



Wind Site Assessor Training

Lesson 2 Wind Quantity

Introduction

Wind is the “fuel” that is used by wind turbines to generate electricity. Wind flow patterns are affected by global as well as local influences.

The wind has two important characteristics, the first of which is its “quantity”, or the speed at which the wind blows. While wind is a variable resource, it has some unique attributes that make it a very valuable renewable energy resource.

This lesson reviews wind speed, how it is calculated, and how wind speed affects the power available in the wind to generate electricity with a wind turbine. A number of key concepts about wind velocity are covered, along with a variety of ideas about visualizing how wind flows across the Earth. This lesson lays the foundation for subsequent understanding of much energy is available to a wind turbine.

Learning Objectives

Upon completion of this lesson, you should be able to:

1. Explain the origin of wind, what causes it, and why.
2. Differentiate between weather and climate as they relate to winds.
3. Explain the power equation for wind energy and the importance of each variable in the equation.
4. Explain the three variables that affect air density and their ramifications.
5. Given inputs for the power equation, calculate the power in the wind available to a wind turbine.
6. Given various rotor diameters, calculate the swept areas of the respective rotors.
7. Explain what a wind profile is, and how a wind profile is affected by ground drag.
8. Define ground drag and explain its effects on air masses using fluid analogies.
9. Define the term “vector” as it applies to wind profiles.
10. Explain the differences between laminar and turbulent air flow.
11. Define “alpha” and its significance to wind velocity.
12. Explain “displacement height”.
13. Explain the relationship between increasing wind speed and its affect on available power in the wind to a wind turbine.
14. Elucidate on the pros and cons of the various ways that wind resources and data are documented and quantified.

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15. Explain seasonal variations in wind resources and the effects these variations have on annual energy output.
16. Explain the difference between weather and climate.

17. Identify the equipment, instruments, procedure, and approximate costs for measuring wind speed, direction, and conducting a wind shear study.
18. Explain when a wind velocity or wind shear study is required for a site.
19. Identify the problems associated with using near-ground collected wind data, such as from airports or weather bureaus.
20. Identify reliable sources of wind speed data and where they can be accessed.
21. Explain the limitations of using wind maps to determine the average annual wind speed at a site.
22. Explain the limitations of an “average” annual wind speeds and wind maps.
23. Define “flagging” and explain its value, limitations, and significance to a wind site assessor.
24. Identify local wind “problems” as indicators of a wind resource, including flagging, shelter belts and fence rows, erosion, and drifting, and the value of each for assessing a wind site.

Assignments

1. Read Gipe *Wind Power*, Chapter 3 pages 29 to 36.
2. Read Chiras *Power from the Wind*, Chapter 2 pages 25 to 36; pages 39 to 44.
3. Read Chiras, Chapter 4 pages 86 to 98
4. Read Gipe *Wind Energy Basics*, Chapter 2, 39 to 47.

Resources

5. Read Sagrillo *Back to the Basics: Ground Drag*
<http://renewwisconsin.org/wind/Toolbox-Homeowners/Back%20to%20the%20Basics%201-Ground%20Drag.pdf>

Or read <http://www.solartoday-digital.org/solartoday/20100102#pg40>

6. Read Sagrillo *Back to the Basics: Collector Size*
<http://renewwisconsin.org/wind/Toolbox-Homeowners/Back%20to%20the%20basics%205-Collector%20Size.pdf>

Or read <http://www.solartoday-digital.org/solartoday/201006#pg52>

7. Read Sagrillo *Back to the Basics: Wind Resource Maps* <http://www.solartoday-digital.org/solartoday/20100809#pg32>

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8. Read WindLogics *Wind Map Methodology*
9. Access NREL's 80m wind map at http://www.windpoweringamerica.gov/wind_maps.asp

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