Activity Five: What Speed Do We Need?

Adopted/ Revised From
NEED - Wind for Schools Curriculum
KidWind – Can Wind Power Your Classroom?

Grade Level
6-12

Objectives
- Conduct an electricity audit of the classroom using a power monitor
- Compare the current and potential electricity output of the school wind turbine to the classroom's electricity needs

Overview
Students use a power monitor to estimate the energy used by all appliances and lights in the classroom and use the wind turbine's power curve to determine if that demand can be met through wind energy.

Materials (per group)
- Power monitor (Kill-a-watt or similar)
- Flicker checker
- Anemometer or anemometer mobile app

Estimated Cost of Materials
$45 per group

Computer Required?
No

Duration
1 class period

Primer References
The Energy in the Wind
School Energy Use
Getting Data from a School Wind Turbine

Engagement
1. Do you think our school wind turbine can power our school? Our classroom?
2. Where does the electricity generated by our wind turbine go when school is closed?
3. What powers the classroom when the wind isn't blowing?
4. How fast does the wind need to blow to power our classroom?

Investigation
Now we're going to measure how much electricity our classroom uses and see if our wind turbine can generate that amount:
1. Divide the class into small groups and hand out listed materials.
2. Ask each group to use the power monitor to measure the wattage of each appliance in the classroom.
3. Each group should also count the number of light fixtures and light bulbs in the classroom.

4. When counting light fixtures, have the students use flicker checkers to determine if they have magnetic (inefficient) or electronic (efficient) ballasts.
5. Each group should also measure the current wind speed near the turbine using either an anemometer or anemometer mobile app.
6. Data should be recorded in their activity sheets and the activity sheets should be completed.

Class Review

1. Ask the class to share the results of their electricity audit and anemometer readings as well as their answers to the activity sheet questions.

Elaboration

Now that we have seen the relative power of your school's wind turbine:

1. Have students read the Primer References for this lesson.
2. If the current wind speed was insufficient to power the classroom, what would you turn off to meet wind energy that is currently being generated? Why?
3. Is the relationship between wind speed and power linear or nonlinear? Why?

Instructor Notes

- Show students how to measure watts using the power monitor and how to use the flicker checker based on the sheets below.

Extensions and Variations

- Calculate the electricity needs of your bedroom at home. What would the average wind speed need to be to power your bedroom for a month? Your living room? Your home?

References/For More Information

- http://www.need.org/needpdf/WindForSchools.pdf
- http://learn.kidwind.org/sites/default/files/Lesson%205.pdf

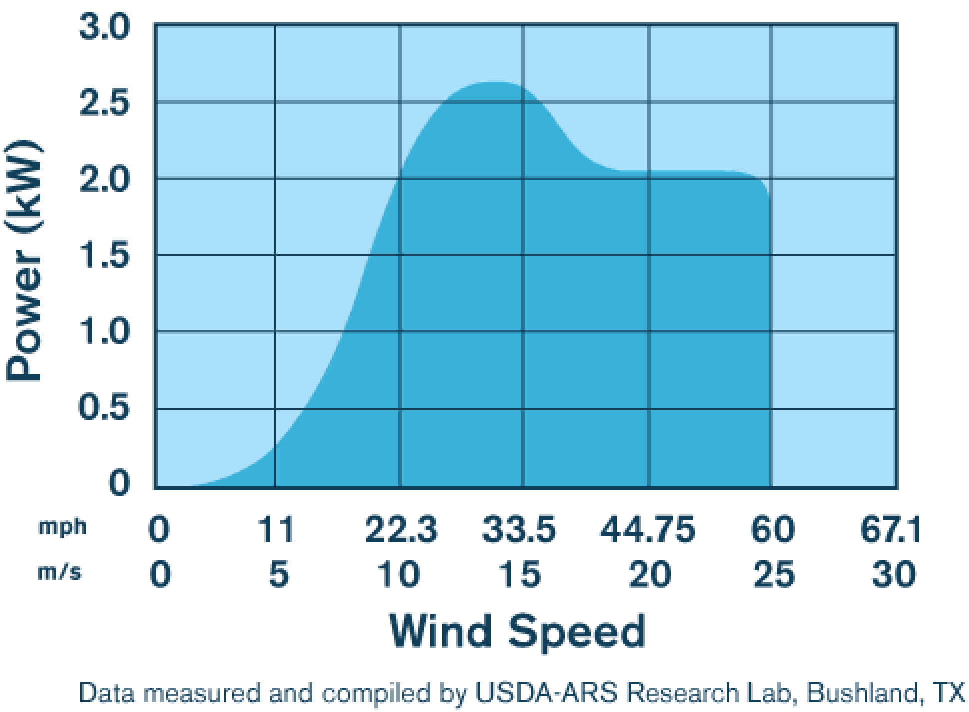
What Speed Do We Need?

Appliance	On now?	Watts - on	Watts - off	Hours on/ day	kWh/ month - on	kWh/ month - off	kWh/ month - total
*Ceiling light fixtures can be assumed to use 43 watts when on if electronic ballasts are present and 117 watts when on if magnetic ballasts are present. For a more accurate determination of wattage, teachers can remove the lens from a sample fixture, identify the number and type of lamps, and multiply volts times amps as listed on the ballast nameplate for the number and type of lamps in the fixture.							
Current wind speed near wind turbine (mph)							

Questions

1. How many watts are being used right now in the classroom? Convert this to kilowatts.

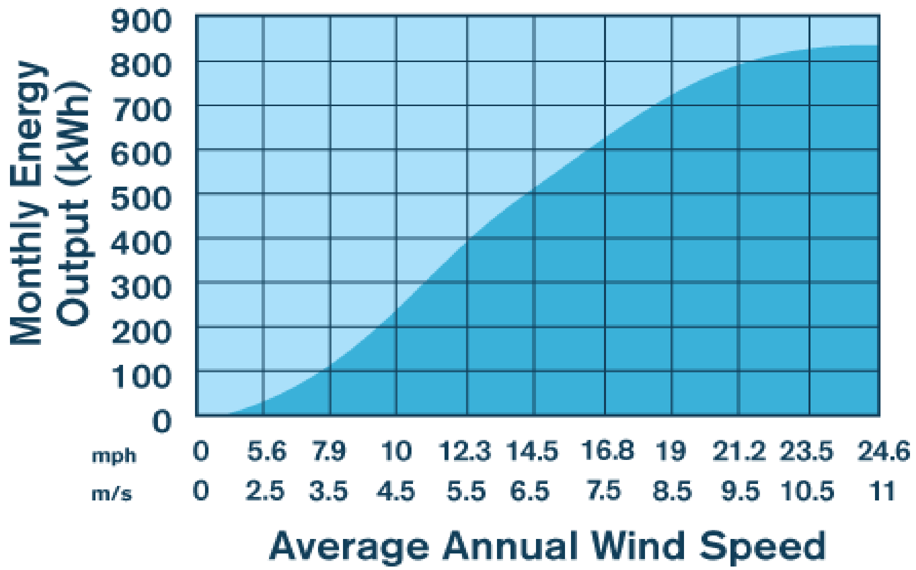
2. Using the power curve below, what does the wind speed need to be (mph) to generate this many kilowatts?



[Source: http://huskerwindpower.com](http://huskerwindpower.com)

3. Is the current wind speed near your school's turbine sufficient to meet your current needs for electricity in the classroom?

4. Using the energy curve below, what does the average wind speed need to be to supply one month's worth of electricity for your classroom?



Source: http://huskerwindpower.com

5. Using your historical wind speed data, is it fair to assume that your classroom's electricity use is offset by what is generated from your turbine? If every classroom in the school had similar electricity demands, how many classrooms could be powered by your turbine?

Using a Flicker Checker

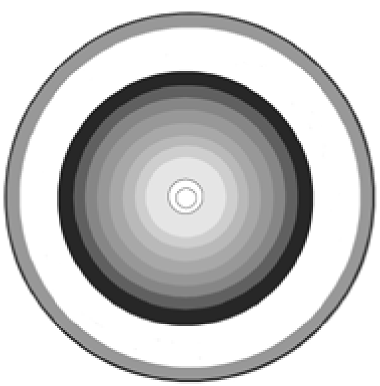
A fluorescent bulb produces light by passing an electric current through a gas using a ballast. The ballast is an electromagnet that can produce a large voltage between the two parts. It is this voltage that gives the electrons of the gas molecules the energy inside the tube. A magnetic ballast has an iron ring wrapped with hundreds of turns of wire. The current from the electrical outlet runs through the wire in the ballast. The wire also is a resistor to some degree, so there is some heat produced. There is also a little heat given off by the gas.

A fluorescent bulb with a magnetic ballast converts about 40 percent of the electricity into light and 60 percent into heat. An electronic ballast has a microchip, like that found in a computer, instead of the coils of wire. This ballast is about 30 percent more efficient in turning electrical energy into light than a magnetic ballast. Some heat is produced in the gas, but not in the ballast itself.

The reason that the Flicker Checker can tell the difference between the magnetic and electronic ballasts is because of the way the current is delivered to the gas. In any outlet in the United States that is powered by an electric company, the electricity is sent as alternating current— it turns on and off 60 times each second. Because the light with the magnetic ballast has wires attached to the outlet, it also turns on and off 60 times per second. The microchip in the electronic ballast can change that frequency. Light bulbs with electronic ballasts are made to turn on and off between 10,000 and 20,000 times each second.

Using the Flicker Checker

Spin the black and white Flicker Checker on a flat surface located beneath your overhead fluorescent light and away from direct, natural light. Any tabletop should do! If you see smooth, grey rings on the Flicker Checker, the fluorescent fixture contains electronic ballast. If you see a checkered pattern with hints of color that move from ring to ring, the fixture contains a magnetic ballast. Other indicators of magnetic ballasts; a flickering effect, a buzzing sound and poor quality light. This suggests you have lighting that wastes energy.



Example of a flicker checker showing smooth grey rings typical of electronic ballasts

Flicker checking showing the checkered pattern typical of magnetic ballasts

From: National Energy Education Development (NEED) Project – www.need.org

Using a Power Monitor

Power monitors have various functions that allow you to check different aspects of electricity usage. For testing energy use, the most important ones are Watts (W) and kilowatt hours (kWh). The Watts function measures the instantaneous draw (how much electricity a device is using), whereas the kWh gives the measure of electricity usage over time. For example, a 1,000 watt electric heater running for one hour will use one kWh of electricity.

For the purpose of this lesson, the Watts function can be accessed on a Kill-a-Watt EZ power monitor by:

1. plugging the monitor into an electrical outlet
2. plugging an appliance into the monitor
3. Hitting the "Up" button four times until the "Watt" function is displayed.

This can be done both when the appliance is turned on and when it is off (to measure "phantom loads".

Many power monitors also allow for electricity use to be converted into cost. While a default value (i.e. $0.10 per kWh) may be pre-entered on a power monitor, monitor users should enter the rate they are charged by their local utility to get the most accurate cost estimates from the monitor.

Functions of less relevance for energy efficiency include Volts (your reading should be close to 120.0, the standard voltage in US electrical outlets), Amps (the measure of the flow rate of electric current), and HZ/PF (60 hertz cycles per second is the standard for alternating current in US electrical outlets).

Special cases
Some appliances such as fans, space heaters, and hair dryers have multiple settings. Read the wattage of these types of appliances as you change the settings for a fun experiment.

Other appliances may have large fluctuations in their draws when actively on. For example, a hair dryer ranged from 240 to 1,000 watts when on high. Still other appliances have such a low draw that they may not immediately register. These may include LED nightlights and carbon monoxide detectors. The electricity usage of these is so small that it may not be worth capturing even over a longer period. It's most important to get accurate readings for the appliances that use the most electricity such as refrigerators or large screen televisions.

Some appliances such as computers and printers use significantly different amounts of energy when "on" depending on whether they are actively "on" or passively "on". Computers are actively "on" when being used or not in sleep mode. Printers are actively on when printing, not standing by.

It is best to capture the cycling of these active and passive stages over a representative period of time as is done with refrigerators and water heaters. A less accurate means of calculating wattage when "on" would be to record the most common wattage (active or passive) or take the average of the active and passive wattages if they are not too far apart.