**LESSON 2**

SOLAR ENERGY LAB

GOALS

1. Understand the science behind solar energy
2. Knowing what conditions maximize and minimize solar energy output
3. Calculate the impact of solar energy

MATERIALS

a. Solar Kits (Solar panels, Multi-meters, Alligator Clips and Wires and LED lights)

b. Data graphing programs (graphing calculator, Excel, Logger Pro etc)

c. Solar Energy Lab: Worksheet

BENEFITS

a. Create scientists by working on hand’s on experiments

b. Inspire students to be scientifically curious and interested

ADVANCE PREPARATION

Review the presentation and lesson materials ahead of time.

HANDOUT LIST

1. Solar Energy Worksheet
2. Solar Energy – Talking Points for the instructor
3. Solar Lab – presentation
4. How much Solar Energy do we need? -presentation

PROCEDURE

Duration: 90 minutes

Targeted Students: 9-12 Grade

 **Lesson Agenda:**

1. Introduction: Background Information on Solar Energy (15 minutes)
2. Group Lab Work: Maximizing solar panel output (35 minutes)
3. Analysis, Discussion and Calculation (20 minutes)
4. Review Questions: What did you learn? (5 minutes)
5. Student Questions (15 minutes)

**1. Introduction:**

 How do solar panels harness the energy of the Sun?

 \**Use the Solar Energy - Talking Points for the instructor*:

 \* *Could use Solar Energy Explained Presentation from Lesson 1*

* + Question for the class: Where is solar being used in your home and around your city? Some examples provided below: -
		- Lights, Street Lights
		- Solar chargers for phones
		- Emergency Phones on freeways
	+ Solar Panels are made of PhotoVoltaic (PV) cells grouped on a module. These PV cells produce energy by interacting with sunlight.
	+ Sunlight is the energy released by the fusion process that takes place in the core of the sun. This fusion process to us, here on earth is a combination of light and heat. The basic particles or units of this energy are called photons.
	+ These tiny energy packets called photons are constantly being emitted by the Sun. Let’s learn how these energy packets are converted into electricity by Solar Cells?
		- An electrical current is the flow of electric charge from one point to another. Solar cells are made of semiconductor materials, mainly - and almost exclusively- crystal silicon.
		- There are two types of silicon that work together in transferring sunlight into power. The first is N Type (negative) silicon, which has been added with phosphorus and has much more electrons for photons to "break loose". The second is P Type (positive) silicon, which contains boron thus having free openings, or holes. Putting it simple: N type silicon has charge to give and P type silicon needs charge.
	+ At last, in terms of the electric process, the cell needs to be connected to an external load. Metal contacts are placed both on the n-type and p-type sides of the solar cell, and electrodes (electrical conductor used to make contact with nonmetallic parts) are connected to an external load. Thus negative charges travel to a wire, power the load and continue until reaching a p-type metal contact where it combines with positive charges.
	+ Solar cells are combined within solar panels, which in turn can be wired up in series in order to give off the required levels of power.
	+ Diagram to draw on the board to help explain:



* + Circuits
		- Energy generated from solar panel will power the LED
		- Multi-meter
			* Measure induced current (flow of electrical charge) through the circuit
	+ Solar Kits and materials inside

**2. Group Lab-Work: Maximizing Solar Panel Output**

* Students are divided into small groups. Each group receives a kit and handout.
* Students collect data on the current and voltage generated by their solar panel outside of the classroom. They use three different variations to measure the current and voltage.
	+ Three different variations are: -
		- Light intensity
			* Shade, direct sunlight, inside the classroom
		- Angle from sun (perpendicular, 45 degree, etc.)
			* Angle to the ground: 0,45,90
		- Orientation
			* North, East, South, West
			* Reminder: Consider the time of day and position of the sun
* Graph data in terms of the variations in groups
	+ How does the set up affect the current and voltage generated?
* Using Solar Energy to Power Lights:
	+ Calculate: How many LEDs could their circuit power?
	+ Connect circuit to power an LED light.

**3. Analysis, Discussion and Calculations:**

* Each group presents their data:
	+ How did the set up affect the voltage and current? Why?
1. Instructor Lead:
	* How can we maximize solar panel output at a larger scale?
	* In which countries would this technology prove to be favorable?

 **Additional Activity: How Much Sunshine is required to power California?**

 **\*** Support with a Presentation - How much solar energy do we need?

 Duration: 10 minutes

* + Step 1: How much energy does California use in a day?
		- Hint: Used 288,245,000 megawatt hours in 2005
		- Answer: around 780,000 megawatts a day
	+ Step 2: How much energy does one square mile of sunlight produce in 24 hours?
		- Hints;
			* One square yard of land receives 5 kilowatts of energy a day
			* Convert to square miles (1760 yards in a mile: 3,097,600 square yards in a square mile)
			* Most recent solar technology is at most 30% efficiency (multiply by 0.2)
			* Convert to megawatts (divide by 1000)
		- Answer: 3,098 megawatts of energy
	+ Step 3: How many square miles of solar plants will produce enough energy for California?
		- Hint: Use answers to previous two steps
		- Answer: 251 square miles
	+ Step 4: How much is 250 square miles?
		- Ex: comparison to Death Valley (more than 2000 square miles)
	+ Step 5: Think about it!

**4. Review:**

Class discussions. Have students share:

* + How does the solar panel work?
	+ What did they learn about the variation in solar energy output?

**Student Questions:**

Time allocated for students to ask questions regarding the lesson.