# Lab 27 Power and Energy

Name: _____ Lab Partner(s): _____

**Driving Question**

How are power and energy related to voltage and current? What is the difference between power and energy?

Power and energy are closely related but describe different ideas. Energy is the total amount of work that can be done or has been done—it represents the capacity to cause change. Power describes how quickly that energy is transferred or converted from one form to another.

In electrical systems, power depends on both voltage and current. Voltage represents the electrical "push" that drives charges through a circuit, while current is the flow of those charges. Together, they determine how rapidly electrical energy is delivered or used.

A wind turbine converts mechanical energy from moving air into electrical energy using electromagnetic induction. The spinning blades drive a small generator that produces a voltage, and when connected to a circuit, current flows through the load. The electrical power produced tells us how rapidly the turbine is converting wind energy into electrical form.

Energy and power are measured in related units. Energy is measured in joules (J), while power, the rate of energy conversion, is measured in joules per second, also known as watts (W). Because our turbine produces relatively little power, we will measure it in milliwatts (mW), where one milliwatt is one-thousandth of a watt.

**Materials**

- Wind turbine
- Voltage sensor with red and black banana plug leads
- Current sensor with red and black banana plug leads
- Alligator clip adapters (2, black)
- Alligator clip leads (2, black and green)
- Box fan, 3 or more speeds (same fan as previous activity, with tape)
- 33-Ω resistor
- Textbooks for weight (2)

**Safety**

- Wear safety goggles throughout the experiment.
- Tie back long hair, remove dangling jewelry, secure loose clothing, and roll up long sleeves.
- Always make sure blades are properly inserted in the turbine and screws are secure before turning on the fan.

**Investigate**

1. Open *SPARKvue* and build a page with one graph.
2. Connect the wireless voltage and current sensors.
3. Set the Sampling Rate to 1 kHz.

4. On the $y$-axis, click Measurement and select the User-entered tab from the menu. Then, select Create/Edit Calculation.
5. Type the following equation inside the text box exactly as shown, including capital letters and spacing:

$$\text{POWER} =$$

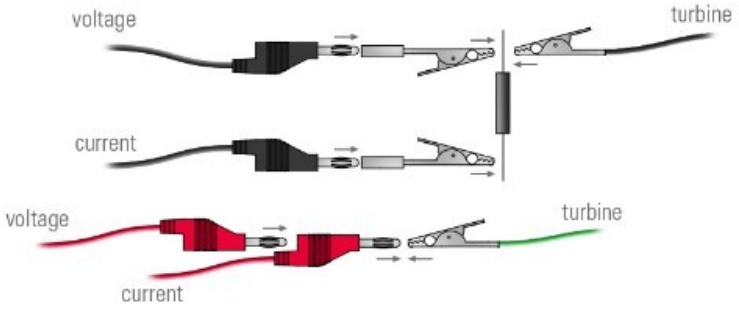
6. With the cursor still in the text box, select the orange Measurements button in the keypad display. Select Current. Choose the Measurements button again and select Voltage. Your equation should now look like this:

$$\text{POWER} = [\text{Current}][\text{Voltage}]$$

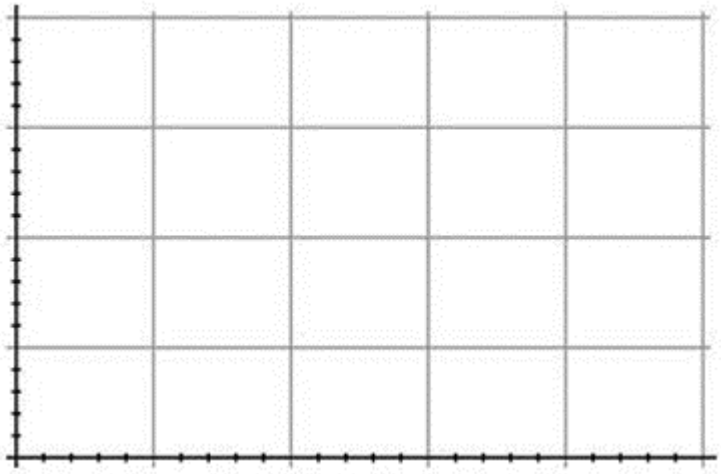
7. Use the keypad display to add $*1000$ to the equation. Your equation should look like this:

$$\text{POWER} = [\text{Current}][\text{Voltage}] * 1000$$

8. In the Units column, type mW.
9. The calculated measurement POWER (mW) should now appear on the $y$-axis of the graph.
10. Assemble the turbine according to the optimal fan distance, blade length, blade pitch, leaf logo facing the fan, and number of blades found in a previous activity. Add textbooks to the base.
11. Attach alligator clip leads to the motor terminals. Assemble the voltage sensor, current sensor, and resistor as shown below.




12. Turn on the fan to the optimum speed. Wait for the turbine to reach full speed.
13. Start collecting data.
14. Stop collecting data after two minutes.
15. Turn the fan off.
16. Sketch the results in the graph. Include numbers and labels with units for both axes.



**Analyze**

1. Open Graph Tools. Under Statistics Tools, select Area. The area under the curve is the total energy produced by the wind turbine in two minutes. How much energy did your wind turbine produce?

2. If you collected data over three minutes, which would stay the same: energy or power? Explain your answer.

3. Return to the graph to draw your prediction of how power might change if you collected data outdoors instead of indoors with a fan. Use Help (?) if you are not familiar with the prediction tool. Explain your prediction in the space provided.

**Extend**

1. Design and conduct an experiment to produce the same amount of energy with the turbine at a different power.