

Traveling Energy Exploration Station

Renewable Resources

Educators Guide

Traveling Energy Exploration Station Renewable Energy Activity Supply List

The following activities are included in the Renewable Energy Traveling Energy Exploration Station. Items in italics will need to be provided by the person checking out the station.

All these activities strive to use the scientific inquiry, teach students field and classroom investigative skills and foster critical thinking skills. We include lab supplies and basic hand tools whenever possible. With this said each activity strives to include Science TEKS 1-4 to some degree.

Activities

Wind

- Make your own wind meter- Index cards, paper clips, patterns, *glue, scissors*
- Blast Off- balloons, straws, string, *tape*
- Testing a Wind Turbine- water bottle, manila folder, thumbtacks, smooth round pencils, thread, rubber bands, stopwatch, *fan, meter stick, scissors*
- Wind Energy: True or False- game pieces

Hydropower

- Build a Dam- plastic tub, plastic animals, fake plant, rocks, *water, natural or recycled materials such as sand, sticks, rocks, wood chips, paper, plastic, metal,*
- Hold that Drop- eyedropper, wax paper, *water*

Solar

- You are my Sunshine – Solar Mask- paper plates, construction paper, *markers, glue, scissors*
- What color absorbs the sun's heat the best? - construction paper, timer, *ice cubes*
- Sun Job Sentences- game pieces

Geothermal

- Make a Geyser- hotplate, pan, funnel, balloon, *water*

Biomass

- Gas From Garbage- dried beans, clear plastic bag, *water*

Resource Outlet

Videos

The Race to Save our Earth Video
Science in Action: Solar Energy Video

Books

Solar Powered Racers: Racing with the Sun
The Wind at Work
Energy for Keeps: Electricity from Renewable Energy
Energy from the Sun
Wind and Water Power
Energist: Water

Energist: Renewable Energy

Nonrenewable and Renewable Resources

Energy Sources are classified as either renewable or nonrenewable.

Nonrenewable energy sources, such as coal, petroleum, natural gas and uranium cannot be replaced once they are gone.

Solar and wind energy, hydropower, biomass, and geothermal energy are renewable. The sun will always shine (scientists estimate for at least 5 billion more years!) and the wind will always blow. Renewable means there is a limitless supply.

Conservation of Energy--The law of conservation of energy states that energy is neither created nor destroyed. This law is called the First Law of Thermodynamics.

When we use energy we are transforming it from one form to another. Gasoline (chemical energy) is transformed into mechanical energy which moves a car.

Solar Energy

- comes from the sun
- is used today for heating and cooling, heating water, making electricity, and cooking
- produces heat by using solar collectors
- turns sunlight into electricity by using solar cells (photovoltaic)
- not only provides light and heat but is also the source of our food, winds, water power and fossil fuels
- must be stored to be used when the sun is not available (night or cloudy days)
- is renewable energy – it is an unlimited source of energy.
- provides more energy to the earth in one hour that the whole world uses in one year
- can be transformed from potential energy to heat, electrical, mechanical, or chemical energy for our uses

The Sun

The sun is a medium sized star about 864,000 miles across – about 100 times the diameter of the earth. At a distance of 93 million miles, the sun is the nearest star to the Earth. Light from the sun takes 8 ½ minutes to reach the earth. If the sun were the size of a soccer ball, the earth would be a pea about 100 feet away.

The sun, like a huge ball of fire, is made up of dense gases, 70% hydrogen and 28% helium. Its energy is released by a process called nuclear fusion (the result of two atoms of hydrogen joining together). The atoms make “heavy hydrogen,” or deuterium. When another hydrogen atom joins on to the deuterium, it makes a helium atom. When the two atoms collide another kind of helium is made and two hydrogen atoms are freed. The process is a chain reaction happening again and again. The transformation from hydrogen to helium results in the release of enormous quantities of energy from the sun’s core. This is the same process that takes the place in the explosion of a hydrogen bomb. Every second, 508 million tons of hydrogen is turned into 504 million tons of helium. The other four million tons of hydrogen are released as energy. The sun will keep shining as long as the supply of hydrogen atoms last.

The sun’s energy is electromagnetic radiation. The most common unit for measuring solar energy is the langley. Solar radiation is measured in langley per minute:

1 langley = 1 calorie of radiant energy per square centimeter

1 langley per minute = 221 BTU (the amount of energy needed to raise one pound of water one degree fahrenheit) per square foot per hour.

A ball of coal the size of the sun would burn for 3000 years, yet the sun has been burning for billions of years. Scientists estimate that the solar system is at least 4.6 billion years old and that the sun, a middle aged star, will shine for another 5 billion years.

The sun sends a constant amount of radiant energy, but only about half of it actually reaches the earth’s surface. The other half is reflected back into space by the earth’s

atmosphere or is absorbed and scattered by molecules within the atmosphere. Of the sun's energy that reaches the earth's atmosphere, 30% is reflected back into outer space, 47% is absorbed by the earth's surface and converted into heat energy, 23% drives hydrologic cycle, less than 1% creates winds and ocean currents and .03% is captured by plants and provides all the world's food energy (This .03% was the source that produced the stored fossil fuel energy in coal, oil and gas!) The solar radiation which reaches the earth is trapped by the layer of gases (mostly ozone) that make up the earth's atmosphere. The trapped energy warms the earth. The process is called the greenhouse effect. Scientists fear that the addition of more and more layers of carbon monoxide and other noxious gases will trap too much of the sun's radiant energy causing temperatures on earth to increase. Even a few degrees difference in average annual temperatures could drastically alter the climate on earth.

History of Solar Energy

People have been experimenting with solar energy for thousands of years. Over 3,000 years ago a king's palace in Turkey was warmed with solar heated water. In 212 B.C. a famous Greek scientist, Archimedes, set up giant reflecting mirrors above the bay in the Greek city of Syracuse which was at war with the Romans. The giant mirrors were used to focus the sun's rays on the approaching Roman ships. The heat of the sun's reflection set fire to the ships.

In 1741 a French scientist, George Buffon, experimented with reflecting mirrors. He was able to set fire to a woodpile 200 feet away. Other scientists worked with reflection mirrors (or solar furnaces, as they were called) over the next 100 years. By the late 1700's scientists were demonstrating solar furnaces that created temperatures as high as 1830 to 3000 degrees Fahrenheit. That is hot enough to melt most metals. Some solar reflectors were used to concentrate heat onto boilers. These boilers generate steam power, which could be used to run other machines.

In the United States solar energy machines date from about 1883. During this time Swedish American named John Ericsson built a machine that produced 2 ½ horsepower of energy. In 1913, an American inventor named Frank Shuman, in collaboration with physicist C.V. Boys, designed and built a solar powered irrigation pump in Cairo, Egypt that produced 50 horsepower. In the late 1940's and 1950's a furnace was built by Dr. Felix Thrombe that could produce 70,000 watts of power and temperatures of over 5000 degrees Fahrenheit. In the late 1960's an even larger furnace was built under the direction of the French government.

In 1890's solar water heaters were first used in California. As mechanical improvements were made, solar systems were used in Arizona, Florida and many other sunny states in the United States. After the discovery of oil and natural gas, low cost fuels became available and solar systems began to be replaced with heaters using fossil fuels.

In more recent years our increasing energy needs and concern about energy crisis have led to a comeback in the use of solar power, exciting possibilities in solar technology and new ideas in energy conservation.

How Solar Energy Is Used

Photovoltaic (P.V.) energy systems are made of “solar cells” that use sunlight to generate electricity. PV cells are found on many small appliances we use everyday, like calculators, gate openers, school crossing signs and railroad crossing signs. They were first developed in the 1950’s for use on the U.S. space satellites.

PV cells are made from silicone. When sunlight strikes the solar cell, electrons are knocked loose. They move toward the front surface of the cell, creating an imbalance between the front and the back. When the two surfaces are joined together by a connector, like a wire, a current of electricity is created. PV cells are arranged together in a PV module. PV modules, when exposed to sunlight, generate electricity. Some modules are even set on tracking devices to follow the sunlight throughout the day.

Photovoltaics are used to provide electricity for everything from hand held calculators to homes and schools.

The sun also supplies energy for passive solar applications. As light energy strikes an object, it is absorbed, reflected or transformed into heat energy that is radiated away from the object, carried off by wind or water (convection) or conducted to surrounding objects.

Passive solar homes are designed to make maximum use of solar energy by using the natural principles of heat absorption, radiation and convection. A passive solar home is designed and oriented so that sunshine penetrates through walls and windows in winter and is kept out in summer. Some of the earliest solar homes were the cliff dwellings of the Southwest Native Americans. Building materials such as stone or concrete are used to store accumulated heat, storing it and distributing it gradually. Ideally, a passive solar house is elongated and oriented in an east-west direction, providing a southern exposure. The size and placement of the windows are very important in capturing the sun’s energy. Properly oriented windows can provide 20 to 50% of the annual space heating needs of a home. Light colored roofs in a warm climate that reflect heat and dark colored roofs in a cool climate that absorb heat are important considerations also.

Active solar energy systems require energy from other sources to transfer the solar energy. Solar energy is gathered in collectors mounted on the roof. Pumps or fans are used to circulate the heat through the collectors and back to a heat storage container (like a tank of water or bed of rocks).

If more homes were built to take advantage of solar principles, a substantial amount of fossil fuel energy could be saved.

Solar Activities

All these activities strive to use the scientific inquiry, teach students field and classroom investigative skills and foster critical thinking skills. We include lab supplies and basic hand tools whenever possible. With this said each activity strives to include Science TEKS 1-4 to some degree.

What color absorbs the sun's heat best?

Lesson Overview: Students will observe an ice cube on different colors of construction paper to see if the different colors have an effect on the melting rate of the ice cube.

Materials: white, black, green, red and blue construction paper (all the same size), timer, *uniformly-sized ice cubes*.

TEKS: Science: K.7B, 1.7B, 2.7B, 3.11AD, 4.7A, 4.11C, 5.8A, 6.9AB, 8.5A
Social Studies: 1.6B, 2.7B, 2.8A, 7.20CD, 8.29AB

Instructions:

1. Place an ice cube on top of each sheet of construction paper.
2. Using a stopwatch to time them, observe which ice cube melts first.

Discussion questions:

1. Would a house with a white roof be cooler than a house with a dark roof?
2. Do house paint colors affect the temperature inside?
3. Do dark colored cars heat up faster than light colored cars?
4. What other applications might color of material have on temperature.

You Are My Sunshine - Solar Mask

Lesson Overview: Students will create sun masks

Materials: Large light weight paper plates, orange, yellow and red construction paper and *markers, scissors, glue*

TEKS: Science: 3.11AD, 4.11C

Instructions:

1. Cut the centers out of the paper plates. Color plates with markers
2. Cut sunbeams from construction paper and glue around outside of paper plates.
3. Mask may be attached to a craft stick or elastic if desired.

Discussion questions:

1. Name the parts of the sun.

Bonus solar activities- not included with the station

Solar Absorber

Lesson Overview: Heat energy from the sun is absorbed and transferred to water. Determine the best color for the outside of a water drum that would be used in solar heating.

Materials: 4 same sized frozen juice cans, red, black, white and yellow construction paper or paint, 4 thermometers, scissors, plastic wrap, measuring cup

TEKS: Science: K.7 AB, 1.7 AB, 2.7AB, 2.10B, 3.11AD, 4.11C, 5.8AB, 6.9AB
Social Studies: 1.6B, 2.7B, 2.8A, 7.20CD, 8.29AB

Instructions:

1. Cover each of the juice cans in a different color construction paper or paint.
2. Fill each can with equal amounts of water. (All the same temperature)
3. Cover each top with plastic wrap.
4. Punch a hole and place a thermometer in each can and place in sun.
5. Record the water temperature in each can at the beginning and at regular intervals for 2 hours.
6. Construct a line graph showing the relationship between water temperature, time, and absorber color.

Discussion questions:

1. Which color was the warmest after 2 hours?
2. Which was the coolest?
3. Which color warmed up the quickest?
4. Which color would you paint a water drum if you were building a passive solar water heater?

Variation:

1. Cover all the cans with black construction paper.
2. Fill one with tap water, one with salt water, one with sand and leave the last empty.
3. Conduct the experiment the same as above from step 3 to 6

Discussion questions:

1. Which material absorbs and retains heat better?
2. Why?

How much hotter does a house get when the windows face south instead of north?

Activities adapted from "The Energist" National Energy Foundation and Energy Education Network

Lesson Overview: Students will simulate different house placement to determine if window placement affects temperature of the house.

Materials: 2 cardboard boxes of same size, white paint or paper, 2 thermometers, plastic wrap, masking tape, compass

TEKS: Science:K.7AB, 1.7AB, 2.7AB, 2.10 B, 3.11AD, 4.11C, 5.8AB, 6.9AB
Social Studies:1.16A, 2.7B, 2.8A, 7.20CD, 8.29AB

Instructions:

1. Cut a window in each box (exactly the same size) and cover each window with plastic wrap - tape tightly all the way around.
2. Paint both boxes white or cover them both with white paper.
3. Place a thermometer in each box and seal box top.
4. Set each box in the sun - one facing south and one facing north.
5. Record the temperatures after 10 minutes, 20minutes and 30 minutes.

Variations:

Add a roof with an overhang to each box and repeat steps 4 and 5.

Add roofs of different colors to each box and repeat steps 4 and 5.

Discussion questions:

1. What is the best color for a roof in a warm climate?
2. What is the best direction for a house to be facing to stay warmer in the winter and cooler in the summer?

Writing With Sunshine

Adapted from: 4-H Energy Program - Energy Encounters

This activity must be performed outdoors in the direct sunshine. Put on sunglasses to protect eyes. Be sure students do not look directly at the sun. This experiment requires adult supervision.

Lesson Overview: Students will discover the relationship between energy and power.

Materials: small pieces of light colored wood (1 per student), magnifying glasses, containers of water, sunglasses

TEKS: Science: 1.7B, 3.11AD, 4.11C, 5.8A, 6.9AB

Instructions:

1. Hold the magnifying glass over the wood at an angle to catch and focus the sun's rays. Move the magnifying glass up and down until there is a small, bright spot of light. This small spot of light will burn the wood, turning it dark.
(Do not hold the magnifying glass in one spot too long, because smoke will begin to appear and the wood will catch fire and burn. Do not focus the magnifying glass on your skin! It will burn you! A magnifying glass focused on grass or other objects will also burn!)
2. When you have the sun's rays focused, create a design on the wood by moving the magnifying glass to different spots.

Discussion questions:

1. What distance from the wood was the optimal distance?
2. How long could you hold the magnifying glass in place before the wood began to smoke?

Making A Solar Water Heater

Activity taken from Infinite Power of Texas Lesson Plan No. 4 "Using Alternative Energy in the Home"

Lesson Overview: Students will use the power of the sun to heat water.

Materials: 1 shoebox, white, black and colored construction paper, 16 oz plastic soda bottle with cap, thermometer, aluminum foil,

TEKS: Science: 1.7B, 2.10B, 3.11AD, 4.11C, 5.8AB, 6.9AB
Social Studies: 1.6B, 1.16A, 2.7B, 2.8A, 7.20CD, 8.29AB

Instructions:

1. Line the inside of a shoebox with a sheet of aluminum foil.
2. Wrap the plastic bottle with a sheet of construction paper.
3. Fill bottle with tap water.
4. Place bottle in your oven and locate oven in direct sunlight. Adjust placement to reflect as much light as possible onto the bottle. Start your water temperature measurements. Record the measurements on a table in your science notebook.
5. Make sure groups measure the beginning water temperature, before the heater is placed in the sun.

Discussion questions:

1. Which color heated the water the most? The least?
2. What modifications could you make to the set up to gather more sunlight?

Tea Time

Lesson Overview: Use the solar power of the sun to brew tea.

Materials: Clear glass jar with lid, 1 regular-size tea bag per two cups of water, thermometer

TEKS: Science: 1.7AB, 2.10B, 3.11AD, 4.11C, 5.8A, 6.9AB

Instructions:

1. Fill your jar with cold tap water and put in tea bags. (2 tea bags for a quart jar, 8 tea bags for a gallon jar)
2. Screw the lid tightly on the jar and place in a sunny location for 4 hours. (Be careful not to let a tree or building shade the jar.)
3. Check the water temperature five times as the tea brew and record below.

At start _____

After 1 Hour _____

After 2 hours _____

After 3 Hours _____

After 4 Hours _____

Discussion questions:

1. How much did the temperature change after four hours?
2. How did the tea get hot?
3. Do we save fossil fuels when we let the sun brew the tea?
4. How?

Growing With the Sun - Plant a "solar" flower seed

Lesson Overview: students will plant flower seeds and monitor the growth.

Materials: flower seeds, potting soil, half eggshells (to plant seeds in), water, sunshine

TEKS: Science: K.6B, 1.7AD, 2.10B, 3.11AD, 4.5A, 4.11C, 5.8A, 7.8B

Instructions:

1. Put soil in the eggshell
2. Poke a hole in the soil and put a seed in the hole.
3. Cover the seed with a little more soil.
4. Give it a little water and set it in a sunny place.
5. When the seed sprouts, plant it (eggshell and all) in a large pot or a flower bed.
When the sunflower blooms, notice how it turns to face the sun.

Discussion questions:

1. Why can you plant the eggshell with the seed.
2. Why does the flower turn to face the sun?

Reaching For the Light

Lesson Overview: Watch a potato find the light of day

Materials: sprouting potato, cardboard shoe box with a lid

TEKS: Science: 1.7AD, 2.10B, 3.11AD, 4.11C, 5.8A, 7.8B

Instructions:

1. Cut a hole, approximately $\frac{3}{4}$ inch, at one end of the top of the box.
2. Put the potato in the bottom of the box at the opposite side from the hole.
3. Wait and watch. The growing shoots will find the light and shoot up through the hole in the box top.

Discussion questions:

1. Why does the potato grow towards the light?
2. What would happen if there was no light?
3. What would happen if there were multiple sources of light or if you moved the light source?

Hydropower ...

- ...is renewable energy.
- ...is water power - Hydro is the Greek word meaning water.
- ...is power produced by falling or moving water.
- ...is stored sunlight.
- ...is energy in flowing or falling water.
- ...uses the kinetic energy of moving water.
- ...represents a clean source of electricity - it is virtually free once the equipment costs are recovered.
- ...impacts fish, wildlife, and local communities - can flood large areas covering land and altering ecosystems.
- ...currently contributes between 10% and 12 % of the electricity supply in the United States.
- ...is considered a "mature" renewable resource - most of the best sites have been developed. However, opportunities still exist to develop and renovate smaller hydropower plants.
- ...has traditionally been the least expensive source of electricity.

The Water Cycle

Water is always on the move. It travels in a repeated pattern called the water or hydrologic cycle. There is no beginning or end to the water cycle!

The sun's heat warms oceans and other bodies of water, making water evaporate into the air. Water also evaporates from the soil and transpires through plant leaves. During evaporation, water vapor rises into the air until it meets colder air. The vapor then condenses into tiny water droplets or sublimates into ice crystals and forms clouds. Eventually, water falls back to earth in the form of rain or snow. Most of the water falls back into bodies of water. Some, however, seeps into the ground until it reaches a layer of clay or solid rock, which it cannot penetrate.

People also play an important role in the water cycle. Because we need water to survive, we manipulate it to our needs. Moving or falling water is used to generate electricity and reservoirs hold water for future use. From there, water goes into treatment plants that remove waste and bacteria. Then it travels through various pipes to where it is needed: homes, factories, farmlands, etc. Sooner or later all water goes back into the ocean and the water cycle starts over again.

Imagine this: The water dinosaurs drank millions of years ago is the same water we drink today!

What is water?

The smallest unit of water is a molecule, comprised of even smaller units, atoms. Chemically, a water molecule is composed of two atoms of hydrogen bonded to one atom of oxygen (H₂O).

Water cohesion

Water molecules have a tendency to stick together. That's why a water droplet maintains a spherical shape. The water molecules inside a droplet attract other water molecules toward them. When two water droplets are near enough to each other, they join together because cohesion is strong. This helps explain why water vapor condenses into clouds, and condenses still more to form raindrops. If water didn't attract itself, we would never have rain.

Water Pollution

Many forms of pollution affect water quality. All pollution comes from either a point or a non-point source. If a single source can be identified (e.g. a pipe or a ditch from a factory) as the cause it is considered point source pollution. If the source of the pollution cannot be identified (e.g. runoff from parking lots or yards) it is called non-point source pollution. We depend on good water for drinking, food, recreation, transportation and agriculture.

How much water is available?

97% of the world's water is ocean
 2% of the world's water is locked in ice caps and glaciers
 1% of the world's water is available for human use
 (rivers, lakes, and groundwater)
 50% of groundwater is ½ mile or more below the earth's surface - beyond the reach of current technology.

If all the world's water fit into a gallon jug,
 2 tablespoons would be our 1%!

HYDROPOWER

Moving water is an important source of energy. Centuries ago the Greeks built water mills by rivers and used them to grind wheat into flour. The power of water was one of the first methods used to generate electricity. The first hydroelectric plant was built at Niagara Falls in 1879. In the following decades, many more hydroelectric plants were built. At one time up to 33% of this country's electricity was provided by hydro generation. By the late 1940's most of the best hydropower sites had been developed and fossil fuels were being used to generate electricity - much more cheaply than hydropower. With the oil crisis of the 1970's and concern for the environment came a renewed interest in hydropower.

Hydroelectric dams are built on rivers to control the flow of water and to provide a reservoir. Water in a reservoir is stored energy. A hydro plant uses the force of falling water to make electricity. The greater the water pressure, the greater the power of the water.

To make electricity, the gates of a dam are opened. Water flows through the gates into pipes called penstocks. The water spins a wheel with blades called a turbine, which drives a generator producing electricity.

The biggest advantage of hydroelectricity is the low cost - once equipment costs are recovered. It is also nonpolluting and can be stored (unlike some other renewable energy resources). The water can be held behind a dam and released as needed. Reservoirs created for hydroelectric facilities can create opportunities for recreation and may provide habitats for some animals.

Objections to hydroelectricity are the building of dams and creating reservoirs - large areas of land are flooded, water flow into bays and estuaries are affected, and some animal habitats are eliminated.

Ocean waves and tides are now being explored as a source of energy. Tidal power generated electricity is similar in concept to hydroelectric generation on a river. Massive gates close after an incoming tide hits its highest point creating a tidal bay. Just before low tide, when the head is at its maximum, water is released through turbines. Once it has spilled out, the gates reopen and the process begins again.

Wave power converts the up and down motion of waves into electricity. Waves are funneled up a special ramp, forcing air through turbines. This system can be used on a small scale, but larger systems are experimental and not yet feasible.

Hydropower Activities

Hold That Drop (Cohesion)

Lesson Overview: students will investigate one of the properties of water

Materials: eyedropper, waxed paper, *water*

TEKS: Science:1.7A, 5.6B

Instructions:

1. Put a drop of water on a piece of waxed paper with an eyedropper.
2. Observe or draw a picture of how the drop looks from the side.
3. Put two drops near the first drop and use the eyedropper to push the drops together.
4. Observe or record the results.
5. Use the dropper to pull apart the water drop.
6. Observe or record results.

Discussion questions:

1. How far apart could the drops be before cohesion took over and they joined into one drop?
2. What other natural phenomena depend on cohesion?

Build a Dam

Dams are a pollution free method for creating electricity. However, when a dam is built, the river ecology changes and this brings other issues to the area. By simulating the building of a dam, the students can see what might happen.

Lesson Overview: students will simulate building a dam to see the changes in an area.

Materials: *recycled or natural materials (wood chips, sand, sticks, paper, metal, plastic...), plants, rocks, house and animal replicas, container (plastic tub), water*

TEKS: Science: 1.7A, 2.10B, 3.11A, 4.5A, 6.9AB, 7.8A, 7.14C
Social Studies:K.5A, K.14AB, 1.6BC, 2.7B, 3.8ACD, 4.9ABC, 8.29ABC

Instructions:

1. Work in groups or pairs. Design and build an environment that includes a river.
2. Fill the river with water and describe your environment.
3. Construct a dam on the river in your environment.
4. Remove the water from downstream of your dam and replace it above the dam.
5. Observe how creating a dam changes the environment.

Discussion questions:

1. How was your environment changed after the addition of the dam?
2. Would your actions have damaged the ecology, humans, or geography of the area? (The Ganges river is a good example to show students)

Hydropower bonus activities- not included in the station

All the World's Water- demonstration

Lesson Overview: students will see a visual representation of the Earth's water supply

Materials: A 1 gallon see through container such as a milk jug, 2 see through cups, ½ cup measuring cup, Tablespoon size measuring spoon, water, ice cubes, salt, blue food coloring

TEKS: Science: K.10B, 1.7A, 2.10B, 3.11A, 5.6B

Social Studies:1.6B, 2.7B, 2.8ACD, 4.5A, 4.9ABC, 5.14B, 6.5A, 7.20D

Instructions:

1. Fill a gallon jug with water- explain that this is all the water found on earth.
2. Remove 6 Tablespoons (½ cup) of water from the gallon jug and place it in the second container.
3. Pour salt and blue food coloring into the first container (the gallon jug) and explain that this is ocean water. Set this aside.
4. The second container now represents all the fresh water we have on earth (1/2 cup). Remove 2 Tablespoons of water and place it in a third cup.
5. The second container (containing 4 tablespoons of water) represents the frozen freshwater found on earth. You can exchange the water for a couple of ice cubes to enhance the visual effect.
6. The third container represents all the freshwater that is available to us to use.

Discussion questions:

1. What are some sources of water?
2. Why did we add salt to the gallon jug of water?
3. Can we use the salty water for human consumption?
4. Can we use the salty water for human uses/ needs? (things like transportation, energy creation, food farming)
5. Can we use the frozen freshwater?
6. What is frozen freshwater called?
7. Who uses this frozen freshwater?
8. What are the sources of usable freshwater?
9. How do we use this freshwater?
10. How is it misused?

Water pollution

Cleaning up water pollution is made more difficult because we don't always know what the pollutant is. Students can work through how to clean up the water using different materials. Today oil spill response teams use many varied items for clean up. Physical barriers such as ropes are used to contain the area. Then polymers can be used to absorb much of what is floating on top. Microbes can also be used to "eat" the pollutants in the water column. Rice cereal is a good item to use for a simulation.

Lesson Overview: Students will illustrate how difficult it is to clean up pollution:

Materials: vegetable oil, bowl, water, various tools (spoon, pencil, leaf, paper, eyedropper, feather, string, yarn, rice cereal etc.)

TEKS: Science: 1.7A, 2.10B, 3.11A

Social Studies: K.5A, 1.6B, 2.7B, 2.8ACD, 4.5A, 4.9ABC, 7.20CD, 8.29ABC

Instructions:

1. Put a few drops of oil into a bowl of water and observe.
2. Write a hypothesis for each tool you have and how effective you think it will be in cleaning up the “oil spill”
3. Try to contain the “spill” with various tools.
4. Try to clean up the “spill” using various methods of removal
5. Record your results

Variation: create a “beach” with sand, water, sea animals, rocks and shells. Create an “oil spill” and try to clean it up.

Discussion questions:

1. Which items were best at absorbing the oil?
2. Which methods work best for corralling the oil?
3. What other items might you try to use?
4. How can pollution in the water affect the animals and plants that live there?
5. How could it affect our ability to use the water as an energy source?

Water Collage

Lesson Overview: Students will create a collage of items relating to water

Materials: glue, paper, magazines

TEKS: Science: K.10 B, 1.7A, 2.10B, 3.11A

Social Studies: K.13AB, K.14AB, 2.7B, 2.8A

Instructions:

Cut out pictures of water and things that need water to live and glue them on paper to make a collage. Add “water words” and facts to collage (e.g. - hydropower, beaches, water conservation,)

Under Pressure

Adapted from The Energist - National Energy Foundation, 1995

Lesson Overview: Students observe the effect of water pressure to understand the need for dams in producing hydroelectricity.

Materials: 3 liter soda bottle with cap, tape, water, nail

TEKS: Science: 1.7A, 2.10B, 3.11A, 5.8A, 6.9AB, 7.8A
Social Studies: 1.6B, 2.7B, 2.8ACD

Instructions:

1. Place three small, equal sized holes one above the other evenly spaced from the bottle's bottom to the bottle's top.
2. Place a piece of tape over the holes
3. Fill the bottle with water (do not put cap on bottle).
4. Remove the tape and observe the results.
5. Repeat activity with cap on - observe the results.

Discussion questions:

1. Which stream of water is under the most pressure? (the bottom stream)
2. What effect does air pressure have on the process? (it increases the force of the stream of water)
3. Does the total pressure affect the rate of water flow? (yes, more pressure means more water flow)
4. If you were designing a hydroelectric dam where would you place your penstock and turbine to obtain the greatest pressure? (At the lowest possible point)

Make a waterwheel

Lesson Overview: This activity illustrates that moving water can do work

Materials: plastic soda bottle, x-acto knife, bottle cork, wooden skewer, thread, ball of clay or small weight.

TEKS: Science: 1.7A, 2.10B, 3.11A, 5.8A, 6.9AB, 7.8A
Social Studies: 1.6B, 2.7B, 2.8ACD

Instructions:

1. Cut soda bottle into three sections. (The middle section should be 3" deep.) Now cut four strips, 1 inch wide, out of the middle piece. Cut each strip in half to make eight blades.
2. Draw eight lines evenly spaced down the side of a cork. Cut slits down the lines with a blunt knife and push a blade into each slit.
3. Cut away a section of the bottle base (so water can flow out). Then pierce two holes just below the rim, one on either side.
4. Cut a wooden skewer in half. Feed each half through a hole and push the sticks into the ends of the cork.
5. Put a second cork on the end of one of the sticks. Tie a length of thread around it and attach a blob of modeling clay. Now put your waterwheel under a faucet. Slowly turn the faucet on and watch your machine lift the weight. (A tray under the waterwheel may be necessary to catch water spills)

Discussion questions:

1. Does the force of water change the speed at which the weight moves?
2. What amount of weight can be handled by the water wheel?
3. Does placement of the water wheel change the effectiveness of it?

Geothermal energy...

...is power from the earth

...is Old Faithful

...is renewable energy

...is a reliable source of electricity. Most geothermal power plants can operate 24 hours a day 95% of the time!

...is a large, secure source of domestic energy

What is Geothermal Energy?

The earth's core is very hot - 7,000 - 8,000 degrees Fahrenheit. Geothermal energy is the internal heat of the earth. "Geo" means earth and "thermal" refers to heat. That heat is the result of radioactive decay, chemical reactions, and friction from the movement of the earth's crustal plates and heat leftover from the formation of the earth.

Heat from molten rock (magma) deep beneath the earth's surface produces hot water and steam when pressure builds up and is brought to the surface through heated, permeable rock. Volcanic eruptions and geysers are examples of geothermal energy.

There are three basic forms of geothermal energy:

1. Hydrothermal - composed of naturally circulating hot water and steam trapped in porous rock near the earth's surface. Texas possesses low temperature hydrothermal resources used for space and water heating, enhanced oil recovery and desalinization.
2. Geopressurized - a mixture of hot water and methane trapped in sedimentary rock far beneath the earth's surface. In Texas, geopressurized zones occur in deep strata under the gulf coast, but have not been developed.
3. Hot Dry Rock - formations containing very hot rock and little water. The proposed method for extracting heat from hot dry rock (HDR) zones involves injecting highly pressurized water through fractured hot rock. The hot water would be collected at a well site. Studies suggest that East Texas has moderately good HDR resources.

Since prehistoric times geothermal energy has been used directly for cooking and bathing. Today, hydrothermal resources supply millions of people with clean, low cost electricity. Most of the country's geothermal resources are located in the western United States. It is a very important source of energy in Iceland and New Zealand.

Geothermal Power Plants

In some places hot water reaches the surface naturally and power stations are established there. But, large deposits remain trapped and can only be obtained by drilling into the porous rock.

Hydrothermal power plants are built in places where very hot water is located near the earth's surface. A pipe is drilled into the rocks to allow steam to escape to the surface, where it is used to drive a turbine and generate electricity. When waste water is pumped back into the ground and water is not withdrawn faster than it is recharged, hydrothermal plants are truly renewable and hydrothermal aquifers are not diminished by overuse. With current technology, hydrothermal reservoirs are the most desirable type.

The Future

Our present knowledge of promising geothermal sites depends on visual evidence like geysers and hot springs. Current technology is not very sophisticated and drilling is complicated and expensive. There are promising geothermal "hot spots" world wide that require further technological developments, commitment and money.

Geothermal Activities

Make a Geyser

Water vapor needs four times as much space as water. Much pressure is produced and the steam escapes. Steam that is underground seeks to escape through cracks in the earth's surface (a geyser).

Students should be supervised in this activity

Lesson Overview: students will create a geyser

Materials: hot plate, pan, funnel, balloon, *water, electricity*

TEKS: Science: 1.7A, 2.10B, 3.11A, 5.8A, 6.9AB, 7.8A
Social Studies: K.5A, 1.6B, 3.4A

Instructions:

1. Fill a pan half full of water.
2. Place a collapsed balloon over the small end of the tube.
3. Place the funnel (large end down) in the pan of water.
4. Place pan on hot plate and heat.
5. Observe what happens.

Discussion questions:

1. Why use a funnel?
2. What fills the balloon?

Variation:

1. Make a pinwheel from light weight paper and attach it to a long stick.
2. Hold the pinwheel over the pan of boiling water. What happens?

Biomass...

- ...is organic energy.
- ...is chemical potential energy.
- ...plant material or vegetation.
- ...is animal matter.
- ...is a form of solar energy - plants depend on sun to grow!
- ...is garbage!
- ...is a fuel source.
- ...has potential as an energy source.
- ...is renewable.

What is biomass?

In the process of being eaten, burned or decayed, organic materials transfer their energy. Biomass was a principle source of energy for centuries. Wood was burned to provide heat and cook food. Food provided energy for beasts of burden. Biomass is still the primary energy resource for many developing countries. New uses now exist for biomass as an energy resource.

Crops like corn and sugar are grown and converted into ethanol (ethyl alcohol - made by the fermentation of grain). 10% Ethanol combined with 90% gasoline makes gasohol - one way to help stretch fossil fuel supplies. Fuel can be produced by converting wood into a methane-rich gas.

Garbage, or organic waste, has potential as an energy source. As waste in landfills breaks down, it releases a gas called methane into the air. When collected and burned, methane can be used to heat water and make electricity. About 16% of the 870 million tons of refuse produced in the United States each year could easily be converted into fuel providing the equivalent of 150 million barrels of oil. Garbage can also be converted into fertilizer and soil conditioner through composting. Presently, organic waste is the most important biomass resource. Over 20 million tons of waste was put in Texas landfills in 1993 - nearly 75% of that was organic.

Texas is the producer of a number of good biomass resources - agriculture, wastes generated by the forest industry and urban waste.

While biomass is an exciting alternative energy source, it takes energy to produce the things that become our waste. Conservation still saves more energy than recycling or converting waste to energy.

Biomass Activities

Gas from Garbage

Adapted from: Young Discoverers - Energy and Power by Sally Morgan and Rosie Harlow

Lesson Overview: students will watch the effects of decomposition

Materials: dried peas or beans, clear plastic bag (zip lock or with twist tie), *water*, *container*

TEKS: Science:K.7A, 1.7A, 2.10B, 3.11a, 5.8A, 6.9AB

Instructions:

1. Soak dried peas or beans in water overnight.
2. Drain and put soaked peas or beans in the clear plastic bag.
3. Squeeze out all the air and seal the bag.
4. Place the bag somewhere warm and leave it for a week.
5. Observe the bag to see what has happened. Throw the bag away without opening once experiment is finished.

Discussion questions:

1. What breaks down the beans?
2. What caused the baggie to inflate?
3. How could we use this gas for electricity?

Wind Energy...

- ...can be used to do work.
- ...is kinetic energy that can be changed into mechanical or electrical energy.
- ...has been used for centuries. It drives boats, pumps water and turns grinding stones to grind wheat or corn.
- ...is used today to make electricity.
- ...is renewable energy.
- ...is nonpolluting.
- ...comes from the sun. About 2% of the sun's energy that reaches Earth is converted to wind energy.

Blow Ye Winds

The air around the earth is called its atmosphere. It is divided into three main layers. Our weather is formed in the lowest layer, called the troposphere. It is about eight miles high. The air in this layer is always moving and being pressed down by gases in the layer above. This weight is called air pressure.

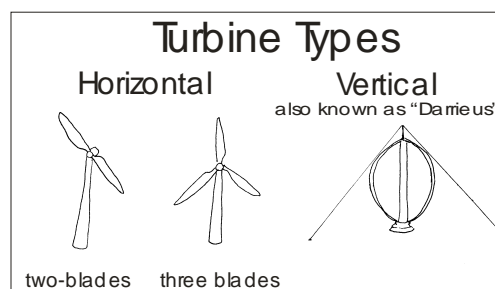
Since warm air is lighter than cold air, air pressure is lower at the equator because the weather is hot there. At the North and South Poles air pressure is higher because the weather is cold. These areas of high and low pressure influence our weather.

As the warm air at the equator rises into the higher levels of the troposphere, cool air from the North and South Poles moves in to take its place. The cooler air is heated by the sun, rises and is replaced by more cool air. This constant movement of air causes winds. The winds blow in the same direction for much of the year depending, for the most part, on the rotation of the earth. Wind patterns are shown on maps.

Harnessing the Wind

About 12,000 years ago Egyptians figured out how to use the wind's power and patterns to move sailing boats. The first windmills were used by Persians about 1,300 years ago. Windmills have been used to pump and drain water, grind grain, and saw wood. 80,000 windmills are still in use today in Texas for pumping water for residential and agricultural uses. Wind energy is now also used to make electricity.

Today's windmills have evolved into sophisticated machines. Some look like huge fans with two or three blades. Each blade can weigh up to 4,500 pounds, range from 20 to 70 across and stand 80 to 140 feet tall. The "Darrieus" wind machine looks like a giant egg beater. It stands 100 feet tall and is about 50 feet wide.

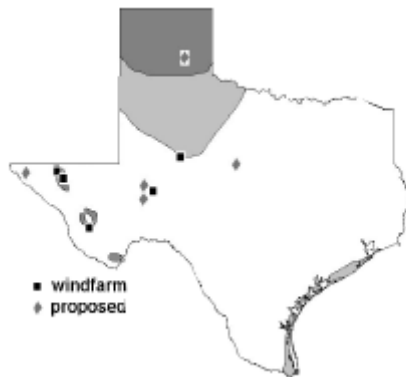


Whatever their shape or size all wind machines work essentially the same. Wind spins the blades on a wind turbine. The blades are attached to a hub that is mounted on a turning shaft. The shaft goes through a gear transmission box where the turning speed is increased. The transmission box is attached to a high speed shaft which turns a generator that makes electricity.

Wind speeds must be above 12 - 14 miles per hour to turn turbines fast enough to make electricity. If the wind is blowing too high, the turbine has a brake that will keep the blades from turning and being damaged. Texas has very high wind energy potential - enough to meet roughly 10% of the nation's electric power needs. Ultimately, West Texas could be the largest center of renewable energy in North America.

From 1995-2000, 187 mega watts of wind turbines were installed on 5 Texas wind farms in West Texas. These provide electricity for 40,000 homes each year. In 2001 another 500 MW were developed in this area. As of 2006 Texas had 2009 MW of power being created by wind. This is enough power to run 750,000 homes.

In 2007 a new wind farm will be built offshore of Galveston to harness the offshore sea breezes. These wind turbines will be modified slightly for use in the water and to be safe for Hurricanes.



Texas wind potential *Windy areas in Texas are indicated on the map as shaded areas (darker color represents stronger wind speeds). New projects are coming online in 2001.*

Wind Power Activities

Blast Off

Lesson Overview: Students will use air as a source of power to turn a balloon into a rocket

Materials: balloons (one for each student), plastic straw, 10 foot length of string, scotch tape

TEKS: Science: K.7A, 1.7A, 2.10B, 3.11A, 5.8A, 6.9AB
Social Studies:K.5A, 1.6B, 2.7AB, 2.8A

Instructions:

1. Slide the straw onto the string. Tie the string to a door knob or chair or other stationary object. Pull the string tight and tie other end.
2. Blow up a balloon (don't tie it). Hold the end tightly closed and tape the balloon to the straw, with the neck of the balloon facing away from the starting end.
3. Do a count down and let the balloon go.

Discussion questions:

1. Does the size of the balloon change the speed it can travel at?
2. Does the shape of the balloon change the speed?
3. How far can the balloon travel?
4. Are there any sources of friction to slow down the balloon?

Variation:

Use 2 or more strings and have contests or do experiments.

Testing a Pinwheel Turbine

Activity taken from Infinite Power of Texas Lesson Plan No. 14 "Testing a Pinwheel Turbine"

Lesson Overview: Students will build and test a windmill and its ability to do work.

TEKS: Science:K.6E, K.7A.7A, 2.10B, 5.8A, 6.9AB, 7.8A
Social Studies: 1.6B, 2.16B, 4.5A, 4.9ABC, 5.24BC, 7.20CD, 8.29A

Materials: (for each group of 4 students)

- 1 liter plastic water bottle (empty) with sipper top
- 1 piece of cover stock or a manila folder
- 1 thumbtack
- 1 smooth, round painted pencil with eraser (pencil should slide through opening of sipper top)
- 1.1 meters of sewing thread
- 1 10 gram mass; (or 1 hole stopper weighing approximately 10 gm) or other suitable 10 gm object
- 1 meter stick 2 small pieces of masking tape

- 1 rubber band
- 1 stopwatch or timer
- 1 *floor fan or a breezy day* (fan can be shared)
- *goggles*

Instructions:

Constructing a pinwheel

1. Cut a square from cover stock paper 21.5 x 21.5 cm; or a square from a manila folder (can be 20 x 20 cm to 24 x 24 cm).
2. Draw 2 lines diagonally on your square from corner to corner.
3. Mark a point 2 cm from the center on each diagonal line (you will have 4 such marks).
4. Using scissors, cut the cover stock square (or manila folder square) from each corner to the 2 cm mark. Do this 4 times, once for each corner of your square.
5. Your square now has 4 triangles drawn on it, connected in the middle. Hold your square and draw a dot in the right hand corner of each triangle, as you turn your square all the way around. Now you have a dot on alternate sides of each of the 2 diagonals.
6. Pin all of the dotted corners together in the center to make a pinwheel.
7. Tack the pinwheel to the end of the eraser on the pencil.
8. Cut a 1 cm square hole into direct opposite sides of the water bottle, 10 cm from the bottom of the bottle on each of the 2 sides.
9. Remove the cap from the empty water bottle and fill the bottle 9 cm from the bottom with sand (water could also be used as the weight). Sand should not reach the height of the 2 holes.
10. Remove the sipper tip from the top of the water bottle cap and place the cap back on the bottle.
11. Wrap a rubber band several times around the pencil; almost 3 cm from the eraser end on the pencil.
12. Slide the free end of the pencil through the sipper tip. The rubber band on the pencil will stop the sipper tip from coming close to the pinwheel. The sipper tip acts as a bushing.
13. Tie or tape the 10 gm mass to the end of the thread.
14. Tape the free end of the thread to the eraser so the length of the thread between the mass and the pencil is 1 meter.
15. Slide the pencil through the plastic bottle, using both square holes.

Performing the Activity (Wear goggles)

1. Holding the pinwheel so it is still and covering the holes with your fingers to keep the sand inside, place the plastic bottle on its side on a table. (The sand will flow to a level below the holes when the bottle is on its side.) Allow the thread to hang down loosely, with the 10 gm mass at the end. (If outside in the wind, hold the bottle.)
2. Holding the pinwheel still, place the bottle in a position that causes the fan to spin the pinwheel.
3. Release the pinwheel and start the stopwatch or timer at the same time. Measure the amount of time it takes for the pinwheel to reel up the 10 gm mass exactly 1 meter. This is work being done by the pinwheel.
4. Repeat five times and record the seconds for all five trials.

5. Sum the 5 readings and divide by 5 to find the average time. Make a data table and enter the readings. Choose your headings.

Discussion Questions:

1. Did the speed of the breeze change the rate at which the weight could be picked up?
2. How does direction of the wind effect the efficiency of the pinwheel?

Make Your Own Wind Meter

Lesson Overview: A good windy day activity.

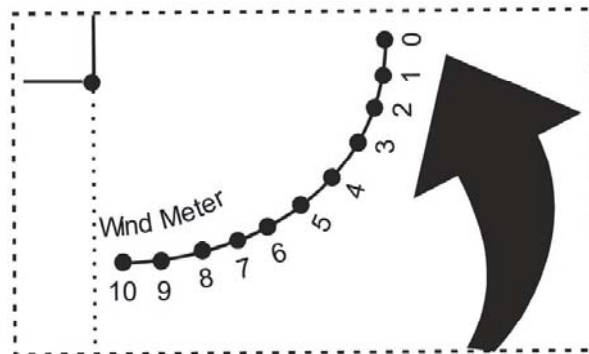
Materials: 3x5 index card, *scissors*, *glue*, small paper clip, wind meter pattern

TEKS: Science: K.7AC, 1.7A, 2.10B, 3.11A, 6.9AB

Social Studies: 1.6B, 2.16B, 3.4A, 4.5A, 4.9ABC, 5.24BC, 7.20CD, 8.29A

Instructions:

1. Cut out the wind meter and glue it on the index card.
2. When the glue dries, cut along the dotted line.
3. Fold along each solid line.
4. Put a paper clip at the end of the strip. Line up the strip with the "0"
5. Go outside. Hold the Wind Meter vertically so the paper clip hangs down.
6. Turn so the wind is in your face, and aim the arrow on the Wind Meter into the wind. What number does your strip move to? Record this number
7. Observe the things in your environment being blown by the wind. Record your observations.
8. Repeat steps 5, 6 and 7 for four more days.
9. Record which day the wind blew fastest. The slowest. Record about how fast the wind was blowing each day. Compare your recordings to local weather reports.



Discussion questions:

1. Does placement of the paperclip effect the meter's use?
2. Does location of testing make a difference?

Resources:

Watt Watchers of Texas www.wattwatchersoftexas.org

Trent Mesa Wind Farm www.treatmesa.com

El Paso Electric www.elpasoelectric.com/internetsite/www_epesite.nsf/homens

Lower Colorado River Authority www.lcra.org/energy/windproj.html

McCarney Wind Farm www.fpl.com/news/1999/contents/99067.shtml

Indian Mesa I www.wind.enron.com

Wind Farm Developers www.awae.org/directory/developers.html

Farm Windmill, American Wind Power Center www.windmill.com

Alternative Energy institute www.windenergy.org

Center for Renewable Energy www.caddet-re.org

National Renewable Energy Laboratories www.nrel.gov

Texas Solar Energy Society www.txses.org

Texas Renewable Energy Industries Association www.treia.org