Experiment 4
Topic: Solar Panel
Week B Procedure

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Office/Hours	12/05 – 12/06 from 5:00 pm to 6:00 pm in Fitzpatrick B14
E-4 Website:	http://www.nd.edu/~jott/Measurements_lab/E4/

Overview

In Week 2, you will conduct an independent study of the solar panel. Think of this as a field test in which you are analyzing the practicality of solar power in a given setting for a given application. You will have to conduct *at least* two different field tests in different locations and/or using different types of solar panels.

Laboratory Equipment

There are a few different solar panels for you to choose from, including the small 5W panels from week A and larger 20W panels that are either "polycrystalline" or "monocrystalline".

Do **NOT** use the 20W solar panel with the irradiance box. It will burn out the resistors. We have special power resistors for you to use with the 20W panels.

Experimental Setup

You will repeat exercise (a) of Week A to obtain *at least* two different efficiency curves. You will then analyze the solar panel's usefulness under these conditions. You may compare different lighting conditions and/or different solar panels (i.e. polycrystalline vs. monocrystalline).

The instructions from Week A exercise (a) are repeated here for convenience.

1. Set the toggle switch to "*Short*"(load toggle in Figure 1) and insert a shorting pin in "*Input B*"(input 2 in Figure 1).
2. Connect the leads of the solar panel into "*Input A*" (input 1 in Figure 1).
3. Connect the "*Voltage*" (V_{meas} in Figure 1) leads to the top Sensor Interface Box

meter and connect the Irradiance Sensor leads to the bottom Sensor Interface Box meter.

4. To measure the current, use a multi-meter set to the 200mA range. Do not use 10A jack.

5. Locate the **Irradiance Sensor**. It has twelve different settings that can be chosen for sensitivity and scaling of the voltage output. Setting (9) is recommended for this laboratory exercise. Professor Patrick Dunn has created a document that explains how to determine the irradiance in $\mu W/cm^2$. This document can be found on the E4 website.

6. You will now record the effect of resistive loads on output power of the solar panel. Be sure the resistance knob is turned counterclockwise completely and record the first line in Table 1. Each clockwise click on the knob increased the resistance by 200 Ω. Continue measuring and recording in Table 1 to a resistive value of 2000 Ω.

NOTE: Care should be taken to insure that the proper resistance is set on the knob.

Location Notes

In your lab notebook, make detailed notes, such as: location, light source, temperature, etc., which may affect the outcome of your experiment and include it in your report/discussion.

Efficiency Curve 1

Do NOT use the 20W solar panel with the irradiance box. It will burn out the resistors. We have special power resistors for you to use with the 20W panels.

Location:____

Type of light source:____

Type of solar panel:____

Irradiance Voltage:____

Irradiance Sensor Setting:_______________________________________

Table 1: Data for efficiency curve 1

Load [Ω]	I_{out} **[mA]**	V_{out} **[V]**	$P = I\ V$ **[mW]**
Short circuit current			
Open circuit voltage			
0			
200			
400			
600			
800			
1000			
1200			
1400			
1600			
1800			
2000			

Efficiency Curve 2

Do NOT use the 20W solar panel with the irradiance box. It will burn out the resistors. We have special power resistors for you to use with the 20W panels.

Location:____

Type of light source:____

Type of solar panel:____

Irradiance Voltage:_______________________________________

Irradiance Sensor Setting:__________________________________

Table 2: Data for efficiency curve 1

Load [Ω]	I_{out} **[mA]**	V_{out} **[V]**	$P = I\ V$ **[mW]**
Short circuit current			
Open circuit voltage			
0			
200			
400			
600			
800			
1000			
1200			
1400			
1600			
1800			
2000			

Feel free to record any additional efficiency curves that you deem necessary for your study.

Case Study

Perform a *quantitative* analysis of the practicality of solar energy. Think of various applications where solar power could be used as an energy source (i.e. powering a cell phone, a laptop, a washing machine, and air conditioner, or an electric vehicle). Look up how much power these various devices require. Would solar energy be feasible? How many batteries would you need to run the various devices and appliances? How many panels would you need to charge these batteries in a single day?

Lastly, look up the average irradiance of the sun in northern Indiana and compare it to other locations around the world. How does northern Indiana compare?

Overall, this analysis must be quantitative in nature. A bland discussion of energy policy will be awarded no points!

Week B Deliverables – You are required to include the following items in your lab report. (See the E4 score sheet for points.)

1. A plot and/or table of data for at least two different conditions studied in the independent field tests.

2. A *quantitative* analysis of the solar panels' usefulness for various different applications and the two different locations on campus. Your analysis should include a table summarizing the important numbers from your analysis.

3. An original schematic illustrating any of the exercises from either week of lab 4 or illustrating a practical use for solar panels.

Suggested Talking Points – This lab is to test your ability to work *independently*, so these are merely *suggestions*. Feel free to be as creative as possible in your analysis.

- Look up the specs for the 12V battery. Based on the current you measured in your field tests, how long would it take to charge the 12V lead acid battery?

- Look up how much power is used by various items such as a cell phone, a lap top, an LED lamp, and incandescent lamp, an air conditioner, and electric heater, an electric vehicle, a washing machine, a clothes dryer, etc. Quantitatively analyze how many solar panels would be needed.

- Look up the efficiency of other solar panels. How do the ones you tested compare?

- Analyze the monetary cost of implementing a solar panel array. Be sure to include the cost of the batteries for energy storage at night and available tax credits. How long would it take to recoup the initial cost of building the solar array?

- Solar panels do not work at night, so it is necessary to store some of the energy produced during the day. Do some research on existing battery technology. For example, a large portion of Tesla's business model is to sell their Lithium ion batteries for just this purpose.

- Look up the solar irradiance in various parts of the world. How do your locations compare?

- Look up the total energy consumption for the United States and the World. How many of these solar panels you need to meet these energy demands?

- If you are truly a dreamer and have faith in unbound progress, do a Google search of "Dyson Spheres" and see how deep the rabbit hole goes!