for electric customers.

- Second, a kilowatt-hour (kWh) of electricity from a wind turbine has less *value* than a kWh of electricity from a reliable ("dispatchable") generating unit; i.e., from a unit that can be called upon to produce electricity whenever the electricity is needed by electric customers.

These issues are important because "wind farm" developers and lobbyists have mislead the public, media and government officials by making false claims and by using terms intended to confuse their listeners.

To address this problem, this brief paper explains a few key electric industry terms that are important in understanding the critically important differences between the *quality* and *value* of (i) the high cost, intermittent, volatile and unreliable electricity produced by wind turbines and (ii) the lower cost, reliable and more valuable electricity produced by generating units that can be called upon to produce electricity whenever it is needed by electric customers. Failure to understand the terms has already led to faulty decisions by government officials and misunderstanding and incorrect reporting by media officials.

1. **<u>Generating capacity,</u>** which is measured in kilowatts (kW) or megawatts (MW). This is a measure of a generating unit's ability to produce electricity at an instant in time. This term can be confusing because there are different legitimate measures of generating capacity:

    a. **<u>Nameplate capacity</u>**, which is the capacity rating shown on the nameplate attached to the generator by the manufacturer. ("Rated capacity" is often used synonymously with "nameplate capacity.")

    b. **<u>Summer capacity</u>** and **<u>winter capacity</u>**, which for many units (e.g., fossil-fueled) are often different from nameplate capacity because the unit's ability to produce is affected by air temperature.

2. <u>C**apacity value,**</u> which is also measured in kW or MW. This is a critically important measure to generating companies and grid managers. It describes the amount of generating capacity that can be counted on to help meet peak electricity demand. For many reasons it differs from any of the above measures. Generally, this number is determined empirically; i.e., with a specific test of what the unit can produce (again in kW or MW) under specific test conditions.

3. **<u>Wind turbine "capacity value."</u>** In fact, the true capacity value of a wind turbine is the kW or MW of generating capacity that is available <u>at the actual time</u> of peak electricity demand on the electric grid serving the area. The true capacity value of a wind turbine or "wind farm" is generally less than 10% of nameplate capacity and often 0% or slightly above -- simply because, *at the time of peak electricity demand*, the wind isn't blowing at a speed that will permit the turbine to produce any or much electricity. Claims of wind turbine capacity value have been exaggerated by wind industry officials and lobbyists, by regulatory agencies, ISOs, RTOs,[1] or other grid manager's arbitrary decisions. [2]

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[1] ISO = Independent System Operator; RTO = Regional Transmission Operator. Both types of organizations are involved in managing an electric grid.

[2] Capacity value was also exaggerated in a misleading report produced by GE in March 2005 for the New York State Energy R&D Authority (NYSERDA). That report was cited by the NY ISO to arbitrarily assign "wind farms" in NY

4. **Capacity value for reliable ("dispatchable") generating units** -- i.e., those designed to be available whenever called upon -- may be less than their "nameplate" (or "summer" or "winter") capacity for a variety of reasons. For example, they may have mechanical problems that prevent them from running at full rated capacity but which problems are not serious enough to take them out of service for repair or overhaul. Grid managers often require that generating unit owners/operators report each day (e.g., around noon) how much capacity can be counted on during the next day from each generating unit.

5. **Availability.** The wind industry often tries to mislead people with this term. Generally, it means that a unit is physically available and has fuel needed to permit it to generate electricity when needed. Or, put another way, it is NOT out of commission ('off line") for maintenance, repair or overhaul. Wind industry spokespersons often misuse this term by ignoring the critical second criterion; i.e. "has the fuel" (wind) needed to permit it to generate electricity. A wind turbine without wind has no real value to electric customers.

6. **Generation,** which is measured in kilowatt-hours (kWh) or megawatt-hours (MWh). This is an *after the fact* measure of the amount of electricity produced over some period of time (hour, day, week, month, year, etc.) Most reports by the US Energy Information Administration (EIA) show "net" generation -- which is usually measured at a substation entry point to a transmission line. The term "net" reflects the fact that some of the electricity produced by a generating unit is used BY that generating unit (lights, pumps, scrubbers, precipitators, etc.).

7. C**apacity factor,** which is measured as a percentage of nameplate capacity. It is *an after the fact* measure with the percentage determined by dividing the actual (metered) output (in kWh or MWh), divided by the nameplate capacity (in kW or MW) times the number of hours in the period for which the calculation is done (e.g., 8760 for a year).

8. **Wind turbine capacity factors.** Wind turbines have low capacity factors because they are dependent on wind speed. They start producing a small amount of electricity with a wind speed about 6 or 7 miles per hour (mph), reach "rated" capacity around 31 mph and cut out around 56 mph. Therefore, their output is inherently *intermittent, volatile and unreliable*. A 1 MW (1,000 kW) wind turbine that produces 2,190,000 kWh of electricity during a year has achieved a capacity factor of 25%. That is 2,190,000 kWh divided by 1,000 kW x 8760 hours; or 2,190,000 divided by 8,760,000 = .25).

9. **Dispatchable unit capacity factors**. Capacity factors for reliable or "dispatchable" generating units vary widely depending upon (i) the design and intended purpose of the unit (i.e., for baseload, intermediate or peak load service) and (ii) the plans and choices of the operator who is responsible for keeping the electric grid in balance (electricity supply & demand, voltage and frequency).

   a. **"Baseload" units** (often powered by coal or nuclear energy that heat water to produce steam that spins the turbine that produces electricity) are designed to run all or most of the time and often have annual capacity factors in the 70% to 90% range. They tend to take longer to start up and bring to full generating capacity.

   b. **"Intermediate load" units** are those that can be "ramped" up and down (i.e., output increased or decreased) more quickly than units designed for "baseload" service). Some "intermediate load" units will use steam turbines and some will use gas turbines and some will use both. Often these

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a 10% capacity credit (i.e., 10% of nameplate capacity) during summers and 30% in winters – an action that has since been found to be unjustified.

units will be powered by natural gas and, much less often, oil. Their annual capacity factors vary widely, perhaps from percentages in the teens to percentages in the 50s or 60s.

c. **"Peak load" units** are those intended for use primarily when electricity demand is at high levels. Generally these units will use gas turbine technology or internal combustion engines, powered by natural gas or oil. They can be started up and shut down quickly. Their annual capacity factors will often be in the range of 3% to 7% *because* they are intended for use only when electricity demand is high.

Hydropower units (falling water turns the turbines) may be used for baseload, intermediate or peak load service – depending on the availability of water in the area. For example, hydropower units provide baseload power in the Pacific Northwest but are used only for peaking service in areas with fewer water resources. Hydropower units are used for "load leveling" (i.e., keeping electricity supply equal to demand) because their output can be controlled instantaneously.

Units powered by biomass (wood, etc.) or geothermal energy are considered "dispatchable" and may also be used in baseload or intermediate service in areas where these energy sources are available.

As indicated above, wind turbines are "intermittent" and neither reliable nor dispatchable because they are dependent on wind speed. Solar photovoltaic panels are also intermittent sources of electricity because they are dependent on sunlight.

10. **Efficiency.** This term is often used incorrectly; that is, when the correct term is "capacity factor." Efficiency, as that term is used in the electric industry, refers to the relationship between BTU of energy input and kWh output. The result of this calculation is generally referred to a unit's "heat rate."

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