CAI335 SOLAR AND WIND ENERGY SYSTEM

UNIT III NOTES

3.1 Introduction to wind Energy

Wind is air set in motion by small amount of insolation reaching the upper atmosphere of earth. It contains kinetic energy (K.E.) which can easily be converted to electrical energy. Nature generates about 1.67 × 105 kWh of wind energy annually over land area of earth and 10 times this figure over the entire globe. l This wind energy, which is an indirect source of energy, can be used to run a wind mill which in turn drives a generator to produce electricity. l Although wind mills have been used for more than a dozen centuries for grinding grain and pumping water, interest in large scale power generation has developed. over the past 50 years. A largest wind generator built in the past was 800 kW unit operated in France from 1958-60. The flexible 3 blades propeller was about 35 m in diameter and produced the rated power in a 60 km/hour wind with a rotation speed of 47 r.p.m.

3.2 Nature of Wind

- The main characteristics of wind are: l Wind speed increases roughly as 1 7 th power of height. Typical tower heights are about 20–30 m. l
- Energy-pattern factor. It is the ratio of the actual energy in varying wind to energy calculated from the cube of mean wind speed. This factor is always greater than unity which means the energy estimates based on mean (hourly) speed are pessimistic

3.3 Wind Structure

Following are the two sources/origins of wind which decided its structure .

- Local winds.

These winds are caused by unequal heating and cooling of ground surfaces and ocean/lake surfaces during day and night. During the day warmer air over land rises upwards and colder air from lakes, ocean, forest areas, and shadow areas flows towards warmer zones.

- Planetary winds.

These winds are caused by daily rotation of earth around its polar axis and unequal temperature between polar regions and equatorial regions. The strength and direction of these planetary winds change with the seasons as the solar input varies.

Despite the wind's intermittent nature, wind patterns at any particular site remain remarkably constant year by year. Average wind speeds are greater in hilly and coastal areas than they are available in land. The winds also tend to blow more consistently and with greater strength over the surface of the water where there is a less surface drag.Wind speeds increases with height. They have traditionally been measured at a standard height of 10 meters where they are found to be 20-25 percent greater than close to the surface. At a height of 60 m they may be 30-60 percent higher because of the reduction in the drag effect of the surface of the earth.

3.4 Wind Availability and Measurement

Wind energy can only be economical in areas of good wind availability. Wind energy differs with region and season and also, possibly to an even greater degree with local terrain and vegetation. Although wind speeds generally increases with height, varying speeds are found over different kinds of terrain. Observations of wind speed are carried out at meteorological stations, airports and lighthouses and are recorded regularly with ten minute mean values being taken every three hours at a height of 10 m. But airports, sometimes are in valleys and many wind speed meters are situated low and combinations of various other factors mean that reading can be misleading. It is difficult, therefore, to determine the real wind speed of a certain place without actual in-situ measurements.

The World Meteorological Organisation (WMO) has accepted the following four methods of wind recording:

(i) Human observation and log book.

(ii) (ii) Mechanical cup-counter anemometers.

(iii) (iii) Data logger.

(iv) (iv) Continuous record of velocity and direction

Human observation and log book.

This involves using the Beaufort Scale of wind strengths which defines visible "symptoms" attributable to different wind speeds. The method is cheap and easily

implemented but is often unreliable. The best that can be said of such records is that they are better than nothing. **Mechanical cup-counter anemometers.**

The majority of meteorological stations use mechanical cup-counter anemometers. By taking the readings twice or three times a day, it is possible to estimate the mean wind speed. This is a low cost method, but is only relatively reliable. The instrument has to be in good working order; it has to be correctly sited and should be reliably read atleast daily.

Data logger.

The equipment summarizes velocity frequency and direction. It is more expensive and prone to technical failures but gives accurate data. The method is tailored to the production of readily interpretable data of relevance to wind energy assessment. It does not keep a time series record but presents the data in processed form.

Continuous record of velocity and direction.

This is how data is recorded at major airports of permanently manned meteorological stations. The equipment is expensive and technically complex, but it retains a detailed times-series record (second-by-second) of wind direction and wind speed. Results are given in copious quantities of data which require lengthy and expensive analysis.