Solar Education for NY
SchoolPower ...Naturally

Solar Kit Lesson #2

Sunshine Timer

TEACHER INFORMATION

LEARNING OUTCOME
After collecting data on cloud cover using a simple instrument and displaying data through graphs, tables, and charts, students interpret data for patterns of cloud cover that affect solar-powered energy production and predict energy production under given cloud conditions.

LESSON OVERVIEW
Students use a simple and easy-to-understand homemade technological device, the sunshine timer, to monitor cloud cover over an extended study period. They become habituated to observing conditions in the sky such as location of the Sun and types of clouds present. This study provides daily and weekly opportunities for students to collect and display data; use graphs, tables, and charts to interpret data; make predictions; and relate patterns of cloud cover to their effect on solar energy production.

GRADE-LEVEL APPROPRIATENESS
This Level I/II Physical Setting lesson is intended for use in grades 3–6. It can easily be adapted for grades 7 and 8.

MATERIALS
- Student handouts
- 1 V, 400 mA mini–solar panel*
- Analog DC-powered clock (must run on one AA battery)
- Maximum temperature thermometer
- Highlighter (optional)

* Available in the provided Solar Education Kit; other materials are to be supplied by the teacher

SAFETY
Tell students not to look directly at the Sun. Permanent eye damage can result.

TEACHING THE LESSON
This lesson could easily be adapted to encompass fractions and percentages. It could readily be transferred to computer data-management software such as spreadsheets.

Preparation—Set up the sunshine timer: Remove the AA battery from the DC-powered clock. Use alligator clips to connect the mini–solar panel's red lead to the clock's positive (+)

battery terminal and black lead to the negative (-). The clock will run when the mini–solar panel is aimed at the Sun unless a cloud obscures the Sun. Set the clock to noon at the start of a data collection period. The clock will advance as long as clouds do not cover the Sun. In this way, the clock will record the number of hours of unobscured sunlight. Students can subtract the number of hours the clock advances from the number of hours of data collection to get the number of hours of cloud cover.

The clock can be powered by a mini–solar panel that is aimed within 45 degrees of facing the Sun directly. From August through April the Sun is within 45 degrees east of south to 45 degrees west of south for a three-hour period centered on noon. From May through July you will need to shorten the daily data collection period to two hours because the Sun will be at too great an angle from due south during the three-hour period centered on noon. Alternatively, you can extend the daily data collection period by adjusting the direction of the sunshine timer to track the Sun.

Opening Discussion: Begin by discussing how solar electric systems depend on radiation from the Sun to produce power. Demonstrate a mini–solar panel powering a small motor. Mention that the School Power Naturally project has installed solar electric systems in 50 New York State schools to partially address their energy needs. Explain that solar electricity is a growing energy source throughout New York State. Use information from the Background Information section to introduce the idea of peak electrical demand and the fact that the highest demand for electricity occurs during hot summer days when there are large amounts of sunshine.

Ask students what might hinder our using sunshine for electricity. What might New York State decision makers want scientists to study to determine if solar electric panels are a good way to supply electricity in the middle of the day?

Tell the students that they will conduct a long-term study of middle-of-the-day cloud cover. Demonstrate how the sunshine timer works and give students an opportunity to handle the timer and become familiar with it.

Help students determine where in the school or in the classroom they can place the cloud meter. It must receive sunlight for one to three hours around noontime unobscured by the shadows of trees, buildings, or other objects. It must face due south and tilt up at an angle to face the Sun at around noon. It must be protected from the weather.

Data Collection: Distribute the student handouts and explain the daily cloud logs. Have students record the length of the data collection period for each day and convert the time to minutes. At set intervals during the daily data collection period, have students check off the box that best fits the current cloud conditions. Have students use the “Weather Notes” section to record daily peak temperature. They could also use it for additional work involving cloud identification or to record experiences for other weather observation opportunities that you may want them to have.

Prediction: At or before the end of the data collection period, but before students check the sunshine timer, have them make a prediction on how many minutes of sunshine will have been recorded.

Data Collection: Have students record the length of sunshine for each day and convert it to minutes.

Data Calculation: Have students subtract the number of minutes of sunshine from the number of minutes for the data collection period to get the number of minutes of cloud cover. Students who would benefit from additional work with fractions or percentages might use these numbers for daily practice and to form additional weekly graphs.

Graphing: Distribute and explain graphs 1–3. Help students label the *x*- and *y*-axes. In the title of graph 2, students must fill in the number of minutes of the daily data collection. Have students fill in these graphs on a regular basis—for instance, daily or once a week.

Graph 1: This graph is actually five bar graphs on top of one another. Students should use a different color for each weather condition. For each day, have students record the number of times each weather condition is observed.

Graph 2: Have students graph their predictions with a pencil dot and the measured value as a bar colored with a highlighter.

Graph 3: Have students graph the peak daily temperature as a line graph.

Review Questions: Go over appropriate review questions daily, weekly, or at the end of the data collection period.

Have your predictions on the amount of sunshine improved over time? Have students discuss why.

What types of clouds or cloud cover seem to affect solar energy production the most?

What types affect it the least?

Visit schoolpowernaturally.org online to compare your data with the data available from the 50 New York schools having solar electric systems.

How do the solar intensity readings collected by the School Power Naturally schools compare to your daily sunshine readings? Have students discuss why these may be the same or different. Have them consider the length of time of daily data collection and the location of the schools.

How could solar electric power help provide electricity for the high midday demand of high-temperature days?

ACCEPTABLE RESPONSES FOR DEVELOP YOUR UNDERSTANDING SECTION

The results will vary depending on the kind and extent of cloud cover during the data collection period.

ADDITIONAL SUPPORT FOR TEACHERS

SOURCE FOR THIS ADAPTED ACTIVITY

The idea of using a solar-powered clock as a sunshine timer came from *Science Projects in Renewable Energy and Energy Efficiency*, written and designed by the National Renewable Energy Laboratory and published by the American Solar Energy Society, 1991.

The organization of classroom activities was adapted from *Renewable Energy Activities for Earth Science* prepared for the U.S. Department of Energy by the Solar Energy Project in cooperation with the New York State Education Department and the University at Albany Atmospheric Sciences Research Center (out of print).

BACKGROUND INFORMATION

Daily peak needs for electrical power in New York State's large metropolitan areas are closely coincident with available sunlight. New York's highest power demands occur during summer heat waves, when there are large amounts of sunshine.

Studies conducted by the University at Albany Atmospheric Sciences Research Center show that for the mid-Atlantic region (including downstate New York) sunlight is available when it is needed to offset peak power 60% to 70% of the time. This is comparable to much of Arizona, Florida, and California—the "traditional" solar areas.

The result is that, together with very small amounts of backup power (such as batteries) and/or programs to reduce peak demand for electricity, solar electric panels could provide a 100% guaranteed peak power source for New York's metropolitan areas.

REFERENCES FOR BACKGROUND INFORMATION

Why PV Makes Sense in New York State. University at Albany Atmospheric Sciences Research Center, 2001

LINKS TO MST LEARNING STANDARDS AND CORE CURRICULA

Standard 1—Analysis, Inquiry, and Design: Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Mathematical Analysis Key Idea 1: Abstraction and symbolic representation are used to communicate mathematically.

Key Idea 2: Deductive and inductive reasoning are used to reach mathematical conclusions.

Key Idea 3: Critical thinking skills are used in the solution of mathematical problems.

Scientific Inquiry Key Idea 1: The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Key Idea 2: Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

Key Idea 3: The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

Standard 3—Mathematics: Students will understand mathematics and become mathematically confident by communicating and reasoning mathematically, by applying mathematics in real-world settings, and by solving problems through the integrated study of number systems, geometry, algebra, data analysis, probability, and trigonometry.

Key Idea 1: Students use mathematical reasoning to analyze mathematical situations, make conjectures, gather evidence, and construct an argument.

Key Idea 2: Students use number sense and numeration to develop an understanding of the multiple uses of numbers in the real world, the use of numbers to communicate mathematically, and the use of numbers in the development of mathematical ideas.

Key Idea 4: Students use mathematical modeling/multiple representation to provide a means of presenting, interpreting, communicating, and connecting mathematical information and relationships.

Key Idea 5: Students use measurement in both metric and English measure to provide a major link between the abstractions of mathematics and the real world in order to describe and compare objects and data.

Key Idea 6: Students use ideas of uncertainty to illustrate that mathematics involves more than exactness when dealing with everyday situations.

Key Idea 7: Students use patterns and functions to develop mathematical power, appreciate the true beauty of mathematics, and construct generalizations that describe patterns simply and efficiently.

Standard 4—The Physical Setting: Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 1: The Earth and celestial phenomena can be described by principles of relative motion and perspective.

Key Idea 4: Energy exists in many forms, and when these forms change energy is conserved.

Standard 5—Technology: Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.

Key Idea 2: Technological tools, materials, and other resources should be selected on the basis of safety, cost, availability, appropriateness, and environmental impact; technological processes change energy, information, and material resources into more useful information.

Standard 6—Interconnectedness: Common Themes: Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

Key Idea 2: Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.

Key Idea 5: Identifying patterns of change is necessary for making predictions about future behavior and conditions.

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www.nyserda.org

Should you have questions about this activity or suggestions for improvement, please contact Chris Mason at cmason@nesea.org.

(STUDENT HANDOUT SECTION FOLLOWS)

Name ___________________________________

Date ____________________________________

Sunshine Timer
Daily Cloud Log

Data collection period: hours ____________ minutes ____________

converted to minutes _____________

Cloud Conditions

	Starting Observation	At the end of the 1st hour	At the end of the 2nd hour	At the end of the 3rd hour
Clear blue sky				
Heavy clouds passing by				
Thin clouds passing by				
Heavily overcast sky				
Light hazy sky				

Weather Notes

Daily peak temperature ___________

Prediction

Over the data collection period, I predict that we received ____________ minutes of sunshine.

Measured Data

length of time of sunshine: hours ____________ minutes ____________

converted to minutes _____________

Calculated Data

number of minutes of the data collection period min.

minus number of minutes of sunshine — ____________ min.

number of minutes of cloud cover min.

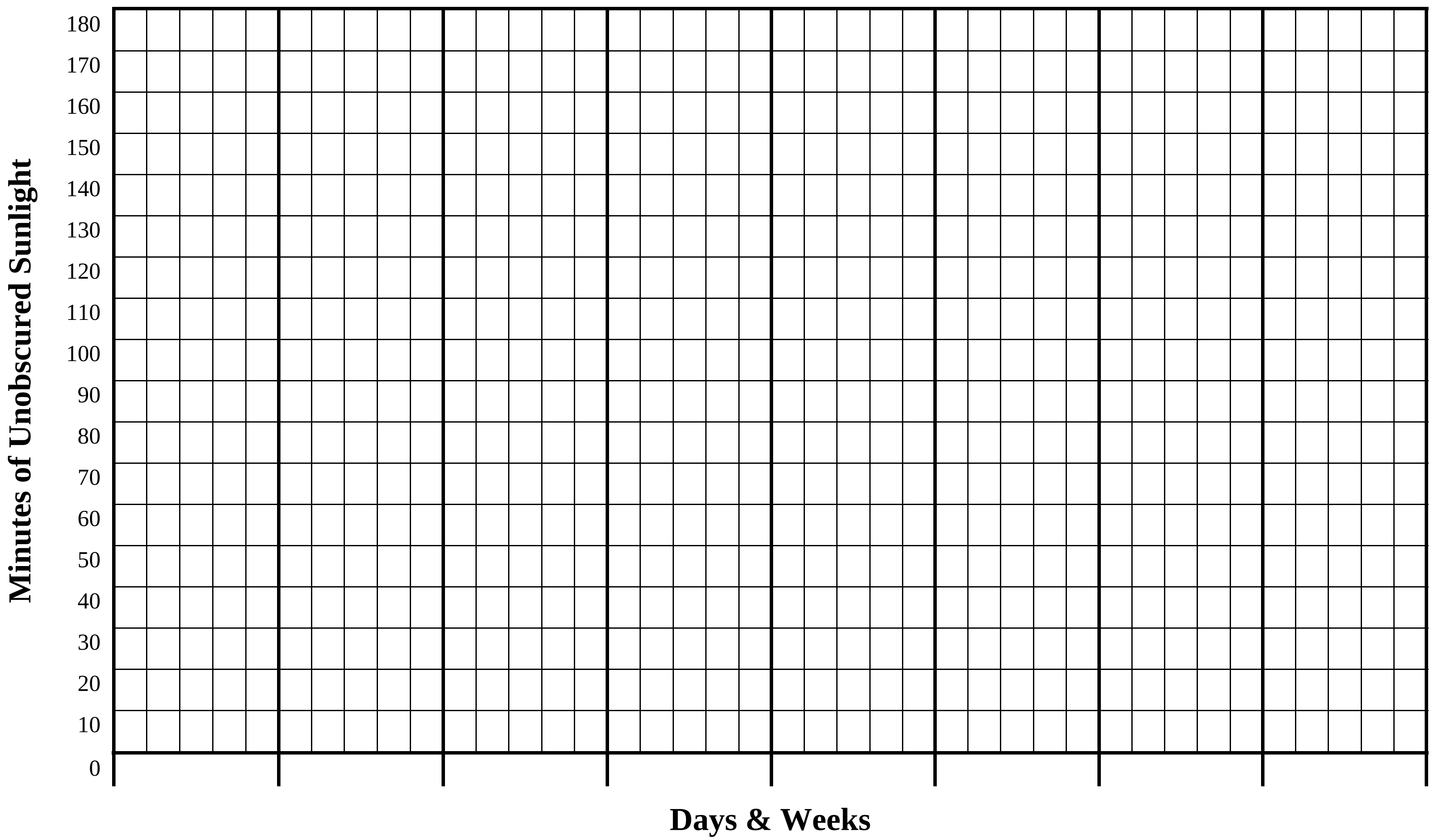
Name ______________________________

Graph 1
Cloud Cover Conditions Over the Sun

Days & Weeks								
Clear blue sky								
Heavy clouds passing by								
Thin clouds passing by								
Heavily overcast sky								
Light hazy sky								

Name ________________________________

Graph 2
Minutes of Sunshine per ______-minute Period



Name ___________________________________

Graph 3
Daily Peak Temperature