LESSON

Sun Path

OBJECTIVES

Students will:

- Explain the impact of the path of the sun and its seasonal changes on solar array placement
- Evaluate site placement with an instrument like a solar pathfinder

BRIGHT SOLAR FUTURES

SOLAR

TOPIC OF STUDY

Earth Science Basics

Level 1:
2 HOURS
Level 2:
2 HOURS
Level 3:
3 HOURS

BIG IDEA(S)

Solar production relies heavily on the intensity and position of the sun. By combining the site-specific shading data of an instrument like the Solar Pathfinder™ with the published global weather data, an accurate solar site analysis can be made. This insolation data, on an hourly and monthly basis can then be applied to solar site analysis and positioning.

OVERVIEW

Solar production relies heavily on the intensity and position of the sun. The position of the earth during the year changes, can increase shading and the angle that the sun hits the location. This all needs to be predicted and helps make placement decisions for the solar array to capture the maximum amount of solar energy.

STANDARDS

PA/SDP

3.4.10.A2. Interpret how **systems** thinking applies logic and creativity with appropriate comprises in complex real-life problems.

3.4.12.B2. Illustrate how, with the aid of technology, various aspects of the environment can be monitored to provide information for decision making.

NGSS

HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

KEY TERMS

winter solstice
summer solstice
equator
sun angle
solar pathfinder
shading
latitude
longitude

INSTRUCTIONAL

TEXTS/REFERENCES

Solar Photovoltaic Basics, Sean White, 2019. Pp 43-63

Solar Pathfinder Demonstration

MATERIALS NEEDED

Teacher Preparation:
https://news.energysage.com/whats-the-best-angle-for-my-solar-panels/

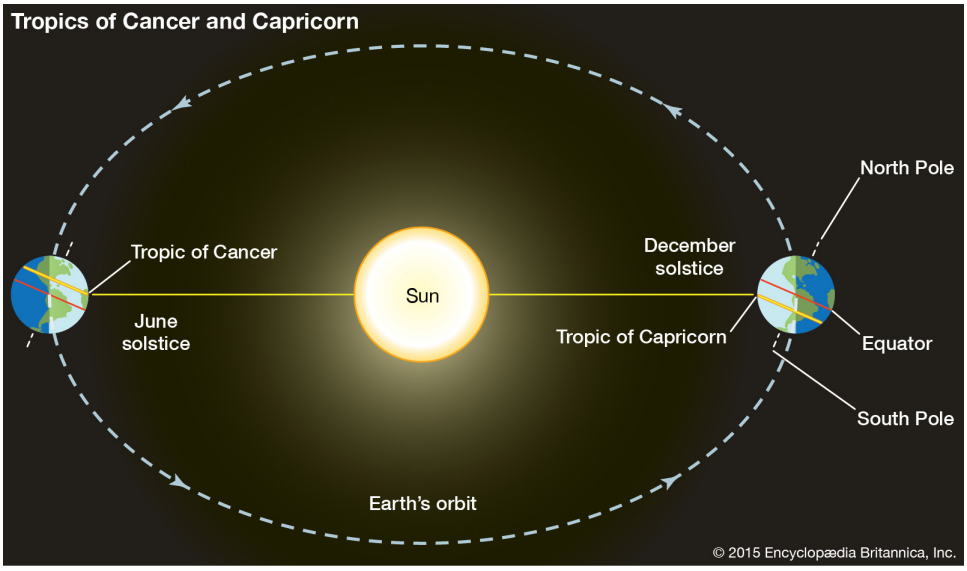
Teacher Presentation: Solar Pathfinder - Solar site analysis

Content:

- Solar Pathfinder Demonstration
- Pathfinder Overview

IMPLEMENTATION (LESSON PLAN)

1. Solar production relies heavily on the intensity and position of the sun.
2. The sun always rises in the east and sets in the west. Depending on what hemisphere you are in and how close you are to the equator the Sun can also mostly be in the southern or northern sky. Since Philadelphia is in the northern hemisphere the sun is mostly in the southern sky as it moves from east to west (remember, the sun is not actually moving, Earth is rotating). Earth rotates from west to east and makes the sun appear to move from east to west.
3. Did you know that Earth is actually closer to the sun in the winter time than in the summertime? Yes, it's true. The reason the temperature is colder in the winter is not because of the earth's proximity to the sun, it is because of the angle the sun's rays hit Earth. During the summer the sun's rays hit the earth at close to a 90º degree angle. During the winter the sun's rays can hit the earth at around a 45º.
4. So, the sun not only moves from east to west every day, but it also slightly changes the angle that the rays hit Earth. When the sun is at its lowest point in the sky it's called the winter solstice. When the sun is at its highest point in the sky it's called the summer solstice. When the sun is exactly between its highest and lowest points its called the equinox.
5. The equator is an imaginary line around the center of the earth and is considered zero degrees latitude. Traveling north or south from the equator will result in the degrees of latitude increasing. For example, Philadelphia is at about 39º latitude. This means it is 39º from the equator.
6. The Tropic of Cancer (or Northern Tropic) is about 23º north of the equator and the Tropic of Capricorn (or Southern Tropic) is about 23º South of the equator.



7. If you live in the Northern Hemisphere then the June solstice is the summer solstice (the longest day of the year) but if you live in the southern hemisphere then the June solstice is the winter solstice and it is the shortest day of the year. All of this is a result of the fact that while Earth is constantly rotating it is also tilted on its axis in respect to how it faces the sun. The tilt of Earth and its orbit around the sun creates different angles that the sun's rays hit the earth throughout the year which in turn creates the seasons.
8. The closer you get to the equator the hotter it gets because the sun angle remains more consistently close to 90º.

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IMPLEMENTATION (LESSON PLAN) - CONTINUED

9. At the equator a solar system should be laid flat as the Sun will be in the northern sky for half of the year and in the southern sky for the other half of the year.
10. The closer you are to the equator the greater the sun hours per day. For example, Miami has more daily sun hours than Philadelphia because Miami is much closer to the equator than Philadelphia.
11. Peak sun hours (PSH) is the term solar professionals use to describe the number of hours with bright sunlight. It is typically average. So on a cloudy day you may get 2 peak sun hours as a result of all of the light that hits the earth for the entire day. Philadelphia averages about 4.5 PSH per day.
12. More PSH means more solar energy! So the closer you get to the equator, the more energy a solar panel will produce. For example, a 400W panel in Philadelphia will create 1.6kWh of energy per year whereas that same panel in Miami will produce a little over 2.0 kWh per year.
13. A sun path chart shows the position and altitude of the sun throughout the year at a given latitude.
14. A solar path finder has a sun path chart and allows you to look at a reflection of the surrounding physical environment overlaid on that sun chart so you can determine if an obstruction is going to shade your solar system and, if so, at what points in the year the shade will affect the solar array
15. DEMO: Solar Path Finder.

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