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Searching for Tomorrow's Energy

Curriculum Unit 10.04.01
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Introduction

This unit "Searching for Tomorrow's Energy" is designed for a fifth grade class particularly because it will give the students the ability to use demonstrations from the seminar to better understand the chemistry, physics and economics of various energy alternatives. This unit will allow students to connect to Science in their everyday life when they are beginning to question their lives in general. This unit will allow students to feel comfortable with the processes of scientific investigation. The students will design, conduct, communicate about, and evaluate such investigations of renewable energy.

I teach fifth grade at Nathan Hale School in New Haven, Connecticut. My fifth grade class is in an urban district and is composed of a diverse, multicultural community of learners that embodies a wide range of achievements, interests, learning and social needs. It is a school that has a strong neighborhood support structure; therefore, the majority of the students enrolled are from the neighborhood.

This unit will help students be able to determine which energy source will be most effective to the economy and the environment in the future. The reason for doing this is to develop the students' understanding of different types of energy sources. At the completion of this unit, the students will be able to distinguish between potential and kinetic energy, identify and describe different forms of energy, demonstrate an understanding of renewable and nonrenewable sources of energy, and most importantly, these very important topics can be integrated directly through Math, Science and Technology. Additionally, it is aligned with New Haven Public Schools goals for students which say "What students learn in school must be relevant to the world in which they live. The learning that takes place in schools is not only academic, but also social and personal. It is profound and must be relevant to the world in which they live." This unit will integrate subjects to fully expand one topic as well as help me to give students a "greater purpose" for learning about how and why it's important to conserve energy because it directly affects their own daily lives.

In recent years, there has been a growing interest in renewable energy due to environmental, health and political concerns. Fossil fuel use correlates to air pollution, especially in urban areas, which is a growing health concern, while acid rain and global warming continues to evoke debate. The youth are the future; that is why it is crucial to educate of our future engineers and policy makers in the laws of thermodynamics and alternative energy sources. Public policy issues concerning energy have direct correlations with the economy.

Setting the Tone

In this 5 week unit, students will study which energy source will be most effective to the economy and the environment in the future. They will compare and contrast renewable and nonrenewable sources of energy. Through various activities and experiments students will explore different types of energy sources, specifically solar energy. Students will be introduced to a simple food chain by putting an example on the board. Example: sun-grass-sheep; explain that the sun provides energy for the grass to grow and the grass provides energy (food) for the sheep.

We will then discuss the following points: The sun gives off energy that is used by the plants. However, the plants do not use all of the energy the sun produces. Animals eat plants to get energy. However, not all of the energy that was captured by the plant is still in the plant since it had to use some for its own growth and reproduction. With each transfer of energy, some is "lost" to the process of staying alive. Students will also learn to distinguish between potential and kinetic energy and identify and describe different forms of energy.

This will be done in terms of what we can do in our everyday life to use an energy source that will be stainable and renewable. Helping students make educated choices is an essential part of their education and well-being. Through this study, students will gain the ability to choose the most efficient and effective energy sources, from choices that are available to them in their everyday lives, which will allow students to become educated consumers.

Overview

Weeks One and Two

In weeks one and two, the class will be introduced to what energy is and the different forms of energy using mnemonic devices and real world applications, as well as, reading materials on energy. The students will gain an understanding of what energy is and the different forms of energy. Vocabulary words that will be introduced and integrated throughout this unit include: potential energy, kinetic energy, and renewable energy, and nonrenewable energy, solar, wind, geothermal, hydrothermal and converted. In doing this, the students will obtain background knowledge about energy which will be used to understand why the choice of energy needs to be a sustainable and renewable one.

Weeks Three and Four

During these weeks, the students will analyze how energy is converted. In order to develop a deep understanding of energy conversion, students will gain a deeper understanding of renewable and nonrenewable energy sources. The students will gain an understanding about the conversion of energy. And how from one form to another energy is converted by a natural law: The Law of Conservation. This law states that energy can be neither created nor destroyed; it can only be changed from one form to another. This change is one of quality, not quantity. As energy performs work it changes from a more concentrated form of energy to a less concentrated form.

Week Five

During this final week of the unit, students will be asked to apply their skills learned to their everyday lives. Projects and activities will allow students to apply their prior knowledge about nonrenewable and renewable energy sources. Based on their cumulative study, students can create and evaluate ways of saving energy. Participating in these activities will raise focus on the issue dealing with saving energy. Students will gain an understanding of good energy choices and how crucial it is for their future and the future of others. Students will then be evaluated on their application of the knowledge through this study.

In accordance with the Connecticut State Standards for Science, after completing this unit, students will be able to have the capacity to build and use tools to advance the quality of their lives, and use advances in technology that will allow individuals to acquire new information about the world. In accordance with the Connecticut State Standards for Language Arts, after completing this unit, students will be able to make connections between the text and outside experiences and knowledge, and select, synthesize and/or use relevant information within the text to write a personal response to the text. In accordance with the Connecticut State Standards for Reading, after completing this unit, students will be able read, comprehend and respond in individual, literal, critical and evaluative ways to literary, informational and persuasive texts in multimedia formats. Students will also be able to select and apply strategies to facilitate word recognition and develop vocabulary in order to comprehend text.

Background Knowledge

What is Energy?

You use energy all the time. When you turn on a light or ride in a vehicle, you use energy. It took energy to make the books that you read, to power the computer that you use and the video games that you play. A lot of energy we use comes from oil and coal. Oil and coal are fossil fuels. They are made inside the earth from dead plants and animals.

Fossil fuels have powered many of the gains we have made during the last two hundred years, although fossil fuels produce a lot of pollution. Sooner or later, they will run out. These types of energy sources are called nonrenewable. Scientists are searching for other ways to replace fossil fuels.

Energy sources such as energy from the sun, wind, waves and Earth's internal heat can never be used up. These types of energy sources are called renewable. And because these renewable energy sources don't burn anything, they don't add to global warming. These types of energy sources are call renewable.

Energy can be defined as the capacity to do work. Work is defined as any interaction in a system with its surroundings that can affect an outcome (1). The nature of energy is very complex, but it is best described by these characteristics in kid friendly terms:

· energy is the ability to do work

- work is the application of force through a distance (e.g., carrying yourself and a loaded backpack up three flights of stairs)
- force is that which can stop or start matter already moving (e.g., you are stopped in the lunch line and someone is talking to a friend and doesn't see you standing in front of them, and can't stop walking before colliding into you, pushing you out of the lunch line.)
- motion is a change in distance or direction with time

Energy cannot be created or destroyed but it can be converted from one form to another. Everything that occurs in our universe revolves around energy. Energy comes in many different forms such as heat, light, sound and electricity. There are two major categories of energy: kinetic and potential energy. If the energy is moving or is in use, it is called kinetic energy. An example of kinetic energy is a car rolling down a hill. If the energy is due to the position or composition of an object, it is called potential energy. An example of potential energy is a car parked on a hill (due to its position). Therefore, Energy is anything that can do Work or cause a change.

The unit of measurement of work combines the unit of force, Newton, with the unit of distance, meter and the resulting unit of work is the Newton-meter. One joule of work is done when a force of 1 N is exerted to move an object through a distance of 1 m. According to Hewitt (1997), James Joule was able to show 1 joule is equal to 4184 Calories (2).

The rate at which work is done is called Power and can be calculated by dividing work by time. The unit of power is named Watt (W) named after the inventor of the first practical steam engine James Watt.

Watt measured the power of his machines by how fast his horses could do work so that people of his era during the 1700's could understand them. Watt's observations showed him that a horse could lift 550 pounds to a height of 1 foot in one second. That rate of doing work is known as a horsepower (HP) and is still used today as a standard measurement in the United States.

A 100 Watt light bulb uses energy at a rate that could move an object with force of 100 N over a distance of 1 m each second. If you run a 60 watt bulb for an hour it brings an awful lot of energy into your house. The amount of electrical energy used over a period of time is measured in a unit called watt. We can use the watt to compare the rates at which different electrical devices use energy. Electric companies or energy companies provide us with a lot of energy for a pretty reasonable price. These companies are converting (changing) chemical energy in coal, oil, gas or nuclear energy into electrical energy for consumers to use as light, heat, or some sort of energy.

Seven Different Forms of Energy

There are seven different forms of energy. These forms of energy can be changed or converted into other forms as well. The most common way to see this change is as heat. In a flashlight battery, the chemical energy in the battery is converted into electrical energy and then finally into light with a little bit of heat (place your hand over the light to feel the heat). Another way energy is changed into other forms is when natural gas burns in a furnace; chemical energy stored in the gas is converted into heat energy. Also, the sun's radiant light is converted by plants into chemical energy in a process that is known as photosynthesis.

An easy way to remember the seven forms of energy is by remembering the name Mrs. Chen.

M Mechanical energy
R Radiant energy or sunlight or solar
S Sound energy
C Chemical energy
H Heat energy
E Electrical energy
N Nuclear energy

Practical Sources of Energy

The practical sources of energy include fossil fuels: natural gas, oil, and coal. Fossil fuels are referred to as nonrenewable energy sources because once they are used they are gone. Many people are exploring other sources of energy called renewable energy sources. These energy sources include sun, wind, geothermal, hydropower, and biomass. The renewable energy resources are very important in our future energy planning because they will never be exhausted.

Solar Energy

The sun is 93 million miles away and still, this hot gas ball is the primary source of all energy on earth. This energy comes from the thermonuclear reaction of fusing hydrogen atoms to form helium, a reaction responsible for the sun to exist. Without the sun, fossil fuels could have never existed. The sun is the energy supplier that also runs the water cycle. The heating of the earth, which is uneven, produces wind energy. Solar energy may also be used to cook food, heat water and generate electricity. It is still the cleanest energy source and it is renewable. The potential for solar energy is vast and should represent a major part of our energy for the future throughout the United States. It is an unlimited supply of energy and causes no pollution to the air or water. However, geographic location, time of day and seasonal change affects the amount of energy received by a solar collector. This causes some reliability issues and a need for storage or a backup source because of the availability of the sunlight.

Wind Energy

Wind is created when the earth is heated unequally creating a difference of temperature, density and pressure within the earth's atmosphere. This wind energy can be converted into mechanical and electrical energy. For thousands of years, wind turbines have been used to convert kinetic energy to mechanical energy that allows simple machines to grind grain and pump water. Today we use wind turbines to produce electricity. Large wind farms produce most of electricity generated by wind turbines. The wind farms sell the electricity generated to utility companies for distribution. The Public Utility Regulatory Act (PURPA) states that the producers of the wind energy sell the electricity at a reasonable rate. Electricity-generating wind turbines are not harmful to the water and do not produce air pollution. These wind farms are inexpensive to build and other crops can be planted on the unused land. Wind patterns can cause a fluctuation in a constant significant amount of wind needed. A common concern is the visual impact the wind turbines have on the cities and homes around them (3).

Geothermal Energy

Geothermal energy is energy found deep within the earth. Geothermal energy is the only renewable energy that does not come from the sun. Decay of radioactive elements (thorium and uranium) in the earth's core releases heat, which gets trapped below the surface of the earth. In deep fault areas, water is heated by the deep rocks below. The contact causes the water to heat up and come back to the earth's surface where it can be captured for use. This energy is not popular in the United States. Native Americans used hot springs for cooking and the Greeks and Romans built public baths over hot springs. Some even heat their homes with it when it is captured. Since 1960, large reservoirs of geothermal steam and other hot water reservoirs in the western United States have been tapped to generate 3,000 megawatts of electricity (4). There are four types of geothermal resources: Hot dry rocks, magma, geopressured brines and hydrothermal reservoirs (water and steam). Hydrothermal reservoirs are more commonly used. Geothermal energy supply is unlimited and very clean. It provides no water or air pollution. Any waste emitted (salt or minerals) can be pumped deep into the ground where no harm is found. Start up costs may be expensive as well as maintaining the area due to corrosion. Heat transfer through rocks is also a slow process. As a result, geothermal plants will use up the available geothermal heat and become inefficient over time unless new geothermal wells are drilled.

Hydropower Energy

Hydropower is water that is trapped behind dams; the trapped energy is a source of electricity. The monstrous amount of falling water has the ability to turn giant turbines. The turbines enable the generators to work, which produce electricity. The amount of power is determined by the amount of water and the distance the water falls. As water moves through the turbine, the kinetic energy of the flowing water is turned into mechanical energy. This energy can be used to grind grain, move a sawmill, pump water and provide electricity. There are many types of turbines that capture kinetic energy. Run-of-the-river turbines and the spinning turbine do not need a dam and have a very low environmental impact. The most commonly used hydropower system uses energy from falling water. A dam is used to capture the water. The larger the drop, the more energy is captured. A turbine is used to collect the kinetic energy. Some rivers have more than one dam and hydropower station. Water power is a clean source of electricity. The cost is low once the entire station has been constructed. The energy produced is free once the equipment costs needed to capture the energy have been paid back. Water reservoirs offer recreational benefits as well (boating and fishing) and can be used with solar and wind power. Hydropower does have its environmental impacts although. Dams cause flooding and cover a larger area than solar plants that produce the same amount of energy. Ecosystems will also be disrupted as running water will now be moving in a calm stream and ponds.

Biomass Energy

Biomass is a term used to describe energy that is derived from garbage and wood. Garbage sites are feeding grounds for bacteria growth. As bacteria decompose the garbage, methane is produced. This methane is the same as natural gas found in the ground. There are a number of power plants in the United States, which are run by methane from these organic wastes, mostly manure. Biomass in the form of wood is the oldest form of renewable energy. Wood has been used to produce heat and for cooking. Some cities even produce electricity by burning the garbage in designed power plants. Biomass is a local energy source especially to those that live in wooded areas and high urban areas have a constant production of waste. Burning wood or dried sewage pollutes the air at the same rate as fossil fuels. Cutting down wood to fuel these plants also disrupts the habitats of other species.

Conservation of Energy

The conversion of energy from one form to another is governed by a natural law: The Law of Conservation. This law states that energy can be neither created nor destroyed; it can only be changed from one form to another. As energy performs work it changes from a more concentrated form of energy to a less concentrated form. Energy that goes into a typical light bulb becomes light and heat. When you touch a light bulb it feels very hot. The chemical energy of gasoline is converted into mechanical energy that moves a car and some of that energy is lost into the environment. You can see this when you stand near a car that is not moving and feel the heat. This is a very important reason why we should conserve or save energy.

Saving energy will allow us more for another day. It will also cut down on the pollution and help energy last longer until our renewable energy sources are more available. This is why it is so important that we educate the students. These students are our future consumers. We need to teach them to make better choices on the types and how much energy they do use. In doing so, we will allow the energy we have to last longer and continue to change the availability of renewable energy sources.

Lesson Plans

Leaf Relay

Grade Level: Grades 3-5

Subject: Science

Duration: 45 minutes

Description: Energy moves through food chains.

Goal: Learn how energy is "lost" when transferred from one system to another.

Objectives:

- Students will create a food chain
- Students will apply new knowledge
- Students will generate ideas and questions for further investigations
- Students will discover new concepts

Materials:

- Enough dry leaves for each group for five to have an armful
- An open flat area
- Chalk board or writing area for teacher

Procedure:

1. Introduce the students to a simple food chain by putting an example on the board. Example: sun-grass-sheep; explain that the sun provides energy for the grass to grow and the grass provides energy (food) for the sheep.

2. Discuss the following points:

- The sun gives off energy that is used by the plants.
- However, the plants do not use all of the energy the sun produces
- Animals eat plants to get energy.
- However, not all of the energy that was captured by the plant is still in the plant since it had to use some for its own growth and reproduction.
- With each transfer of energy, some is "lost" to the process of staying alive.

3. Place the pile of leaves at one end of the area in a pile. Form five teams of five students.

4. Have each team line up in a parallel line, with 2 to 3 feet separating each person, and several yards separating each group. The teams should be lined up 100 yards away from the "energy pile."

5. Assign one of the following roles to each student: The first person in line will be the sun; the second a plant; the third a herbivore; fourth a carnivore; and fifth a human.

6. Have each player, except the sun, mark their spot. Have the suns stand behind the "energy pile" facing the group.

7. Explain that the sun provides the energy needed in each of the food chains. Have the suns scoop up as many leaves as they can hold in their arms.

8. At the "go" signal, the suns race to the plants who (gently) grab as much of the suns' energy as they can.

9. The plants turn and move without running, and the herbivores race up to grab as much energy as they can hold. The herbivores return to their spot. As soon as then herbivores come back to their spots, the carnivores run up and capture the energy from the herbivores. Continue with the humans. When the humans return to their spot, have them raise the remaining energy source above their heads to show that they are finished.

10. Look on the ground. What happened to the energy during the transport and transfer? Compare the amount held by the first person and the last person. If there were fewer transfers, how much energy would the last person have? How could we make fewer transfers in our lives?

11. Introduce environmental disasters like pesticides, floods, or oil spills at one stage. Have the students drop half their energy supply. This represents the damage and lessens the energy taken or transferred. Discuss the effects of having less energy for the food chain and problems that may arise.

Assessment:

· Teacher generated questions
· Participation
· Construction of their own food chain

Generating Electricity

Grade Level: Grades 3-5

Subject: Science and Math

Duration: 45 minutes to an hour

Description: To understand the importance of renewable energy, and how electricity is made.

Goal: To understand that, in order to make electricity, something has to turn a turbine.

Objectives:

· Students will understand the importance of renewable energy.
· Students will construct a turbine.
· Students will apply new knowledge.
· Students will generate ideas and questions for further investigations.
· Students will discover new concepts.

Materials: (are needed for each group of students)

· 100 cm of bare copper wire

· Magnetic bar
· Electric meter
· Paper towel roll
· Student sheet

Background Knowledge: (highlights words should be placed on the board)

Most electricity is commercially produced using large generators. The generator has two parts: the armature, which is a large coil wire, and magnets, which are usually electromagnets. By moving the coil of wire through the field of magnetic, current, or a flow of electrons, is made in the wire.

It does not matter whether the coil of wire moves through the magnetic field or whether the magnetic field moves over the wire. The current is always produced in the wire.

As you can see, something has to turn the coil or the magnet. Tell the students that without energy to do the turning, no electricity can be made. In an electric generating plant, that energy usually comes from a large windmill-type machine called a turbine. The turbine has many blades attached to it (the shaft). The turbine usually is spun by steam produced by a hot boiler. The steam is produced by burning fossil fuels. Running water (hydropower) and wind can also be used to spin the turbine.

Procedure:

1. Break students into groups of 2 or 3.
2. As students work through the activity, introduce the idea that an electric current is a flow of electrons. A magnet can pull tacks or nails, and it can also pull electrons.
3. Ask the students "Do you think it makes any difference if we move the magnet different directions?" Have them try it.
4. Ask the students "Are there any other things you can think of that might change the amount of current produced?"
5. Once the students have completed the task ask the students to construct a turbine generator using some form of renewable energy (wind or water) to do the turning. (You can use the following resources to help guide the students. Tesco Greener living everyday tesco.com/greenerliving/kids) (5).

Assessment

· Teacher generated questions
· Participation

· Student sheets
· Constructing a turbine

How Can You Measure Wind Energy?

Grade Level: Grade 3-5

Subject: Science

Duration: 45 minutes

Description: Making a simple anemometer and measure the wind energy around your school.

Goal: Construct an anemometer and measure wind.

Objectives:

· Students will figure out ways to measure wind.
· Students will compare and contrast places that have wind.
· Students will construct an anemometer.
· Students will measure the amount of wind in different locations of their school.

Materials:

· Pencil with an eraser
· Pin or paper clips
· Soda straws (each student gets two)
· Stapler
· Scissors
· Cone pattern (Each student gets four circles. Students can make their own circle patterns all four being the same size. Tracing around tape rolls can give the a template.)
· Paper
· Tape
· Red Crayons
· Bottle with narrow neck
· Stopwatches or clock with second hand

Background Information:

Some places have a lot of wind and others don't. For example, places that are higher or more open usually have stronger winds. Before you bought or built a windmill, you would want to be sure that you location had enough wind. But how can you measure the wind? An anemometer is used to measure wind energy. You sometimes see them at airports. (Showing a picture may help them make a connection). You are going to make a simple anemometer and measure the wind energy around your school.

Procedure:

1. Staple 2 straws so they make an X.
2. Color one cone pattern red. Students can use the pattern given to them or make bigger cones.
3. Staple one cone pattern to each straw end, so they all face the same way.
4. Curve each pattern to form a cone shape.
5. Pin the center of the X to the pencil eraser. Students can also straighten one side of a paper clip and fasten the straws with the paper clip.
6. Insert the pencil in the narrow neck bottle, so that you can hold the bottle and the anemometer will spin freely. If you do not have a bottle, students can just hold the straws.

Assessment:

· Teacher generated questions
· Participation
· Constructing an anemometer

Vocabulary Words

Biomass- The total amount of living material in a given habitat, population, or sample. Specific measures of biomass are generally expressed in dry weight (after removal of all water from the sample) per unit area of land or unit volume of water. Renewable organic materials, such as wood, agricultural crops or wastes, and municipal wastes, especially when used as a source of fuel or energy. Biomass can be burned directly or processed into biofuels such as ethanol and methane. See more at biofuel (6).

Conservation- The protection, preservation, management, or restoration of natural environments and the ecological communities that inhabit them. Conservation is generally held to include the management of human use of natural resources for current public benefit and sustainable social and economic utilization (6).

Converted- To change (something) into a different form or property; transmute; transform (6).

Energy- The capacity to do work; the property of a system that diminishes when the system does work on any other system, by an amount equal to the work so done; potential energy (6).

Fossil Fuel- Hydrocarbon deposit, such as petroleum, coal, or natural gas, derived from the accumulated remains of ancient plants and animals and used as fuel. Carbon dioxide and other greenhouse gases generated by burning fossil fuels are considered to be one of the principal causes of global warming (6).

Generator- Machine that converts mechanical energy into electricity to serve as a power source for other machines. Electrical generators found in power plants use water turbines, combustion engines, windmills, or other sources of mechanical energy to spin wire coils in strong magnetic fields, inducing an electric potential in the coils. A generator that provides alternating current power is called an alternator (6).

Geothermal- Relating to the internal heat of the Earth. The water of hot springs and geysers is heated by geothermal sources. Geothermal energy is power generated from natural steam, hot water, hot rocks, or lava in the Earth's crust. In general, geothermal power is produced by pumping water into cracks in the Earth's crust and then conveying the heated water or steam back to the surface so that its heat can be extracted through a heat exchanger, or its pressure can be used to drive turbines (6)

Hydrothermal- Relating to or produced by hot water, especially water heated underground by the Earth's internal heat. Hydrothermal energy is power that is generated using the Earth's hot water (6).

Joule- The SI unit of work or energy, equal to the work done by a force of one newton when its point of application moves through a distance of one meter in the direction of the force: equivalent to 10^{7} ergs and one watt-second. Abbreviation: J, j (6).

Kinetic energy- The energy possessed by a system or object as a result of its motion. The kinetic energy of objects with mass is dependent upon the velocity and mass of the object, while the energy of waves depends on their velocity, frequency, and amplitude, as well as the density of the medium if there is one (as with ocean waves) (6).

Nonrenewable energy- Energy sources are nonrenewable if they cannot be replenished (made again) in a short period of time (6).

Potential energy- The energy possessed by a body as a result of its position or condition rather than its motion. A raised weight, coiled spring, or charged battery has potential energy (6).

Power- a. work done or energy transferred per unit of time. Symbol: P

b. the time rate of doing work (6).

Renewable energy- Any naturally occurring, theoretically inexhaustible source of energy, as biomass, solar, wind, tidal, wave, and hydroelectric power, that is not derived from fossil or nuclear fuel (6).

Solar energy- The radiant energy emitted by the Sun. Energy derived from the Sun's radiation. Passive solar energy can be exploited through architectural design, as by positioning windows to allow sunlight to enter and help heat a space. Active solar energy involves the conversion of sunlight to electrical energy, especially in solar (photovoltaic) cells. See also solar cell (6).

Turbine- Any of various machines in which the kinetic energy of a moving fluid, such as water, steam, or gas, is converted to rotary motion. Turbines are used in boat propulsion systems, hydroelectric power generators, and jet aircraft engines. See also gas turbine (6)

Watt- The SI unit of power, equivalent to one joule per second and equal to the power in a circuit in which a current of one ampere flows across a potential difference of one volt. Abbreviation: W, w (6).

Wind energy- Power derived from wind: used to generate electricity or mechanical power (6).

Work- Force times the distance through which it acts; specifically, the transference of energy equal to the product of the component of a force that acts in the direction of the motion of the point of application of the force and the distance through which the point of application moves (6).

Notes

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5.Tesco Greener Living everyday. http://www.tesco.com/greenerliving/kids/landing.page. (accessed July 08, 2010).

6. Dictionary.com. The American Heritage® Science Dictionary. Houghton Mifflin Company. http://www.dictionary.reference.com/browse/Geothermal (accessed: July 02, 2010).

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