Renewable Energy Education Activities Adapted for K-4

Adapted for
K-4 Teachers in Wisconsin

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Activities adapted by Janie Besharse and Dria Setter

The Wisconsin K-12 Energy Education Program (KEEP)

Wisconsin K-12 Energy Education Program (KEEP)
Wisconsin Center for Environmental Education
Learning Resource Center - 403
University of Wisconsin – Stevens Point
Stevens Point, WI 54481
Phone: 715.346.4770
Fax: 715.346.4698
Email: energy@uwsp.edu
Web: www.uwsp.edu/keep

Funding for the adaptation of these activities was provided by We Energies.

Don’t Waste Waste

Adapted from *Biofutures* KEEP Activity Guide pages 25-28 and *Doable Renewables* KEEP Activity Guide pages 94-96.

SUMMARY

Students “harvest” celery to demonstrate waste accumulation from timber practices and brainstorm uses for the waste products

OBJECTIVES

Students will be able to
• describe the parts of a tree;
• define biomass;
• identify alternative uses of the wood that is left behind after harvesting; and
• explain how biomass can be used to create energy.

BACKGROUND

Biomass is defined as any plant-derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials. Biomass can provide energy in the form of electricity, heat, steam, and fuels. Bioenergy is the energy, which can be generated from the use of biomass. Because biomass uses crops that are available on a renewable basis, it is considered a renewable energy source like sun, wind, water, and the heat from the earth (geothermal energy). According to the United States Department of Energy, biomass has been the largest source of renewable energy every year since 2000. Agricultural crops can be grown solely for bioenergy production, or the agricultural by-products can be used to create bioenergy.

According to the Department of Tourism, Wisconsin’s history is tied closely with the history of its forests. Before Wisconsin was

<ins>Grade Level</ins>:
K- 4

<ins>Subject Areas</ins>:
Science, Math, Environmental Education

<ins>Setting</ins>:
Classroom

<ins>Time</ins>:
Preparation: 30-60 minutes
Activity: One week

<ins>Vocabulary</ins>:
Bioenergy, Biomass, Industrial wood residue

<ins>Materials</ins>:
- Scale (see Getting Ready)
- *Diagram of Tree*

Each group of students will need the following:
- A plastic knife
- Clean disposable gloves for students to use if celery is to be eaten later
- A ruler
- Two large trays
- Calculators (optional)
- Copies of *Don’t Waste Waste – Recording Page* (optional)

<ins>Getting Ready</ins>:
Tare the weight of the tray that will be used to weigh the celery so that the weight of the tray is not included in the celery weight.

admitted into the Union in 1848, approximately 63-86 percent of Wisconsin was covered with forests. Between 1859 and 1930, more than half of Wisconsin's forests were cut down. It is during this time that Wisconsin became a world leader in logging. Since then, many of our forests have been restored, but Wisconsin still generates income from logging and the use of its forests. Forests are used by industry and individuals for various purposes including profit and recreation.

Wisconsin's industrial sector is already using bioenergy from wood wastes and residues. Companies are able to use wood to produce heat (thermal energy) and electricity. According to the United States Department of Energy, the forest products industry uses 85% of the wood waste available to generate heat energy and electricity. Due to technological improvements, the amount of wood wasted when converting a log into a product has greatly improved. Some companies generated over half of their energy from biomass. Industrial wood residue or wood waste is any part of the tree that is not used for the primary product such as paper or timber. This can include leaves, branches, stumps, or any other part of the tree that is determined unusable by the company. Sawdust and woodchips can also be utilized to generate bioenergy. The wood residue can be used to heat a substance such as water or air. This heated water or air can then be used, for example, to maintain the temperature of an on-site kiln used for drying the wood products. Wood residue can also be burned to create steam, which then turns a turbine and creates energy.

NOTE: This activity calls the wood left after logging "waste." That "waste" is actually a very important part of the ecosystem. The organic materials such as leaves, branches, and twigs that remain after a harvest act as shelter for some animals. This material also decomposes as it lies on the forest floor and nutrients are released into the soil, making it better suited for the current trees and the trees to come in future years.

PROCEDURE

1. Show *Diagram of Tree*. Identify the roots, trunk, branches, and leaves with the class. The **roots** of the tree are mainly underground and collect nutrients and water from the soil. The **trunk** is the main stem of the tree and provides support for the tree as it grows taller. The **branches** are limbs or offshoots from the trunk of the tree that carry nutrients to various parts of the tree. The **leaves** collect sunlight and carbon dioxide from the air.

2. Discuss how humans use the parts of a tree and how we get woods from the trees. Discuss the roles of foresters in harvesting trees for lumber, paper, and other uses. Make sure students understand terms such as logs and lumber.

3. Show students a piece of celery, and compare the celery stalk to a tree. Identify parts of a tree on the celery stalk. List the parts of a tree and use a stalk of celery to show those parts. Draw the tree on the board as the students name the parts of the tree.

4. Divide the class into groups of two to four students each. Tell them that each team is a group of foresters (they can create a name for their company if they want), and their job is to produce "logs" for lumber.

5. Show students a model cut piece of celery that they should reproduce. Discuss the importance of making sure the logs are even and of the same size. Older students can weigh their celery and predict how much "lumber" they will produced (e.g., how many grams).

6. Hand out a bunch of celery to each group of students along with a ruler, plastic knives, and trays. Knives should be given to the parent helper or student buddy for safety reasons. Students should cut straight pieces of celery that are three inches (7.6 cm) long. Walk around the room making sure the pieces are straight and accurately measured. Instruct the groups to put their cut pieces on one tray and the leftovers on another.

7. After students have produced their lumber, ask them how much of the celery bunch they used (they can classify their assessment into "all," "most," or "some"). Provide more advanced students with the *Don't Waste Waste – Recording Page* and demonstrate how to use the scale to read weight in grams (explain that the scales are adjusted so that the weight of the tray is not included in the weight of the celery).

8. Point out that the groups successfully produced lumber, but what about the waste/leftovers? Have the class list the parts of a tree were leftover as a result of timber production (leaves, branches, bark, roots). Ask students to compare the amount of leftovers to amount that was "logged." Which do they think there is more of? More advanced students can weigh their "leftovers" and enter the weight in grams in the *Don't Waste Waste – Recording Page.*

9. Explain that the waste from industrial use of timber is called industrial wood residue and is a form of biomass. Review the term biomass (see Background and Glossary) Ask the class to list what they think happens or should happen to this waste material, noting if they mention using the biomass as an energy source (e.g., burning for heat). Introduce the term

bioenergy and explain its role in industrial energy production (see Background).

10. Discuss how the class might use their celery "logs" as well as the leftovers. If students used gloves and the work area is clean, the celery may be eaten. Otherwise, encourage students to compost the celery reviewing how biomass is recycled into soil and reused. Relate this to actual forests and forestry, noting that wood not used by the timber company is not really wasted, even if it is left on the forest floor. As it decomposes, it adds valuable nutrients that are important to the ecosystem. Ask students if they can think of a new term for this wood. Examples include: secondary materials, wood residue, co-products.

ASSESSMENT

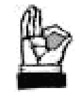
- Were students able to relate celery logs and leftovers to an actual tree and forestry lumber and biomass?
- Can students define biomass?
- Can students provide ideas for how to use leftover wood from a harvest? Do they include energy among their ideas?

EXTENSION

Take students on a field trip to a local company who utilizes wood products (paper company, timber company) and uses biomass energy or invite a representative from that company to come to the classroom to discuss how they use biomass as an energy source.

Have students explore the Internet and other sources to learn more about the use of industrial timber waste for bioenergy. Ask students why it is both good to list benefits and bad to use drawbacks of using timber waste for energy.

Don't Waste Waste Recording Page



Forester Team Name: ____________________________

What is the total weight of your tree (celery bunch) in grams?

____

Predict and then circle the word that tells how much of your "tree" is useable as logs.

All Most Half Some None

Predict and then circle the word that tells how much of your "tree" is left and available for other uses.

All Most Half Some None

Cut the celery stems into straight "logs" that are three inches (7.6 cm) long.

Put the "logs" in one tray and the waste/leftovers in another tray. Weigh the tray of cut logs.

Weight of celery logs: ___________

Subtract the weight of the celery logs from the weight of the total celery bunch.

Weight of celery available for other uses: _____________

Were your predictions (questions 2 and 3) correct? Yes No (Circle the correct response)

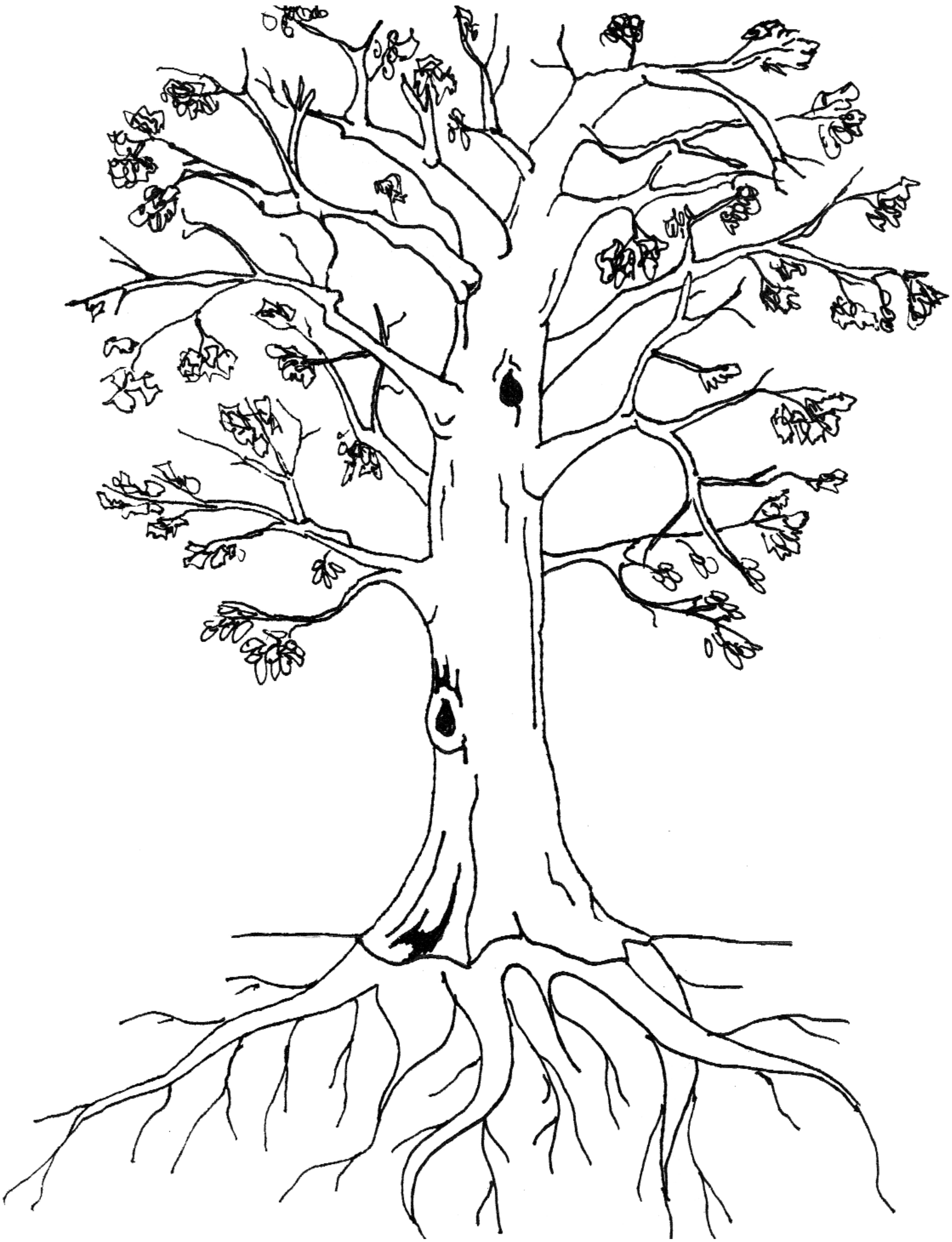
What can the leftovers of trees be used for?

____

What can the celery leftovers and logs be used for?

____

TREE



Source: LEAF Guide, K-1 Unit

Let It Flow

Adapted from *Renewable Energy Education for Kids We Energies Activity Guide*, pages 20-22 and *Working Water (Doable Renewables* activity guide*: page 69).*

SUMMARY
Students make model dams out of quart milk cartons, experimenting with water heights and flow openings to explore the kinetic energy of water.

OBJECTIVES
Students will be able to

- compare flow rate of various sized doors of dammed water and height of water;
- Describe how potential energy is stored in water;
- Explain how water can be used to move things (do work).

BACKGROUND
Water constantly moves through a vast global cycle. The sun evaporates the water from lakes and oceans. The water forms clouds and precipitates as rain or snow, and then flows back to the lakes and oceans. As water travels through the water cycle, it has potential and kinetic energy. When it is stored in a lake or behind a dam, it has potential energy. When it is flowing it is kinetic. Humans have learned to tap into water's potential and kinetic energy to do work, including generating electricity through hydroelectric dams.

Hydropower is a source of renewable energy and accounts for 80 percent of the nation's renewable electricity generation. The United States is the second largest producer of hydropower in the world; Canada is the largest producer. One fifth of all power generated in the world is hydropower.

Wisconsin residents have used hydropower for many years. Dams provide power by harnessing the kinetic energy of the water as it falls over the dam. Moving water can be used to do work because its potential energy changes to kinetic energy. For example, when holes in a container

<u>Grade Level</u>: K-4

<u>Subject Areas</u>:
Science, Math, Art, Social Studies

<u>Setting</u>:
Outdoors or in the classroom

<u>Time:</u>
Preparation: Time to gather and organize materials for groups and demonstrations

Activity: Two sessions of 30 minutes each

<u>Vocabulary</u>
Hydroelectric energy, energy, work, potential energy, kinetic energy

<u>Materials</u>

- A water source
- Pictures of natural and built dams

Dam experiment materials:

- 1 cardboard quart milk/juice carton
- 1 plastic container to catch water stream if inside classroom
- Copies of ***Water Flow Observation Table***
- pencil
- scissor
- ruler
- magic marker
- nickel

Note: Older students can work in groups and each group will need a set of materials allow water to escape, the water's potential energy becomes kinetic energy. The energy generated by water can be transferred to other objects, causing them to move and thus accomplish work (such as over a turbine or into a lock).

Today, hydroelectric dams are built of concrete and steel across large rivers to hold water back in large reservoirs. When a gate is opened, the water falls over a large wheel, or turbine, causing the wheel to turn. The wheel or turbine is connected to the electric generator, which produces electricity.

Visit the KEEP Web site to view a map of Wisconsin's dams.

Getting Ready
Prepare milk carton as follows (students in grades 3 and 4 can prepare their own cartons when ready to experiment):

Mark and label lines indicating "Full," "Half Full," and "Almost Empty" on the side of the carton as follows:

- Almost Empty: one inch (2.54 cm) from the bottom
- Half full: around 4 inches (about 10 cm) from the bottom
- Full: 7.5 inches (19 cm) from the bottom or where the closing fold begins

Use a pen or pencil to poke a small hole poked below the "almost empty" line about ½ inch (about 1 cm) from the bottom.

For preliterate students add images to the ***Water Flow Observation Table*** as needed. For example, add a question mark "?" to the guess rows, an eyeball to the "observation" rows.

PROCEDURE
Orientation
Pour water out of a milk jug at different speeds and quantities. Help students to qualify fast, medium, and slow. Review student understanding of full and empty as needed. Also make sure they notice how quantity of water affects the speed.

Ask students if they have ever seen a waterfall in nature or on television. How is the waterfall like the water pouring out of the jug? Imagine what it might feel like under the fall of the water. What could the force of the falling water make happen?

Steps
Note: This activity is a demonstration. Older students can conduct the experiment in groups.

1. Show pictures of hydroelectric dams as well as diagrams of how the dams work. See Resources for list of online sources of diagrams. Help students identify the role of dams in generating power. Students should be able to

see that water is blocked in one area (behind the dam) and then allowed to fall down—generating power involves capturing some of the energy from the falling water. Greater water flows, along with other factors like water level, create more electricity.

2. Hand out copies of ***Water Flow Observation Table***. Explain that the form will be used for them to make guesses (predictions) and observations. Discuss the idea that scientists are not always correct. It's okay for a hypothesis to be incorrect.

3. Show students the prepared demonstration milk carton with the small hole and explain that they will make pretend dams like this one to conduct experiments. Make the analogy that this is like a dam. Water flowing out can be used to do work.

4. Ask students if they think water will flow out at the same rate when a carton is full compared to when it is half full and almost empty. Have them make a guess at which level water will flow the fastest. Discuss how they can record their guesses on the ***Water Flow Observation Table***. Depending on student age levels and competency they can use words, drawings or symbols (e.g., the words fast, medium, slow; the letters F, M, S; large, medium, and small arrows; illustrations of big, medium, and large rain drops). Students record their hypotheses under Experiment 1 on the Water Flow Observation Table

5. Students prepare their cartons and run the experiment observing the water flow as the carton drains. Students record the results of their experiment

6. Ask students if they think larger holes will make a difference in the flow rate. Show the students how to increase the size of the hole by using a magic marker to trace around a nickel placed over the small hole and cutting the circle out to make a larger door. Will the results still be the same? Students write their hypothesis on the table. Students conduct the experiment and record their results on the ***Water Flow Observation Table***

7. Explain that the water in the carton is stored water and has the potential to do work. When the water is released, it can be used to do work (move objects over a distance). Introduce the term Kinetic energy and compare to Potential energy. Use the water flowing out of the cartons to wash items down a sidewalk or to spin a turbine on a pinwheel. Discuss how flowing water is harnessed by hydroelectric dams to produce electricity (see **Background**).

ASSESSMENT

Relate the water flowing out of the carton to a dam. Explain how a dam traps water and creates flow to move objects, such as a turbine. Ask students which hole and hole size of the carton they would use to move something the most?

EXTENSIONS

- Students might time the flow of water from "full" till the stream stops flowing. What sized opening would a dam operator need when a greater amount of water was needed to do more work (make more electricity)? What sized opening might allow water to work (produce electricity) for a longer time at a constant rate?

- To lead students to conduct additional independent investigations ask, "What happens to the water flow if either sized hole is made at the "half full" or the "full" mark?

RESOURCES

How it works, USGS Water Science for Schools: http://ga.water.usgs.gov/edu/hyhowworks.html

<u>Mill</u>, David MacAulay. Houghton Mifflin, New York, NY (1983).

<u>The Magic School Bus and the Electric Field Trip</u>, Joanna Cole. Scholastic Inc., New York, NY (1997).

In Appleton, WI, visit The Hearthstone, the world's first hydroelectric-run home, and plant replica. Visit www.focol.org/hearthstone to find out more.

Water Flow Observation Table

AMOUNT OF WATER	Experiment 1: Small hole	Experiment 2: Large hole
Full	Guess:	Guess:
	Observation:	Observation:
Half Full	Guess:	Guess:
	Observation:	Observation:
Almost Empty	Guess:	Guess:
	Observation:	Observation:

Schoolyard Breezes

Adapted from *Know the Flow of Energy in Your School* KEEP Elementary Supplement pages 24-32.

SUMMARY

Students build and use simple wind measurement instruments to record air movements in their schoolyard.

OBJECTIVES

Students will be able to observe and measure the wind outdoors.

BACKGROUND

Please read the background information found in the activity "*Where the Wind Blows*" on pages 62-63 in the Doable Renewables Supplement.

PROCEDURE

***General K-2 Instructions:**

All activities should be done as a demonstration. Recording Sheet and Energy Log should be done as a class activity.

***General Instructions for Grades 3 & 4:**

1. Ask for students' ideas about wind and about how to observe wind activity. Help students narrow their observations to direction and speed. Tell students they are going to act as weather people and record and report on the wind in their schoolyard using a variety of simple wind tools that measure direction and speed. Tools for measuring wind direction include a pinwheel and an anemometer. A protractor wind speed indicator measures the speed at which the wind is blowing.

Grades 3-4: The directions for the protractor wind speed indicator may be found at www.nauticus.org/activities/pon/pon_pingponganem.html.

Grade Level:
K-4

Subject Areas:
Earth and Physical Science, Language Arts, Math, Art, Social Studies

Setting:
Various stations set up throughout the schoolyard

Time:

Preparation: 20 minutes

Activity: 50-minute period for each outdoor visit

Vocabulary:
Anemometer, Temperature, Thermal, Wind, Wind vane

Materials:

- **Wind Scale Chart**
- Box Fan
- Material to construct wind instruments (see **Wind Instrument Construction**)
- **Journal** and writing implements
- **Schoolyard Breezes Recording Sheet** (optional – see example)
- Weather thermometer set up at each weather station (optional)
- Compass (optional)

2. The wind scale can be adapted for young students by using calm, gentle, moderate, and strong to replace numbers that measure the wind in miles per hour. Younger students might also want to use the wind chimes made in the "**Wind Chime Rhapsody"** activity, "What the Wind Does for Me" on page 23 in *Know the Flow of Energy in Your School*.

3. Have a prototype of the weather instruments made up and available for students to observe. Students should generate ideas about what they think each tool measures and why measuring that property of wind is important.

4. Review the direction orientations with students (north, south, east, and west). NOTE: To help younger students understand directions, you might want to orient them to a landmark in the schoolyard, such as a tree or a building.

5. Model the wind direction tools and the wind speed tools to the class. Use a box fan at about 10- 20 feet from students to help identify the wind speeds of calm (off), gentle (low speed), moderate (medium speed) and strong (high speed). Then introduce the "**Wind Scale Chart**" on page 23 in *Know the Flow of Energy in Your School*. It might be helpful to create student sheets to ensure that everyone is following the same method of recording (see **Schoolyard Breezes Recording Sheet** and **Journal**).

6. Divide the class into groups and assign each group to different locations around the schoolyard (four to five weather stations are recommended). Instruct each group to make one wind direction instrument and one wind speed instrument at their location. You may find it better to return to the classroom to make the instruments.

Grade 3 and 4 students will enjoy making the protractor wind speed indicator (see link at #1) if they have made the anemometer in grades K-2 and either the "Wind Direction Indicator" page 20, or the "Wind Vane" on page 21.

To instruct the students in how to make the protractor, model the construction of the protractor wind speed instrument and the marking of the mph designations or descriptive words on the protractor. It is important that students use the length of string indicated in the directions.

7. Repeat the wind measurements daily throughout the week. If possible, do the measurements two to three times a day. Students can record their findings in the **Schoolyard Breezes Recording Sheet** and their **Journal**.

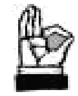
8. At the end of the week students should look back through the **Journal** and discuss their findings. Did they notice any patterns in the wind? Is it windier during certain times of the day or under certain weather conditions?

9. Once students have measured the wind patterns and speed around the schoolyard have them present to the class a mini weather report with the data they have gathered in their **Journal**. They can also diagram the schoolyard to note wind patterns according to their **Journal**.

ASSESSMENT

- Have students identify and construct various simple wind-measuring devices and accurately explain what wind property each instrument measures.
- Have students log simple wind measurements and report their findings to the class.
- Have students diagram the wind patterns around the schoolyard and think about where they could stand to either feel the wind or stay sheltered from it.

Schoolyard Breezes Recording Sheet

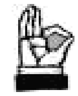


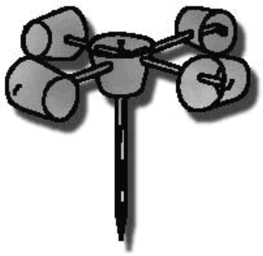
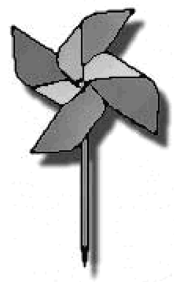
Weather Station #_____ Measuring Tool ____________ Date _______ Time _______

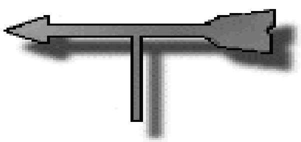
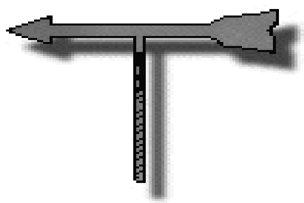
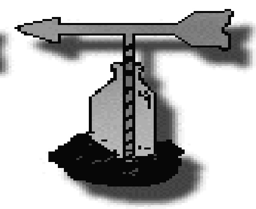
Diagram of Schoolyard and Weather Stations

N

	Circle one
Wind Direction	N S E W
Wind speed	Calm Gentle Moderate Strong
Temperature (optional)	
Cloud cover (optional)	

Possible Wind Direction Tools: wind vanes, wind direction indicators 

Possible Wind Speed Tools:
Pinwheels, anemometers, and wind chimes (See **Wind Chime Rhapsody** in "What the Wind Does for Me"). To measure wind speed, students will need to develop a scale to gauge for calm, gentle, moderate, and strong categories (see **Wind Scale Chart** in "What the Wind Does for Me").

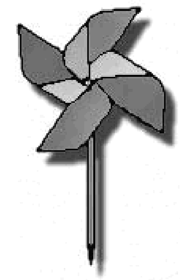
It may be difficult for students to count the number of revolutions wind speed tools complete when determining wind speed and because the instruments are made of paper, the instruments may not hold up in higher winds. If you need accuracy in mph when measuring wind velocity, a wind speed instrument that is easy to use and is fairly inexpensive may be ordered through Davis Instruments at http://www.weatherconnection.com/product.asp?itmky=330807.

Or, advanced students might want to try the protractor wind speed indicator from the *KEEP Activity Guide* (in the activity "Siting for Solar and Wind Energy"). NOTE: The wind scale can be adapted for young students by using calm, gentle, moderate, and strong to replace the numbers.

Wind instrument designs are fairly easy to find. An Internet search is a great way to find instructions for wind-measuring tools. Included are instructions from The Franklin Institute Online (www.fi.edu/) Blustery Beginnings: Windy Things to Make Web page (www.fi.edu/tfi/units/energy/blustery.html).

Wind Instrument Construction

Pinwheel Wind Collector



Materials:

- A straight pin
- A square piece of construction paper (about 8.5” x 8.5”)
- A sharpened pencil with an eraser
- Scissors

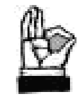
Procedure:

Lay the square of paper flat on a table and draw a line diagonally from each corner to the opposite corner. Mark the center of the square where the two lines cross and punch a small hole through it with the pencil tip. Next, cut along each line, topping about an inch from the hole in the center of the square. Take the straight pin and punch a hole in the top left corner of each of the four flaps. (No two holes should be next to each other.) Pick up a flap at a punched corner and carefully curve it over toward the center hole, securing it with the straight pin. Repeat this for the other flaps. When all four flaps are held by the straight pin, carefully lift the paper without letting the flaps unfurl. Lay the pencil flat on a table and carefully push the point of the straight pin into the side of the eraser.

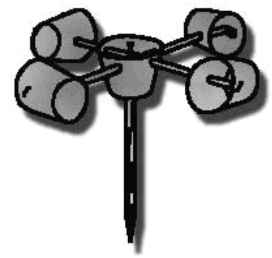
Now your pinwheel is complete and ready to go. Pick up the pinwheel near the pencil point and let it catch the wind. Notice that the pinwheel only spins when the wind hits its center.

You now have a simple wind collector. The pinwheel is an example of a horizontal-axis active wind collector. It must be pointed into the wind in order to spin.

Wind Instrument Construction



Anemometer



Materials:

- Five 3-ounce paper drinking cups
- Two straight plastic soda straws
- One straight pin
- Scissors
- Small stapler
- Sharp pencil with an eraser
- Paper punch

Procedure:

Take four of the paper cups. Using the paper punch, punch one hole in each, about a half inch below the rim.

Take the fifth cup. Punch four equally spaced holes about a quarter inch below the rim. Then, using a pencil, punch a hole in the center of the bottom of the cup.

Take one of the one-hole cups and push a soda straw through the hole. Fold the end of the straw, and staple it to the side of the cup across from the hole. Repeat this procedure for another one-hole cup and the second straw.

Now slide one cup and straw assembly through two opposite holes in the cup with five holes. Push another one-hole cup onto the end of the straw just pushed through the five-hole cup. Bend the straw and staple it to the one-hole cup, making certain that the cup faces in the opposite direction from the first cup. Repeat this procedure using the other cup and straw assembly and the remaining one-hole cup.

Align the four cups so that their open ends face in the same direction (clockwise or counterclockwise) around the center cup. Push the straight pin through the two straws where they intersect. Push the eraser end of the pencil through the bottom hole in the center cup. Push the straight pin into the end of the pencil eraser as far as it will go. Your anemometer is ready to use.

Your anemometer is useful because it rotates at the same speed as the wind. This instrument is quite helpful in accurately determining wind speeds because it gives a direct measure of the speed of the wind. To find the wind speed, determine the number of revolutions per minute. Next calculate the circumference of the circle (in feet) made by the rotating paper cups. Multiply the revolutions per minute by the circumference of the circle (in feet per revolution), and you will have the velocity of the wind in feet per minute. The anemometer is an example of a vertical-axis wind collector. It does not need to be pointed into the wind to spin.

Wind Instrument Construction

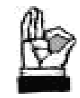
Wind Direction Indicator

Materials:
- One straight plastic soda straw
- One piece of construction paper
- A pencil with an eraser tip
- One straight pin
- Stapler
- Scissors

Procedure:
Cut one end off the piece of construction paper so that it is square. Fold one corner of the square over until it meets the opposite corner to form a large triangle. Crease the fold and open the paper. Cut along the fold to make two triangles. Fold one triangle in half once again and crease it along the fold. Next place an open edge of this folded triangle over the soda straw with the point toward the center of the straw and the other open edge at the end of the straw. Staple the tail to the straw. Next push the straight pin through the soda straw about one inch ahead of the front of the tail. Push the straight pin into the top of the eraser on the pencil. Your wind direction indicator is now ready to use.

Hold the wind direction indicator in the wind. It automatically turns around until the tail of the straw points away from the wind and the tip points into the wind. This instrument is useful in determining where the wind is coming from at any time and in noting variations during the day or from season to season. Hold your wind direction indicator in the wind and notice how often the wind direction changes.

Windy Things to Make

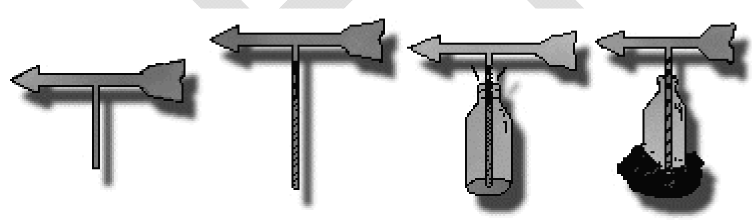


Wind Vane

Before You Start:
A weather vane is also called a wind vane. It is a tool for measuring wind direction. It spins on a rod and points in the direction from which the wind comes.

The weather vane is one of the oldest weather tools. The part of the vane that turns into the wind is usually shaped like an arrow. The other end is wide so it will catch the smallest breeze. The breeze turns the arrow until it catches both sides of the wide end equally. The arrow always points into the wind, telling you the direction from which the wind is coming. If the wind is blowing from the south, the wind is usually warm. If the wind is blowing from the north, the wind is usually cooler. The breeze turns the arrow on the weather vane until it catches both sides of the wide end equally.

Materials:
- Paper and pencil
- Scissors
- Cardboard
- Compass
- Plastic soft drink bottle
- Plastic drinking straw
- Shallow pan filled with rocks
- Felt-tipped marking pen

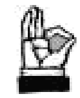


Procedure:
Ask the children what a weather vane is, and where they have seen weather vanes. Write down their answers. Ask them to draw a picture of a weather vane.

Have the children carefully cut an arrow with a tab from the cardboard, as shown. If the end opposite the arrow is longer and wider than the arrow, it will work better. Remind the children that scissors are sharp, so they must handle them carefully. Have them bend the tab slightly so the arrow turns easily when you put it in one end of the straw. They can put the other end of the straw in the bottle. Have them remove enough rocks from the pan to make room for the bottle and pile the rocks back around the bottle so it won't be blown over. (See illustrations above.)

A compass always points north. Have the children use their compass (or schoolyard landmark) to find north, and then mark the four sides of the bottle E, W, N, and S with a felt-tipped pen.

Windy Things to Make (Continued)



Have the children set their wind vane in a high place such as the top of a playhouse or a slide. Make sure that it does not wobble or tilt and that it is unobstructed so it can catch the slightest breeze.

Have them watch their weather vanes closely and then describe how they work. Test them on windy days and again when there is just a light breeze.

Background Information:
A weather vane is a tool used to tell which direction the wind is coming from (many people mistakenly think the vane points in the direction the wind is going). This information can be useful in a number of ways; for example, early explorers needed to know what direction the wind was coming from to sail their ships, which helped them sail to America. Weather vanes are usually found on top of buildings so they will catch an open breeze. Look for them on top of barns, houses, weather stations, hardware stores, and other places that sell or use weather tools. The part of the vane that turns into the wind is usually shaped like an arrow. The other end is wide so it will catch the smallest breeze. Sometimes a metal rooster or other animal sits on top of the weather vane.

Some weather vanes have directional strips underneath the arrow to make it easier to read. Your markings on the bottle do the same thing.

It is easier to see how the energy from the wind moves your weather vane if it is up high and in an open area. You might also want to experiment by putting it on the ground.

Although a weather vane is one of the oldest weather tools, it is still used today to measure the direction of the wind. Weather vanes can only measure wind direction a few yards (meters) off the ground. Large, helium-filled weather balloons are used to measure winds high above Earth’s surface. The balloons move with the same speed and in the same direction as the wind.

Solar Explorations

Adapted from *Doable Renewables* KEEP Activity Guide pages 41-43.

Grade Level:
K-4

Subject Areas:
Science

Setting:
Classroom and outdoor setting

Time:
Preparation: 50 minutes
Activity: Two to three 50-minute periods

Vocabulary:
Energy, Heat, Solar energy, Temperature

Materials:
See materials listed under each of the *Sun Experiments.*

SUMMARY

Students will learn how why the sun heats different items

OBJECTIVES

Students will be able to explain what role colors and/or materials play in solar energy production and energy efficiency.

BACKGROUND

For more information, see the *Renewable Energy Fact Sheets* in the Appendix. Energy from the sun can reach us in two ways: heat and light. Solar energy is used to heat the air and water for applications such as space heating, pool heating, and water heating for homes and businesses. These technologies are solar thermal since they use the heating properties of solar energy. Solar thermal collectors are often mounted in a sunny spot like the roof of a building.

The color of the solar thermal collector plays an important part in collecting the sun's heat. Dark colors collect more energy than light colors. Therefore, a dark panel will collect more energy than a light panel. Darker colors are commonly used in the construction of solar panels.

Photovoltaic (PV) technology converts the sun's light energy directly into electrical current. The electrical current can be used right away or stored in a battery for future use. PV panels come in many shapes and sizes. You can see them on buildings or on roadside construction signs. New technologies are being developed to incorporate PV panels into building materials such as shingles.

PROCEDURE

Orientation

Ask students which they would wear on a hot summer day – a black or a white shirt. Explain to students that they will be exploring how the sun affects materials and colors. Place an incandescent lamp so it shines on a piece of white paper and a piece of black paper for at least fifteen minutes. Ask students which paper will be hotter and why. Allow students to go feel the paper to see if they were correct.

Steps

1. Have students conduct the *Sun Experiments*. NOTE: *Sun Experiments* includes a variety of ways students can explore different aspects of the sun and how sunlight is absorbed by other objects. You may want to conduct each experiment as a class or in small groups. Older students may conduct the experiments on their own at individual stations.

2. Tell students that they will be asked to figure out what happened in the experiments. They should think carefully about their answers and then discuss what they think with classmates.

Closure

Have students record and discuss the results on either a class chart or on a group data sheet of your design.

Questions:

- Ask students what color clothes they might wear on a hot, sunny day to stay cool? On a cold, sunny day to stay warm?
- What color roof might help melt snow?
- What color roof might help keep a home cool?

ASSESSMENT

Formative

• Are students able to identify which colors absorb the most light?
• Why do students think it might be important to know which materials absorb light?
• Can students explain which substances retained heat the longest after being removed from the sun?

Summative

Show students pictures of different types and colors of roofing materials (black roof, tin roof, clay, etc). Have students discuss what type of roof would maintain cool temperatures in a house and why. Ask them what material collects the sun's energy most effectively and could be used to build solar panels.

Sun Experiments

Visit the KEEP Web site for more renewable energy investigations

Solar Soup Cans

Materials:
16 soup cans
Four shoeboxes and lids
- Shoebox 1 should be pre painted black inside
- Shoebox 2 should be pre painted white inside
- Shoebox 3 should be lined with aluminum foil
- Shoebox 4 should not be painted of lined inside

16 laboratory style thermometers – 1 for each soup can (Do not use oral thermometers.)
Salt
Sand/soil
Water
Shredded paper
Plastic wrap
Masking tape

* A data sheet for Solar Soup Cans is located on the KEEP Web site on the *Doable Renewables* Support Page.

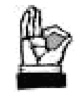
Instructions:
Divide students into four groups: A, B, C, and D. Have each group fill up four soup cans with water, sand/soil, shredded paper, and salt. Give Group A the shoebox with a black painted interior. Group B will use a box painted white inside. Group C will use a box lined with aluminum foil, and Group D will use a box without a painted inside (should not be black or white). Have students place thermometers in each can. Take an initial reading for each substance and leave the thermometers inside the soup cans.

Have each group place the soup cans in their boxes and set them in a sunny window. Cover each box with plastic wrap and secure it with masking tape. Be sure thermometers are arranged so students can read the temperatures without removing the plastic wrap.

At 10-minute intervals, students should read and record the temperature of each substance. They can stop after they have taken four or five temperature readings. Put lids on the boxes and remove them from the sun. After 15 minutes and again after 30 minutes, take the temperatures of the substances by quickly removing the lids and checking the thermometers. Record data on data sheet provided on Web site (or create your own).

NOTE: For younger grades, simplify the activity to test one aspect, either colors or materials.

Solar Balloon



Materials:
Two large white bags and two large black bags
Tape
Scissors
Kite string

*Grades K-2: This activity could also be done with one bag of each other, eliminating the use of scissors and preparation for younger students.

Instructions:
Select one black bag, but do not open it. Lay the bag on a flat surface and, using scissors, cut open the sealed end of the bag. Get another black plastic bag, but do not cut off the end. Align the uncut bag with the cut bag so that the cylinder will be closed off at one end. Tape the adjoining open ends of the two black bags together (instead of using tape you can use a low setting on an iron to seal the ends of the bags). This should result in a two-bag cylinder or solar balloon with one closed end.

Repeat the procedure for the white bags.

When it is sunny and the winds are calm, take the black and the white solar balloons into a large open area free of obstacles. While holding the bags open walk or run to inflate the balloon. Using kite string, tie off the open end of the bags leaving extra string to hold onto the solar balloons. If there is a breeze, stand upwind of the balloons. The balloons may start to slide across the ground. If they do, walk with the balloons until the black one starts to rise, on its own.

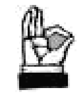
Grades K-2: Then ask, "Do you think temperature inside of the bag will be different depending on the color of the bag? Why?"

Grades 3-4: Then ask, "What does the color of the bag have to do with absorbing heat so that one of bags rose more than the other?"

(Molecules in the bag started to heat up and move faster which then caused more pressure inside the bag).

Before deflating each of the bags, have the students observe the temperature of the inside of each bag.

Sun Prints



Materials:
Dark colored construction paper
Various objects to form negative images on paper (e.g., paper clips, pencils, combs, cut out alphabet letters)
Cardboard (large enough to cover construction paper)

Instructions:
Practice by putting objects on regular paper. When you find a pattern you like, sit in a dark area and arrange the objects on the dark colored construction paper. Carry the paper and design objects into the sunlight. and expose the arrangement to the sun for the rest of the day. Weigh down the designs and letters so they don't shift or blow away.

When left in the sun for at least four hours, the uncovered portions will be bleached by the sun. The covered portions will retain the original color.