

Sunlight versus Artificial Light

A REEL Power™ (Renewable Energy Education Lab) Lesson
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LESSON OVERVIEW

This lesson demonstrates the difference between sunlight and artificial light as it strikes a solar panel. It shows that sunlight provides a constant source of voltage and current while artificial light produces “ripples” due to its AC nature.

LEARNING OUTCOME

Students learn that solar panels can “see” the difference between sunlight and artificial light. Sunlight presents a nearly steady voltage output while artificial light contains “ripples” on the voltage. The ripples are a result of the 60 Hz AC that powers the light bulbs and fluorescent lights.

Students come to understand that:

1. Alternating Current (AC) that powers their classroom lights causes variations in light output at a rate of 60 times per second.
2. Solar panels can detect the light variance while the human eye cannot with the reasons to explain why.
3. Fluorescent light output varies more than incandescent light output along with the reasons why.

STUDENT ACTIVITIES

Students setup the equipment to measure both sunlight and artificial light in the classroom using a solar panel along with the **Smart Meter – Data Logger™** and the classroom computer. Students place the solar panel near a window to capture sunlight and then near incandescent (regular light bulb) and fluorescent lights to capture artificial light. During the course of the lesson students measure and record voltage, current, resistance, power and energy with the **Smart Meter**

– **Data Logger™** and then print out plots of the data on a printer or download data files gathered on the computer to be included in reports about the lesson.

GRADE-LEVEL APPROPRIATENESS

This lesson is appropriate as an introduction to solar energy data interpretation for students in grades 5–10.

LESSON TIME

This lesson should take between 30 minutes to 45 minutes depending on discussion time about the experiment.

SAFETY

Make sure that students do not stand on chairs or table tops to position the solar panels near the light source as injury could occur from a fall.

REQUIRED MATERIALS

Qty	Description
1	Solar Panel
1	Smart Meter – Data Logger™
1	USB cable
4	Clip leads
1	100 ohm resistor
1	Classroom Windows PC computer with REEL Power™ software (MACs must have Parallel's "Desktop 3.0 for Windows")
1	Printer (optional)

PRELIMINARY STEPS

1. Install the graphical software on the classroom computer.
2. Refer to the **Smart Meter – Data Logger™ Tutorial** for extra help.

EQUIPMENT SETUP

1. Setup the equipment as shown in Figure 1 below. Wire the opposite side of the solar panel so that all 3 modules are in series in order to produce maximum voltage. You can use clip leads or the wires with looped ends to hookup the two inner solar modules together (+ to -). Then attach a clip lead from the left-most negative (-) post to the Black Input terminal on the **Smart Meter – Data Logger™** and another clip lead from the right-most positive (+) post to the Red Input terminal on the **Smart Meter – Data Logger™**. Also add a 100 ohm resistor to the Output terminals – the polarity doesn't matter.

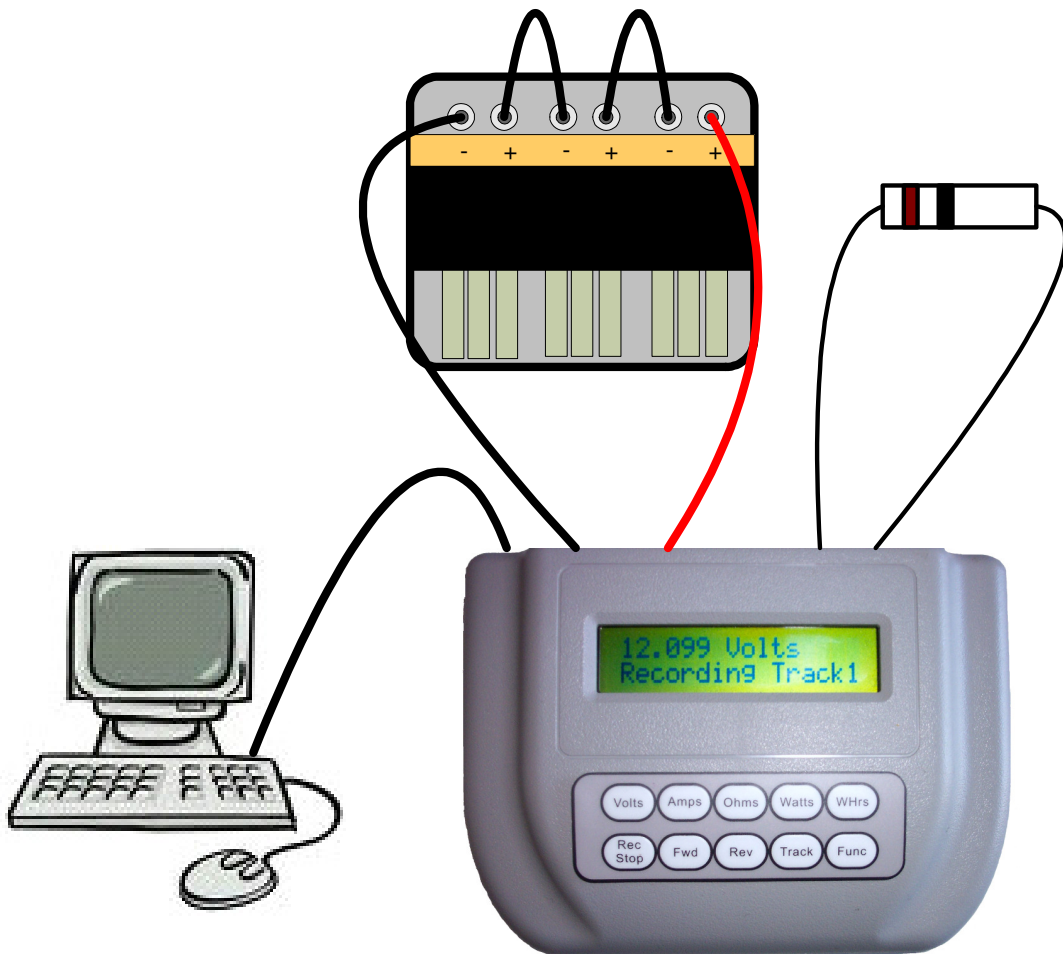


Figure 1 – Initial Equipment Setup

TEACHING THE LESSON

1. Plug in a USB cable between the **Smart Meter – Data Logger™** and the classroom computer and set the switch to the USB position so that it receives power from the computer's USB port. Set the power switch to the USB position and verify the sign on message on the LCD screen.

2. Click on the **REEL Power™** icon to bring up the software menu. Then click on the **MPP Auto Trac – Data Logger** icon.



3. On the computer adjust the voltage (vertical) scale on the **REEL Power™** software to 5.00 volts maximum.
4. Adjust the time (horizontal) scale on the **REEL Power™** software to show a red line marching across the bottom of the plot area.

5. Point the solar panel to a window to capture sunlight. Note the steady "line" of voltage as in Figure 2. Point this out to the students as they watch. Optionally, click on the snapshot icon to capture a screen shot of the data for later print out or inclusion into reports.

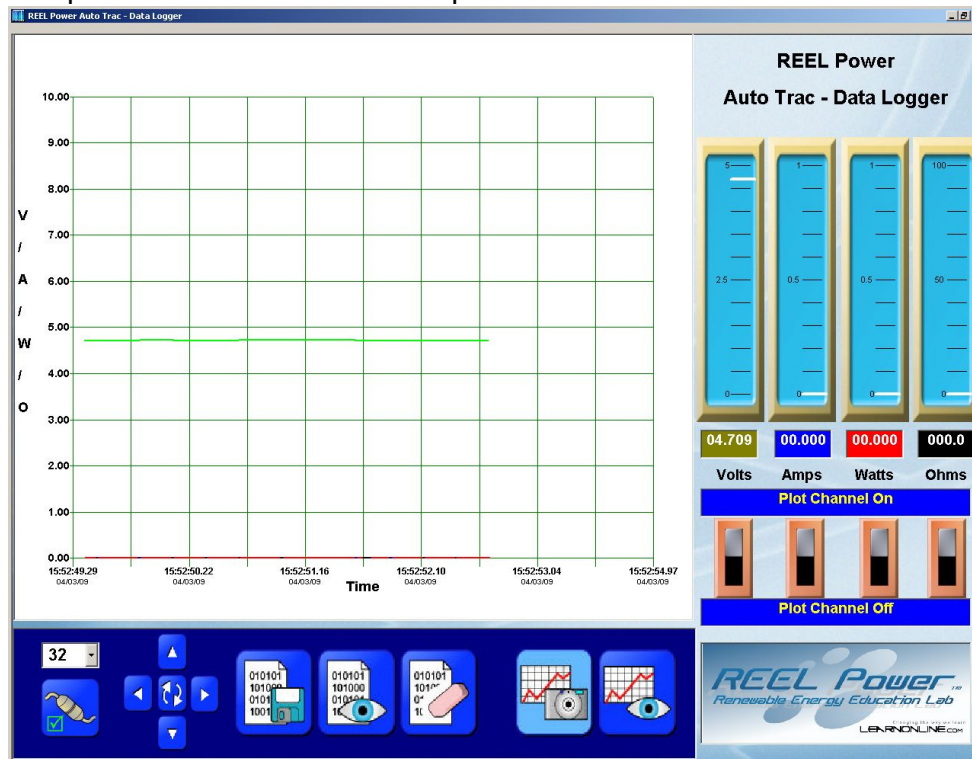


Figure 2 – Plot of Sunlight Captured by the Solar Panel

- Now point the solar panel to the fluorescent lights overhead or to an incandescent light bulb. Note the presence of ripples on the waveform as in Figure 3. Point out to students that the ripples are caused by the alternating voltage that is illuminating the light. Moving the solar panel closer to the light generates more voltage and visa versa.

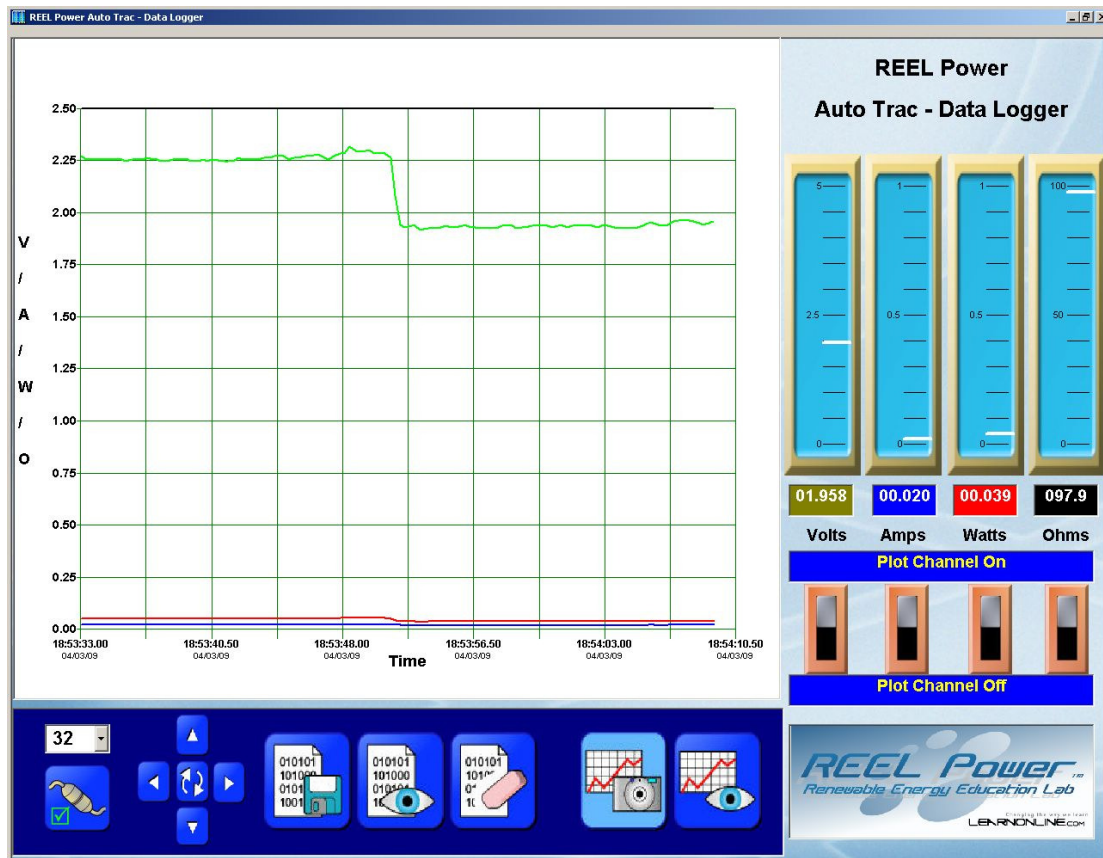


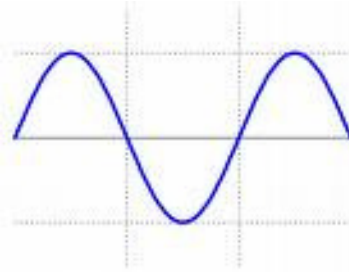
Figure 3 – Plot of Artificial Light Captured by the Solar Panel

DISCUSSING THE LESSON OUTCOME

The important points to relate to student are:

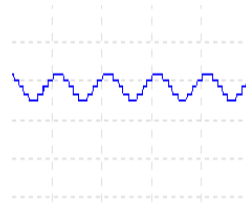
1. Sunlight is a steady source of light, since it is produced naturally.

2. Artificial light that is generated from power coming into the school or home from a power plant is not steady and has ripples. This is caused by the voltage varying 60 times a

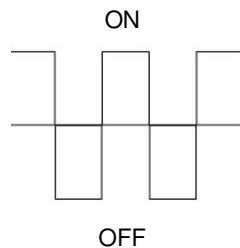


second (60 Hz), which is a result of the rotating machines (called generators) that produce the power.

3. Incandescent light bulbs have filaments that glow when electricity is applied. The filament keeps the light at nearly a constant brightness; however, there is some ripple on the light output caused by the 60 Hz current. Light from a DC source like a flashlight bulb is steady with no ripples, but light from an AC source like wall voltage contains ripples.



4. Fluorescent light varies more than incandescent light because it has no filament to keep the light steady. Fluorescent light is created by illuminating a gas and it looks like this – turning completely ON and OFF 60 times a second! This is why some people get headaches after being in fluorescent light for an extended period of time. Fluorescent lights are more efficient than incandescent lights but do have this disadvantage.



5. The human eye doesn't see the ripples or flicker from these lights because it occurs too fast. This is the same reason that the human eye perceives motion pictures as moving even though they are still pictures displayed on the screen at 24 frames per second. Any slower than 24 frames per second for movies and 60 Hz for light and the human eye will detect the flicker. Solar panels can see the flicker as seen in the plots.

TEACHER TIPS AND GUIDELINES

- For class work have students research incandescent lights and fluorescent lights on the web or in books and magazines.
- The purpose of the research is to show how the difference in power versus light output between the two types of lights.
- For example, a fluorescent light produces the same, or more, light for much less power. Therefore, it is more efficient in producing light – and not light and heat as in an incandescent bulb.
- Repeat the experiment with a 100 watt incandescent lamp shining on the solar panel versus a 100 watt fluorescent lamp doing the same. Show that the solar panel output voltage is greater for the fluorescent lamp, since it generates more light output as compared with the incandescent lamp.
- Have students record the data then capture and print out screen images for their reports.
- Click this icon to capture screen images.
- On the computer go to **C:\My Documents\Reel Power\Data** to find and to copy the images for print out or inclusion into reports.

