CAI335 SOLAR AND WIND ENERGY SYSTEM

UNIT IV NOTES

4.6 Wind Farm

A wind farm or wind park, also called a wind power station or wind power plant, is a group of wind turbines in the same location used to produce electricity. Wind farms vary in size from a small number of turbines to several hundred wind turbines covering an extensive area. Wind farms can be either onshore or offshore.

Wind turbines can turn the power of wind into the electricity we all use to power our homes and businesses. They can be stand-alone, supplying just one or a very small number of homes or businesses, or they can be clustered to form part of a wind farm.

4.6.1 Types of Wind Farm

There are three types of wind farms:

- Onshore wind farms. They are currently the most common. ...
- Nearshore wind farms. They are also located on land, but less than 3 kilometers from the coast.
- Offshore wind farms. These structures are built in the open sea several miles from the coast.

4.7 Wheeling and banking

Wheeling is the act of transporting electricity from a generator to a remotely located end-user through the use of an existing distribution or transmission system. This may also be across multiple different distribution networks, such as through Eskom to a municipality.

In electric power transmission, wheeling is the transportation of electric energy (megawatt-hours) from within an electrical grid to an electrical load outside the grid boundaries.

wheeling charges are the transportation cost of electricity. It is the charge that is paid to transport electricity from a power plant to a house or user's house. The wheeling charges in India are calculated as per megawatt-hour.

It's an equivalent alternative to foot/pedestrian-based mobility. Includes wheeled mobilities such as manual self- or assistant-propelled wheelchairs, including: wheelchairs with power attachments or all-terrain attachments (such as the 'Freewheel')

At present, the Banking charges determined by the Commission are 2% of the injected energy for Wind, Minihydel and solar power plants for the electricity generated and wheeled within the State. Further, RE generators availing banking facility have to pay the difference in UI charges at the time of injection and drawal.

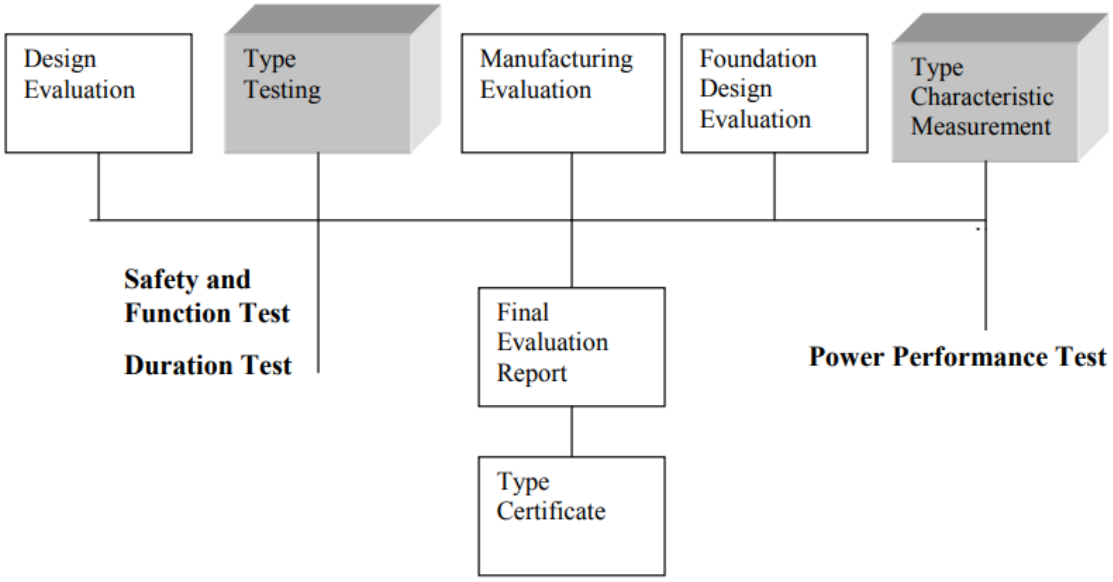
Wheeling charges - Charges are payable to the distribution company for using the infrastructure. Transmission losses and Wheeling losses- These are the electricity losses incurred during the transmission and distribution of power.

Energy can neither be stored nor be destroyed. However, the developing societies and the modern capitalistic business models led to the development of something known as the Banking of Renewable Energy. The concept deals with storing the surplus of energy generated and withdrawing it whenever needed.

4.8 Testing and Certification

Specific tests are required under “type testing.” Optional but desirable tests are shown under “type characteristics measurements.” However, the blade tests and load measurements required under type testing for large turbines can be waived in lieu of a “duration test” per IEC 61400-22 Annex E. Also required under type testing is a safety and function test. SWWP chose to certify a power curve for their turbine, therefore a power performance test is being

conducted according to the requirements of IEC 61400-12. The safety and function, duration, and power performance tests are the three main tests required for the certification of the AIR 403. NREL has written a detailed test plan for each test being conducted that describes the testing approach, configuration, and procedures. NREL is also obtaining some additional data on the SWWP turbine's characteristics in order to provide inputs to the design evaluation process.



4.8.1 Safety and Function Test

The purpose of the safety and function test is to verify that the turbine has adequate provisions to operate safely under all conditions. It is conducted in accordance with provisions listed in IEC 61400-22 Annex D. For larger turbines, this testing focuses on the control system for the turbine. However, the control systems for small turbines are very simple and often passive.

For the AIR 403 turbine, the safety and function test consists of the following: Emergency shutdown operation. Conduct a brake test to ensure the turbine stops in high winds when the brake is applied. Power and speed control. Verify that the aero-elastic stall mechanism of the

blades limits speed and power and verify that the charge controller limits current in high winds when the battery voltage is greater or equal to the charge controller voltage set-point. Yaw control.

Visual inspection, if problems are noted a test plan will be developed. Grid loss behavior. Open circuit test includes 4 Hz sampling of current to verify internal braking mechanism of turbine controller reduces current to zero. Over-speed protection. Verify blade "aeroelastic stall" reduces current output. The above tests are contained in a checklist and capture the intent of the IEC 61400-2 Annex D requirements without making the testing so burdensome and expensive that small turbine manufacturers would be unable to afford the it. For example, visual inspection of adequate yaw control is relatively inexpensive compared to instrumenting, recording, and analyzing yaw and wind direction signals.

4.8.2 Duration Test

Duration test may replace the blade tests and load measurements required under type testing for small turbines. This variance from the large turbine standard can help reduce the cost of testing small turbines because it is usually easier to conduct a duration test as opposed to blade and load tests. The IEC 61400-2 Annex E requires that the turbine undergo testing for 1,500 hours of power generation and six months test duration, as well as operation in winds greater than 10 m/s (22 mph) for 250 hours and operation in winds greater than 15 m/s (33 mph) for 25 hours. The operating requirements per IEC 61400-2 Annex E are that the turbine achieve at least 90% availability.

In addition to the availability requirement, NREL requires that the turbine’s monthly energy production throughout the test be no less than 20% of the first month’s energy production after correction for wind resource differences. A 20% change in the monthly energy production would indicate a problem with yaw bearings, blades, bearings, generator, or the

rectifier. To compare energy production, both the expected energy production and measured energy production are determined.

Expected energy production is the energy that would have been produced under the measured wind conditions if the turbine operated on its power curve as measured during the first month. Measured energy production is energy that the turbine actually produced as measured by the power transducer. The comparison uses data obtained when turbine and anemometer are clear of wakes from any obstacles and when the winds are within the range of the power curve measured during the first month of duration testing.

Power is measured by a power transducer and also calculated from current and voltage measurements for the duration test. Voltage measurements are taken at the top of the wind turbine tower and also at the battery bank, so that the line losses can be calculated. The AIR 403 is available in a 12-, 24-, and 48-volt version; the 12-volt version was selected for the duration test because it produces the highest current, and, therefore, the highest thermal loading. Turbine availability is determined from the test log and supplemented by a manual switch connected to the data acquisition system. If NREL staff note any problems with the turbine the switch is thrown and an entry is made in the log. This method avoids the undesirable loss of availability when the turbine is shut down for instrumentation changes or special tests.

4.8.3 Power Performance Test

The power performance test follows the IEC 61400-12 standard except that changes are required to account for the effect that battery state-of-charge (i.e., voltage variation in the load) has on power output. The electrical load is controlled at voltages corresponding to a battery SOC of approximately 40%, 70%, and 100%, and 60 hours of operation is required for each SOC voltage. In addition, for each of the three voltage settings, 30 minutes of data is

required for each 0.5 m/s (1 mph) wind speed bin. Because this is the first power performance test for a small wind turbine certification, the variation of the power curve as a function of voltage will be evaluated to determine the sensitivity of the power curve to battery SOC. If the voltage variation has a small effect on the power output, then the final power curve will be an average of the three voltages. If voltage has a significant effect on the power curve output (e.g., greater than 5%), then the power curves corresponding to the three voltage settings may be shown separately.