WIND POWER by Andrea Melvin

Several states in the U.S. have good resources for wind energy. Oklahoma is ranked 8th in the country for potential wind energy resource. To even be considered, a wind farm site must have a minimum annual average wind speed around 11 to 13 mph (approximaely 5 m/s to 5.8 m/s).

Wind turbines are sophisticated machines with computer controls. On a calm day, the turbine sits idle with its blades not spinning. As the wind picks up, it eventually reaches the cut-in speed of the turbine, which is around 10 mph. At this wind speed, the turbine blades spin up to operating speed, usually around 14 to 29 revolutions per minute, and the turbine starts generating electricity. As the wind speed increases, the generator output increases. When the wind speed increases to the rated wind speed, usually around 30 to 35 mph (~13.4 m/s to 15.6 m/s), the generator will be outputting its nameplate-rated capacity. For example, a 750 kilowatt (kW) turbine will be outputting 750 kilowatts of electricity.

As the wind speed continues to increase, the generator output will remain at the rated capacity (i.e., 75 kW) until such time as the wind speed reaches the cut-out speed, usually around 55 to 65 mph (~24.6 m/s to 29 m/s). At this wind speed, the turbine will activate a disk brake, stopping the blades in a few revolutions, and then rotate itself 90 degrees out of the wind and park itself. This way the turbine has less surface area in the wind, thereby reducing the risk of damage to the turbine. If the wind speed drops to a level below the cut-out speed for a sufficient length of time, the turbine will point itself back into the wind, release the brake, and the blades will spin back up to operating speed, and the turbine will resume producing power.

Wind power is a clean, renewable alternative fuel source. A single 1.5 megawatt (mW) wind turbine powers about 500 average American homes, year after year. This offsets 13 tons of sulfur dioxide and 6 tons of nitrogen oxide emissions each year. It also displaces 2,700 tons of carbon dioxide a year – that's the equivalent of planting 1.5 square miles of forest.

References

Visit the Oklahoma Wind Power Initiative at:
http://www.seic.okstate.edu/owpi/ .

CLASSROOM ACTIVITY

Wind energy is becoming a popular resource. In Oklahoma, the wind "comes sweeping down the plains", but is it profitable to build a wind farm anywhere in Oklahoma? Your job is to determine the best location to set up a wind farm. You have been given data from two Oklahoma Mesonet sites. Keep in mind the height of a Mesonet tower is 10 meters. Wind turbines are generally 50 meters where winds are even higher than near the surface.

1. Which location has a higher mean wind speed, Tahlequah or Weatherford?

2. For each location, which month has a higher mean wind speed?

3. What time of day does the highest mean wind occur at each site?

4. You have four graphs of mean wind speeds from 1994 to 2005 [Figures 1-4 (page 26-27)]. Place them in order from highest to lowest. Which month/site combination will produce the most potential wind energy?

5. Divide into four groups. Have each group create a graph from the table of 2005 mean wind speeds. Compare the 2005 graphs to the 11-year means in Figures 1-4. Do the 2005 graphs follow the same pattern as the 11-year mean graphs?

6. Research the terrain near each of the sites. Let's say that Tahlequah is a good representative of eastern Oklahoma and Weatherford is a good representative of western Oklahoma. How does terrain influence the mean wind speeds?

7. Select a site/month combination. Write a paragraph or two explaining where you would locate a wind farm. Provide reasons based on terrain and mean wind speeds to support your choice.

Table 1 - 2005 Mean Wind Speeds

2005 Mean Wind Speeds				
	Tahlequah		Weatherford	
	March	August	March	August
Hour of Day	Mean Wind (m/s)	Mean Wind (m/s)	Mean Wind (m/s)	Mean Wind (m/s)
1	6.9	4.0	12.3	10.0
2	7.0	3.8	12.5	9.8
3	6.9	3.9	12.8	9.4
4	6.9	3.8	13.1	9.6
5	7.1	4.2	13.3	9.5
6	6.3	4.3	12.7	9.4
7	6.5	4.2	11.9	9.1
8	7.3	5.2	12.1	9.3
9	8.9	5.9	13.6	10.4
10	9.9	5.9	15.1	10.9
11	10.6	5.8	16.1	11.4
12	10.4	5.8	15.6	10.6
13	10.3	6.0	15.8	10.9
14	10.6	6.2	15.8	11.2
15	10.6	7.1	15.4	11.5
16	10.3	6.0	15.7	12.2
17	9.7	5.7	15.4	11.7
18	8.6	5.1	13.8	11.1
19	6.8	3.5	12.5	10.6
20	6.0	3.3	12.5	9.8
21	6.2	3.2	13.0	10.2
22	7.2	3.4	13.1	10.9
23	7.3	3.7	13.2	10.5
24	7.3	4.2	12.9	10.2

Figure 1 - March Mean Wind Speed (1994-2005) for the Tahlequah Mesonet Site

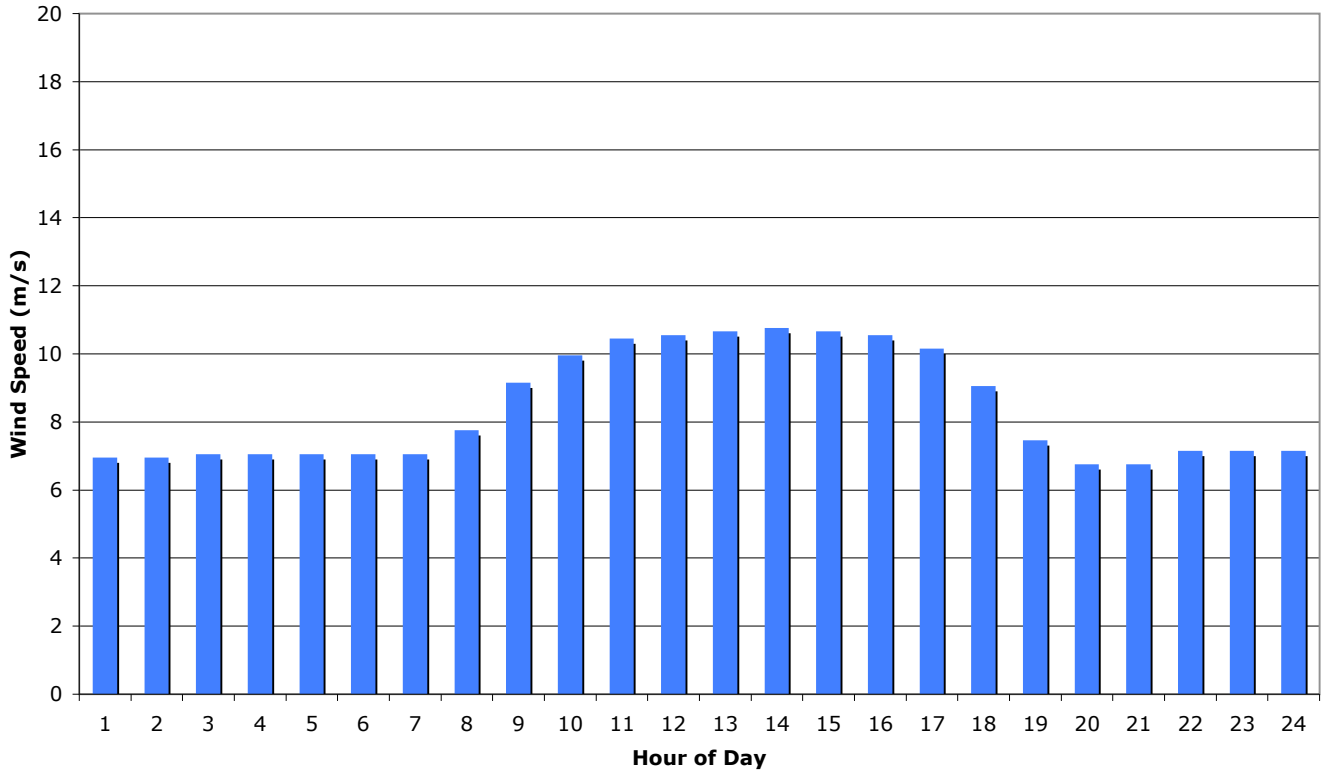

Figure 2 - August Mean Wind Speed (1994-2005) for the Tahlequah Mesonet Site

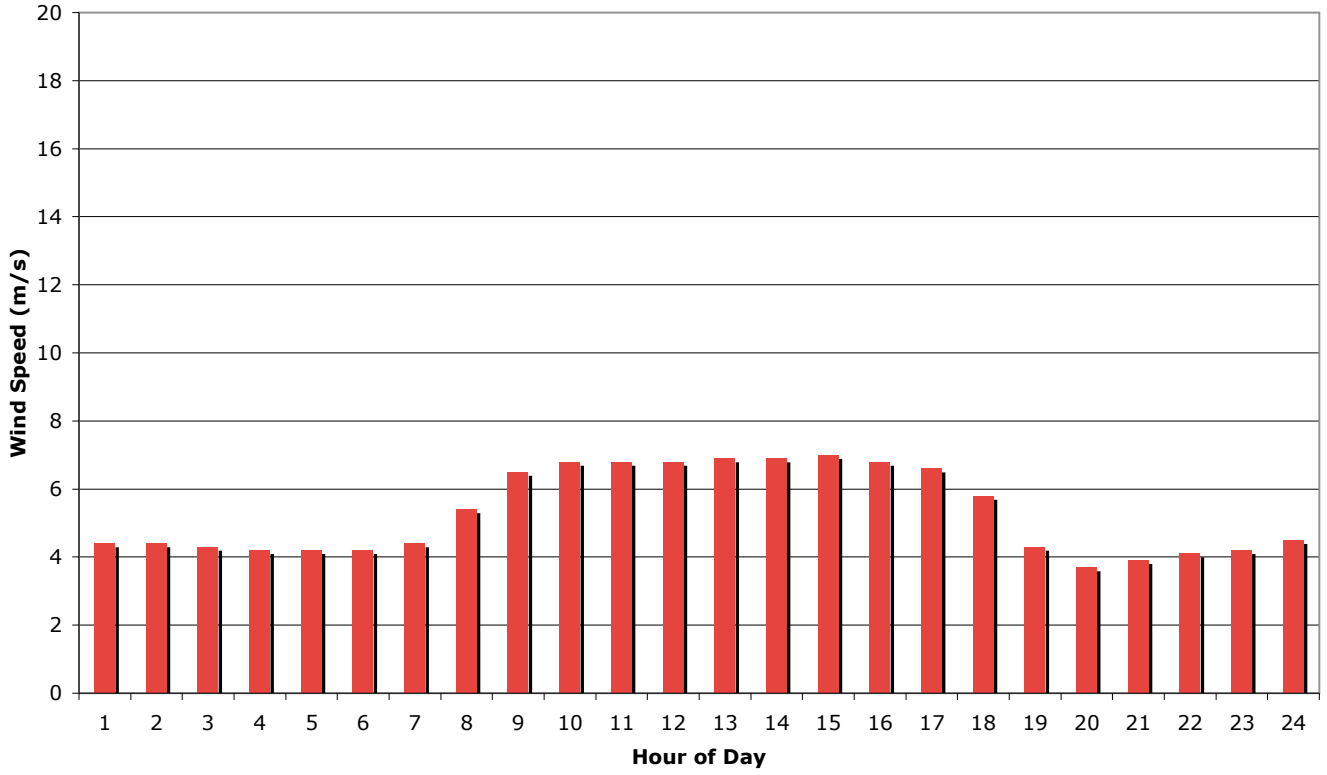

Figure 3 - March Mean Wind Speed (1994-2005) for the Weatherford Mesonet Site

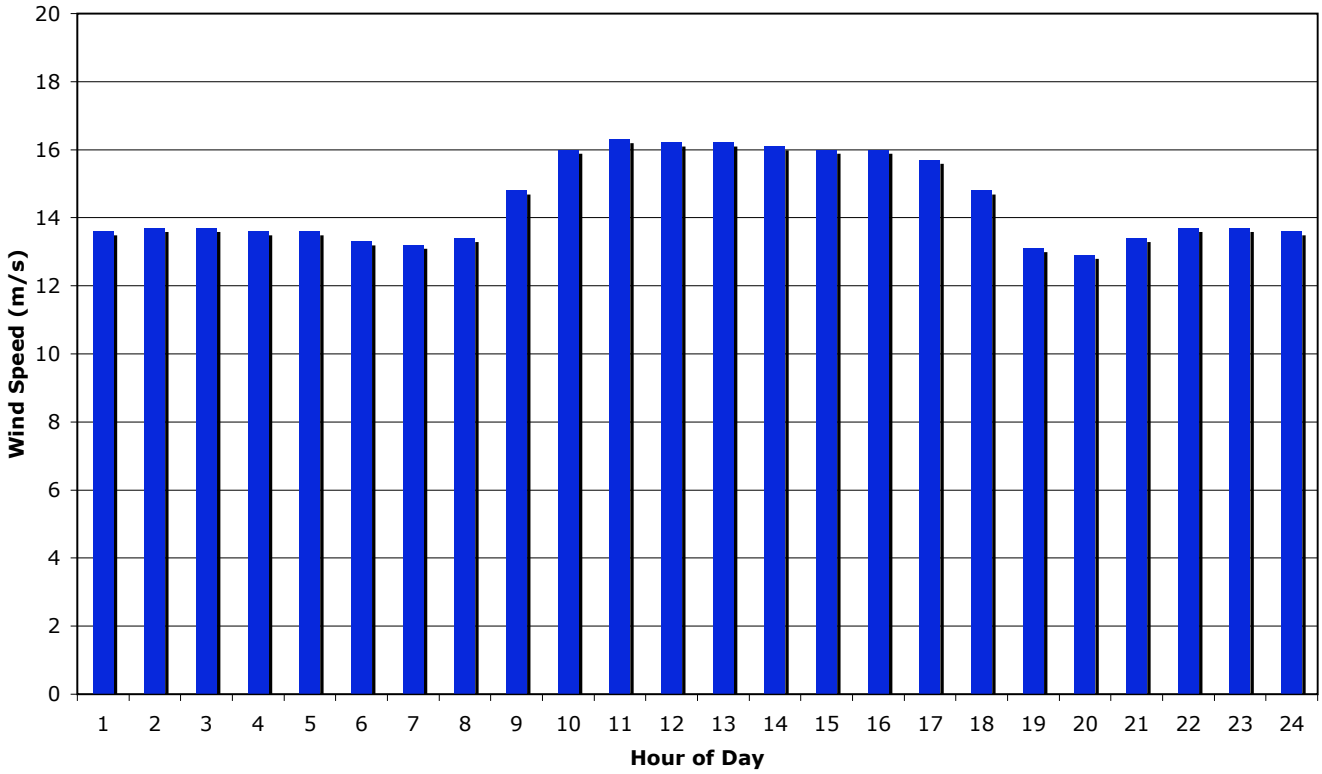

Figure 4 - August Mean Wind Speed (1994-2005) for the Weatherford Mesonet Site