Solar Site Assessment

AUTHOR: Clayton Hudiburg

DESCRIPTION: Students will do an actual site assessment to determine the available solar resource for a chosen location.

GRADE LEVEL(S): 9, 10, 11, 12

SUBJECT AREA(S): Solar energy, renewable energy, design

ACTIVITY LENGTH: 1 hours, 50 minutes

LEARNING GOAL(S):

- Students will be able to use a Solar Pathfinder to determine the amount of solar resource lost to shading from nearby trees, buildings, etc.
- Students will be able to calculate the number of kWh of electricity that can be produced in a specific location and in a specific sized area.
- Students will be able to calculate the amount of carbon emissions that can be offset due to installing photovoltaic panels of various sizes.
- Students will be able to calculate the size array needed to offset all electricity use for the high school.

STANDARDS MET:

Next Generation Science Standards:

- HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics, as well as possible social, cultural, and environmental impacts.

- HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles and energy associated with the relative positions of particles.

……

Student Background:

- My students will be completing this unit near the end of the school year after having already been through units on energy and climate change. Therefore, I am taking for granted that they already understand the need for technology such as photovoltaics, along with an understanding of the difference between renewable and nonrenewable resources.
- Students should also have had some exposure to the Solar Pathfinder tool. My students will already have completed a practice exercise called “Solar Pathfinder Tutorial.”

Educator Background:

- Teachers should have some level of comfort with photovoltaic technology, including knowledge about the specific photovoltaic modules students will use as a design template.
- I chose a 2 kW array because the size is easy to work with for small groups. The actual size of each module can be found by looking at a specification sheet for whatever manufacturer you choose. We are using the output and sizing for the 200-Watt panels produced by Silicon Energy because they are made in Washington State where my school is located.

Science Kit Materials List:

- (1) Solar Pathfinder

Other Materials List:

- “Student Worksheets #6 and #7”
- Digital camera
- Stool or chair to raise pathfinder to desired height
- Bean bag (optional, depending on reading location)
- Plywood (for a wider base, if desirable)
- Calculator
- (4) wooden stakes
- (3) “sprinkler flags”
- Tape measure (metric)
- String

Vocabulary:

- Photovoltaic module
- Photovoltaic array
- Geographic north
- Magnetic north
- Magnetic declination
- Obstruction
- Sun-path diagram
- Tilt
- Orientation

……

Lesson Details:

Day 1:

Opening (15-20 minutes)
Prior to the start of class, have your school's satellite image pre-loaded and ready to show your class. Spend some time having your students (already in groups of three) choose a location to run their site-assessment. I find that the satellite image works well because, for a large campus, it is far easier to spot good locations in a short period of time. It may also be helpful to identify "off-limits" areas. Also, it may be best to have the student groups try to go to different parts of campus and not all choose the same open field. You may even want to assign locations if you choose.

Hand-out the Solar Pathfinders to each group and have them quickly review how to assemble and record measurements using the device.

Once students have a general idea of where they would like to run their site assessment, hand out student sheets #6 and #7.

Body (20-30 minutes)
Have the students first read through student sheet #6. Students may wonder why the rectangle they mark-out with string is smaller than the actual dimensions of the array. If so, you could quickly give a geometry lesson (the array is tilted 35 degrees in these materials, but you could change this to be optimal tilt in your geographical region).

Allow students to identify any confusion they may have and attempt to clear up any ambiguity.

Next, direct their attention to student sheet #7 and go over what is expected by the end of the activity. I would focus on just the measurement side of the sheet for now then move to clearing up the calculation side later.

Once students are clear on what exactly they will be doing, have them take their solar pathfinders outside (without the stools, measuring tape, etc.) to the location they have chosen. They should do a quick “eye-ball” estimate by looking at the projection on their sunpath diagram to identify the best 2m x 6m space in the general area they have chosen.

Day 2

Opening (10 minutes)
Do a quick review of the task and expectations.

Body (20-30 minutes)
Have the students gather all materials listed and prepare to go to their location and take the three measurements indicated in the directions. They should double-check each of their digital photographs to make sure they are “readable” before heading back to class.

Closing (rest of class period)
Have the students use their digital photographs to fill-out the data tables.

Day 3

Opening (15 minutes)
It is likely that students will be at various stages of completion, but it will probably be necessary to give some direct instruction regarding the follow-up calculations around this time. Structure this time in your own way.

Body (rest of class period)
Set some benchmark or time limit to finish all tables and calculations. Again, use your own judgment as to how much time and help you want to give each group.

Assessment (3-4 days)
I am choosing to run my assessment in two parts. For part one, I will have each group compile their results into a presentation (poster, electronic, etc.). For part two, I will have some “fake” data ready and test each individual student’s mastery of the calculations done during the activity.

BONNEVILLE ENVIRONMENTAL FOUNDATION
240 SW 1st Avenue
Portland OR 97204
503-248-1905
www.b-e-f.org