Good Day Sunshine!

Student Objective

The student:
- will be able to explain the relationship between the amount of sunlight and the power produced by a photovoltaic device
- given a graph of a photovoltaic system's power output will be able to deduce what the weather was for the given day

Key Words:
hypothesis
irradiance
irradiation

Time:
1 class period

Materials:
- computer with internet access
- Science Journal pages

Background Information

The performance of the school's solar photovoltaic system at any given time depends primarily on the amount of sunlight available to it. On bright, sunny days, the system gradually produces more and more energy throughout the day until the sun is directly overhead. A graph showing the energy production of the PV system over time on a sunny day will resemble a smooth, tall, bell shaped curve.

On consistently overcast days, the curve will have the same width but will be much lower, and on partly cloudy days with patched of clouds intermingled with bright sun, the curve will tend to be spiky, showing that the system produces more energy during sunny periods and less energy during cloudy periods.

Procedure

1. If necessary, divide the students into groups according to how many computers are available to them.
2. Lead a review discussion on their findings during the *Solar Powered System* activity as it related to sun and shade.
3. Students should complete their Science Journal pages. Assist them as needed. Instruct the students to use the information and graphs from the Sun Town site on the EnergyWhiz page (find it in the school name pull downs). This ensures that they will be using graphs that will be easy for them to analyze.

4. If the students are unable to print the graphs for use in the exercise, they can trace them off of the screen using tracing paper.
5. After the students complete their Science Journal pages, lead a discussion on their findings. Points to include are:
    - Temperature has less to do with the amount of total irradiance than cloud cover.
    - Florida has rainy seasons, and times of afternoon thunderstorms. This reduces the total amount of sunlight we receive.

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Grade 3										
The Practice of Science	Big Idea 1	SC.3.N.1	**X**	**X**				**X**	**X**	
Grade 4										
The Practice of Science	Big Idea 1	SC.4.N.1	**X**	**X**		**X**				
Earth in Space and Time	Big Idea 5	SC.4.E.5			**X**					
Grade 5										
The Practice of Science	Big Idea 1	SC.5.N.1	**X**							

Third Grade Benchmarks
Science–Big Idea 1: The Practice of Science

- SC.3.N.1.1 - Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
- SC.3.N.1.2 - Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.
- SC.3.N.1.6 - Infer based on observation.
- SC.3.N.1.7 - Explain that empirical evidence is information, such as observations or measurements, that is used to help validate explanations of natural phenomena.

Fourth Grade Benchmarks
Science–Big Idea 1: The Practice of Science

- SC.4.N.1.1 - Raise questions about the natural world, use appropriate reference materials that support understanding to obtain information (identifying the source), conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
- SC.4.N.1.2 - Compare the observations made by different groups using multiple tools and seek reasons to explain the differences across groups.
- SC.4.N.1.4 - Attempt reasonable answers to scientific questions and cite evidence in support.

Science–Big Idea 5: Earth in Space and Time

- SC.4.E.5.3 - Recognize that the Earth revolves around the Sun in a year and rotates on its axis in a 24-hour day.

Fifth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.5.N.1.1 - Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

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hypothesis – An explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation.

irradiance - The measure of the power density of sunlight. Expressed in watts per square meter.

irradiation - The measure of the energy density of sunlight reaching an area summed over time. Usually expressed in kilowatts per square meter per day.

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Scientists have been collecting irradiance data from places all over the world since 1960. This data has been used to calculate the average amount of sunlight at these places for different times of the year. In order to make the data comparable from place to place and average out the effects of daily weather, the data is converted into an equivalent number of 'Sun Hours' (the amount of time that the sun is very, very bright and intense). A very sunny day would have a value of 4 - 6 Sun Hours while a cloudy day may only have the equivalence of 1 Sun Hour.

The irradiance data for Orlando, Florida is shown below for panels that are flat to the ground (0° tilt), 20°, 30°, and 40° tilt off the ground:

Insolation (irradiance) – for Orlando, FL (28.55° North Latitude)

Panel Tilt	Jan	Feb	Mar	Apr	Ma	Jun	July	Aug	Sept	Oct	Nov	Dec	Yearly
0°	3.14	3.92	4.99	5.99	6.27	5.78	5.68	5.28	4.72	4.11	3.46	2.92	4.69
20°	3.92	4.56	5.36	6.01	5.99	5.41	5.37	5.18	4.90	4.63	4.23	3.74	4.94
30°	4.19	4.75	5.39	5.85	5.67	5.07	5.06	4.99	4.86	4.75	4.49	4.04	4.93
40°	4.37	4.82	5.31	5.56	5.24	4.63	4.66	4.69	4.71	4.76	4.64	4.24	4.80

1. According to your school's data page, what is the tilt of your school's panel? _____

Use the tilt angle in the table above that is closest to your schools system's tilt angle to answer the following questions.

2. According to the chart above, which month has the greatest amount of Sun Hours, March or August? _____

3. We usually think of the summer months as being the sunniest and therefore the best for photovoltaic systems. From the data table above, do the summer months (June, July and August) have the most Sun Hours?

_____

4. Which month out of the year has greatest amount of Sun Hours? _____

5. Which month of the year has the least amount of Sun Hours? _____

8. Why do you think April and May have more Sun Hours than July in Florida?

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