

SECTION 3 ACTIVITIES

Activity 9: Sun Charts

ACTIVITY TYPE: Worksheet

OVERVIEW: This is a two-part activity. In Part I, students are introduced to sun charts, sun angles, and the role of shading in solar-electric systems. In Part II, students perform a site assessment of their school's solar-electric system.

GOAL: Students learn how to determine the angle of the sun in the sky and how to interpret sun charts.

SUBJECTS: Math and Science

TIME PART I: 20-30 minutes

TIME PART II: 30-45 minutes

SETTING PART II: Classroom

SETTING PART II: Outside on a sunny day

MATERIALS PART I: Sun Chart Worksheet: Part 1

MATERIALS PART II: Sun Chart Worksheet: Part 2, Elevation and Azimuth Angle Gage Template (2 copies per student), internet access, printer, elevation gage or protractor, cardboard, glue, small nails, small weights (e.g., nuts or bolts), compass, and string.

KEY VOCABULARY: Azimuth, solar altitude, and sun chart.

CORRELATIONS TO STANDARDS	
NATIONAL	<p>Science as Inquiry – 1c: Using tools to measure results.</p> <p>Physical Science – 3g: The sun is the major source of energy for changes on the earth's surface.</p>
IDAHO	<p>Science – Goal 1.1: Understand systems, order, and organization.</p>
OREGON	<p>Science – The Earth in Space: Explain how mass and distances affect the interaction between Earth and other objects in space.</p>
WASHINGTON	<p>Science – Inquiry 2.1 Investigating Systems: Develop the knowledge and skills necessary to do scientific inquiry.</p> <p>Math – 1.1: Understand and apply concepts and procedures from number sense—number and numeration, computation, estimation.</p>

ABOUT THE AUTHORS: Founded in 1998, Bonneville Environmental Foundation (BEF) is essentially a non-profit business. Through the sales and marketing of green power products (known as carbon offsets) BEF gives individuals and businesses a way to participate in solving our most pressing environmental issues. All of the net revenues, or “profits,” that the organization makes are reinvested in projects that restore damaged watersheds and support the development and understanding of renewable energy technologies such as solar, wind, and biomass.



* ACTIVITY 9: SUN CHARTS

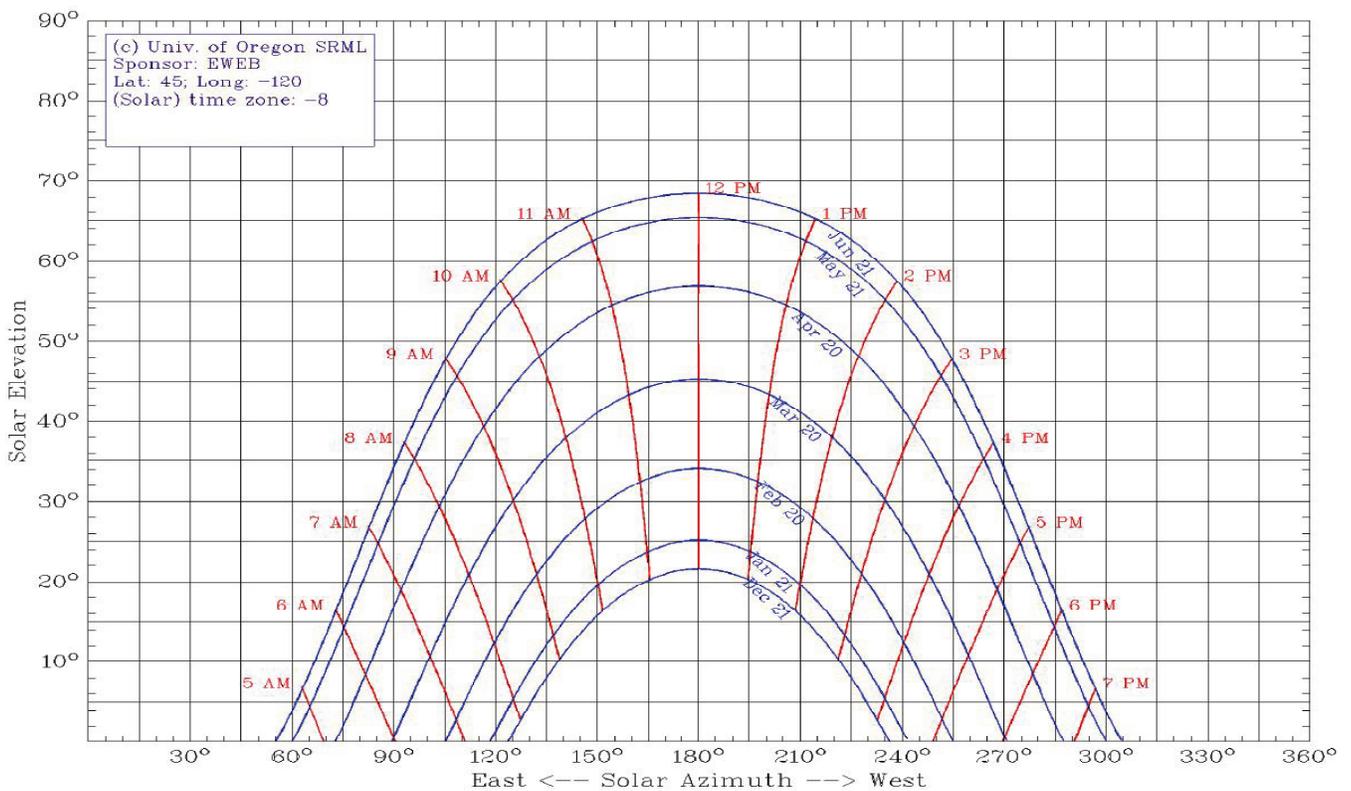
source: Bonneville Environmental Foundation (BEF)

Sun Charts Worksheet: Part 1

Before installing a solar-electric system, a site survey is conducted to determine the best location for the system. Generally, a PV system is oriented south and in a position where it will not be obstructed by shadows.

A sun chart can be used to help determine possible obstructions that will affect a PV system's performance over the course of a year. A sun chart is a graph of solar azimuth and solar altitude. Azimuth is the sun's location east and west of true south in the sky. Solar altitude is a measure of the sun's location in degrees above the horizon. The chart can help to determine if there are critical times of the day and year when the PV system will receive too much shading to make the installation worth while.

The sun chart below shows the movement of the sun across the sky over the course of the day for an entire year. Charts vary depending on what latitude and longitude is used. The chart below represents the sun's path across the sky at latitude 45 and longitude -120. Using the sun chart provided, complete the exercise by answering the questions below.



1. The first day of summer (June 21st), the azimuth at sunrise is 55° . What is the azimuth at 9 a.m. on the same day?
 - A. 100°
 - B. 95°
 - C. 110°
 - D. 105°

2. What is the approximate maximum altitude the sun reaches on March 20th?
 - A. 40°
 - B. 45°
 - C. 50°
 - D. 55°

3. Assume that the PV will be shaded if the altitude is less than 30° when the azimuth is 120° . The months of the year when the array will be shaded between 9 a.m. and 3 p.m. include:
 - A. April, May, June
 - B. January, February, March
 - C. November, December, January
 - D. December

4. The *maximum*, annual solar elevation between 9 a.m. and 3 p.m. sun time is closest to:
 - A. 30
 - B. 50
 - C. 60
 - D. 70

5. The *minimum*, annual solar elevation between 9 am and 3 pm sun time is closest to:
 - A. 10
 - B. 20
 - C. 30
 - D. 40



* ACTIVITY 9: SUN CHARTS

source: Bonneville Environmental Foundation (BEF)

Sun Charts Worksheet: Part 2

ANSWER KEY

1. The first day of summer (June 21st), the azimuth at sunrise is 55° . What is the azimuth at 9 a.m. on the same day?
 - A. 100°
 - B. 95°
 - C. 110°
 - D. 105°**

2. What is the approximate maximum altitude the sun reaches on March 20th?
 - A. 40°
 - B. 45°**
 - C. 50°
 - D. 55°

3. Assume that the PV will be shaded if the altitude is less than 30° when the azimuth is 120° . The months of the year when the array will be shaded between 9 a.m. and 3 p.m. include:
 - A. April, May, June
 - B. January, February, March
 - C. November, December, January**
 - D. December

4. The *maximum*, annual solar elevation between 9 a.m. and 3 p.m. sun time is closest to:
 - A. 30
 - B. 50
 - C. 60
 - D. 70**

5. The *minimum*, annual solar elevation between 9 am and 3 pm sun time is closest to:
 - A. 10
 - B. 20**
 - C. 30
 - D. 40

