Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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Current Sources of Energy to Maintain a Sustainable Future

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by Laura Namnoum

Introduction

I teach fourth grade at Nathan Hale School in New Haven, Connecticut. Nathan Hale is a prekindergarten to eighth grade neighborhood school. My fourth grade classroom is in a middle class neighborhood. The students in my classroom come from a variety of backgrounds and have a diverse set of needs and skills. Students are held to a high standard and are expected to internalize the material being taught. They are given opportunities to create their own ideas about the world through exploration. Assessment is done via projects which are evaluated through rubrics and students have an unlimited depth to their new understandings.

Teachers have an imperative role to not only teach current information, but also explain how it is relevant to each student. This unit is designed to explain what energy is, the different sources we use to harness energy, and how it relates to students. Students will understand which sources have many negative effects on our environment and which renewable sources will bring our world to a more sustainable future

Objectives

This unit will give students the opportunity to evaluate and draw on their own conclusions. Children are growing up in a world where technology is booming. They play on the computer, watch television, and play video games. Their recreational activities all require energy. They have it drilled into their heads to conserve electricity by turning off the television when they aren't watching it, or turning off the lights when they leave the room, but do they really understand how their energy usage affects the world? This unit will allow them the ability to internalize their effect on the world when they overuse electricity. Students first need to understand where electricity comes from. They will experiment with energy and be able to describe energy in one sentence. In order to understand the availability of energy sources, students will compare renewable resources with nonrenewable resources. Once background knowledge is set into place, students will begin learning about wind power, solar power, hydropower, and fossil fuels. They will demonstrate understanding of how it is transported to their home and how they are able to use it. Students will research and evaluate the cost, effect on the environment, and availability of wind power, solar power, hydro power, and fossil fuels.

They will come to their own realization about which energy source makes the most financial and environmental sense to power our world and will create a diagram of how it will be transported to homes in their neighborhood. As a result of this unit, students will understand the energy source their home currently uses, and will internalize the importance of finding alternative sources and conserving electricity.

Standards

This unit is in accordance to the Connecticut State Standards and New Haven Standards. The standards covered include biological and physical sciences, math, technology and language arts. This unit is designed to meet the following state standards: (science) 4.4.a. Electricity in circuits can be transformed into light, heat, sound and magnetic effects, (reading and responding) 1.0 Students read, comprehend and respond in individual, literal, critical and evaluative ways to literary, informational and persuasive texts in multimedia formats, (reading and responding) 2.0 Students interpret, analyze and evaluate text in order to extend understanding and appreciation, (math) 1.2 Represent and analyze quantitative relationships in a variety of ways. This unit also meets the following New Haven standards: (science) 4.1 All organisms depend on the living and non-living features of the environment for survival. (science) 4.4- Electrical and magnetic energy can be transferred and transformed.

Overview

Week 1

This first week will provide the students with an understanding of what energy is as well as how we use it. Energy is the ability to move or change things. The teacher will model energy at work by demonstrating both the moving of something and something changing. The students will then create their own classroom definition of what energy is to refer back to throughout the unit.

Week 2

The second week will focus on renewable and nonrenewable resources. Students will understand what natural resources the earth provides. They will generate a list of what the natural resources can be used for. Finally, they will act out a demonstration of how the resources can deteriorate. As a result of this week, students will understand which resources can be sustained and which resources are not sustainable. They will also create a list of energy sources that derive from the list of resources.

Week 3

This week students will be researching four different energy sources. The four energy sources are wind power, solar power, fossil fuels, and hydropower. They will work in groups to support each other. Each group member will be responsible for researching one energy source and sharing their findings with the group. The research will include determining if the source is renewable or nonrenewable, the cost of the source, and the environmental or community effects of the source. They will categorize their findings into pros and cons, and will share with their group and determine which energy source will create a sustainable future. During this period of time, students will also be responsible to determine which energy source their family uses to power their home.

Week 4

This final week will solidify students' understanding of how energy relates to them. Students will rank appliances based on their energy usage and will determine how energy efficient their home is. They will then use a timeline to understand how fossil fuels are transported in New Haven to their house. They will finally use the energy source that they choose as the most sustainable and create a timeline of how it can be transported to their house.

Background Knowledge

What is Energy?

Energy is the ability to make things happen. It allows us to ride our bikes, sharpen a pencil, drive a car, or melt ice. Energy is needed for our brains to work and our bodies to develop. Most commonly in classrooms we define energy as the ability to do work. The first law of thermodynamics explains this further. The first law is that energy can be neither created nor destroyed. The energy of the universe is constant. This means that "work" is a process of energy transfer. When force is exerted it is the work of energy transferring from one source to another making it move or change. For example, the suns energy pours into solar cells, solar cells change radiant energy into electrical energy. Hydrogen and oxygen play a big role in the transfer of energy. "Most human energy requirements are met by forming bonds between hydrogen and oxygen, whether we are thinking in terms of metabolism, agriculture, industry, transport, building or domestic needs such as heating, cooking, refrigeration, or whatever," (Walker p 23).

Energy is measured in watts. A watt is a unit of power equal to one joule per second. In order to discuss energy globally, it is easiest to measure energy in terawatts. A terawatt is equal to one million (10^{12}) watts (Wiktionary, 2007). In the year 2000, the global energy consumption rate was 13 terawatts (Lewis, 2006). With the rise of third world countries, the demand for energy will increase quickly. It is expected that in the year 2050 20 terawatts of power will be needed to supply the global demand (Lewis, 2006).

The Greenhouse Effect

There has been a huge push for "clean energy". "Clean energy" is energy that does not emit carbon dioxide. Renewable resources are sustainable and include all energy sources that do not lead to a net increase in atmospheric carbon dioxide when utilized. Nonrenewable resources, however, do emit carbon dioxide. Carbon dioxide is a gas that is emitted when burning fossil fuels. Carbon dioxide is considered a greenhouse gas (Royston, 2008). The carbon dioxide in the air acts like a blanket covering the earth in the atmosphere. Without any greenhouse gasses covering the earth, the sun's rays beat down to the earth, they bounce around and leave the atmosphere and travel back into space. When there are too many greenhouse gasses in the atmosphere, the sun's heat is trapped by the gasses and cannot escape the earth as easily. This causes warmer air to stay on earth and eventually creates a warmer planet. The Earth's temperature only increases a small amount each year but will continue to increase over time. It is probable that using fossil fuels is changing the climate (MacKay, 2009). Therefore, climate change caused by increasing amounts of greenhouse gasses in the atmosphere is a problem that can be fixed by using other energy sources instead of fossil fuels.

Renewable Resources

Energy sources can be categorized into renewable and nonrenewable sources. Renewable resources account for about 7% of our nation's energy use (U.S. Energy Information Administration, 2008). Renewable resources include wind, solar, tidal and geothermal. Solar energy is captured through solar panels, wind is captured through turbines, hydropower is captured through hydroelectric dams, and geothermal can be found deep within the earth's layers. These sources are more expensive to use because of the way they need to be captured. Building wind turbines, solar panels, and dams are expensive to first set up. However, once the power stations are created to capture these resources, there is little cost associated with obtaining the source. Renewable resources are plentiful and will not deplete. They are also "clean" energy and do not contribute to carbon dioxide pollution. Therefore, they do not add to the increasing problem of the greenhouse effect and global warming.

Nonrenewable Resources

Nonrenewable sources include all fossil fuels. We get most of our energy from nonrenewable energy sources. Nonrenewable resources account for 93% of our nation's energy supply (U.S. Energy Information Administration, 2008). Nonrenewable energy sources are called fossil fuels and include oil, natural gas, and coal. They're called fossil fuels because they were formed over millions and millions of years by the action of heat from the Earth's core and pressure from rock and soil on the remains (or "fossils") of dead plants and creatures. We use fossil fuels to provide electricity to our homes, heat our buildings, and power our cars. They are the most widely used resource. They are heated or burned to create energy and when this occurs pollution is sent into the air. Burning fossil fuels causes carbon dioxide which is a greenhouse gas. By increasing the greenhouse effect in our atmosphere, the average global temperature increases. Not only do fossil fuels create pollution, but the supply is limited and cannot support our current energy demands without diminishing the supply for future generations. Globally there are between 40 and 80 years worth of oil reserves if we continue to burn at the same rate, and between 50 - 150 years of oil if the resource base is included (Lewis, 2006). It is possible that oil will run out in our lifetime or our student's lifetime. Fossil fuels can also be used for other reasons such as making plastic. We should be saving this finite resource to be utilized for a more creative reason (MacKay, 2009).

Solar Power

Solar energy is a renewable resource. The sun is our nearest star that gives our planet energy in many different ways. We can use the sun's energy to dry our clothes, plants use the sun's light to create food, and decaying plants when pressurized in the earth can produce fossil fuels.

Solar energy has been used since the late 1800's with solar water heaters. They became a very popular and cheap way to heat one's home. However, when large deposits of fossil fuels were discovered in the U.S. many people switched from solar water heaters to burning fossil fuels. Another way to capture the sun's energy is to use a highly curved mirror called a parabolic trough. This parabolic trough focuses the sunlight to strike the pipe and it gets so hot that it can boil water to create steam. The steam is used to turn a turbine to create electricity. A third way to collect the sun's energy is through solar cells called photovoltaic cells. These are the small cells that you might see on a calculator. When the cells come in contact with sunlight, electrons are knocked loose and begin to move toward the surface of the cell (California Energy Commission, 2010).

Because of this, an electron imbalance is created and an electric current begins between the negative and positive sides. These same cells can be arranged in a larger model and used in a person's home or buildings. This type of solar collection provides immediate electricity.

Average solar panels have an efficiency of about 10% and more expensive panels have about 20% (MacKay, 2009). Therefore, covering your roof with solar panels will not be enough to power your home year round. Solar power plants that send power through lines would also be expensive but would be able to produce enough energy to power our homes. Also, keep in mind that some energy is lost in transportation.

The best places to capture the sun's energy are places that get direct sunlight for most of the day. Because deserts very rarely rain, they are a great location for solar power plants and can produce a lot of electricity. The Mojave Desert in Southeastern California is one example of utilizing a desert for solar power. Solar power plants would not be very efficient in a place with a lot of clouds or with short days. Solar power cannot be collected at night. The mirrors also take up a large amount of space covering land. Lastly, they are expensive to build and would not be cost effective unless constant direct sunlight was supplied near your home.

Building solar power plants is currently expensive. However, there is ample solar energy potential. Once the power stations are built, there is very little cost thereafter and they supply a great amount of energy. Solar energy is the only renewable resource that has enough potential energy to satisfy the future needs of 10-20 terawatts of carbon-free energy in the year 2050 and only 0.16% of the earth's surface is needed to collect this is energy (Lewis, 2006). No other source has the potential to supply such a great amount of energy for the demand our earth will face in the year 2050.

Hydropower

Hydropower is another renewable resource. Hydropower is harnessed from flowing water. Students have probably seen river mills where water can either go over the top of the wheel or can push past the wheel. These mills have been used for hundreds of years to grind flour or corn.

Today we use a similar concept to generate electricity. The three different ways of using water to generate electricity are hydroelectric, tidal, and wave power. The most common way to generate electricity is with hydroelectric. Hydro means water, so hydro-electric means making electricity from water. Moving or falling water can be used to do work. Hydroelectric power is when a large amount of water tries to squeeze through a narrow gap and produces a strong force. This strong force is harnessed and turned into electricity. To do this, a dam is built across a river to stop the flow of water. This forms a reservoir lake to fill up behind the dam. The dam has to be built very strong to make sure it can hold the water back from spilling over into the river. The dam is also constructed with a small tunnel. Water from the lake is able to stream through the tunnel with great force. The water has so much force from all the pressure of the lake that it spins a turbine and generates electricity (Royston, 2008). Hydroelectric power stations are very efficient at converting the water's energy into electricity. States with high mountains and a lot of rivers are great for generating hydroelectricity.

Hydroelectricity is a very reliable resource for energy and appears to be a model energy source. For example, once the dam is built the lake is so big that even when there is a drought the water is not depleted. Water is a renewable resource so it is very sustainable. The water cycle is a great example to show students how it will not deplete. Collecting the energy and turning it into electricity does not emit carbon dioxide. However, with every resource there are also some negative reasons for harnessing its energy. Hydroelectricity does not contribute to the greenhouse effect when it is being harnessed but it does contribute to the greenhouse effect through the building of the dam. It does take a lot of concrete to build the dam which releases tons of carbon dioxide into the atmosphere (Royston, 2008). There are also some environmental concerns once the dam is built in rivers. One issue is the impact dams have on ecosystems. Fish are blocked from swimming up and down the river to reproduce. The river also floods creating a large lake behind the dam and people and other animals have to relocate from their homes.

Hydroelectric is a very attractive renewable resource. It should be captured in locations with large flowing rivers if possible. The plants are also efficient at harnessing the energy of flowing water and in 1997 it produced 0.3 terawatts globally (Lewis, 2006). Although this is a lot of clean energy produced, this is not nearly enough energy to reach the global need of 10-20 terawatts of carbon-free power in the year 2050. Hydropower alone will not be enough to power our planet.

Fossil Fuels

Fossil fuels are a nonrenewable resource. Fossil fuels include coal, oil, and natural gas. They were formed from decaying plants and tiny sea creatures that lived hundreds of millions of years ago (Royston, 2008). When the plants and tiny sea creatures died they were covered by layers of silt. As the silt piled up, the plants became pressurized and over millions of years became coal and natural gas. The sea creatures became oil and natural gas.

Coal is often found underground and the seabed. A lot of coal is cut from mines near the surface. Some coal mines are dug by putting shafts under the earth surface. Coal miners then travel deep underground by elevators or trains and dig the coal out. Another way coal is mined is in strip mines. In these mines, huge steam shovels strip away top layers above the coal. Once all coal is removed, the earth's layers are restored back (California Energy Commission, 2010). After coal is removed, it is shipped by train, boats, and pipelines. For shipment through pipelines, the coal is ground and mixed with water until it turns into a slurry. It is then pumped through pipelines until it reaches power plants.

Oil is also found under the ground and the seabed. Some scientists believe that tiny diatoms are the source of oil (California Energy Commission, 2010). Diatoms are tiny sea creatures. These organisms are similar to plants because they use photosynthesis to convert sunlight into stored energy. When the diatoms died their remains fell to the seafloor and were buried under rocks. The rock pressurized the diatoms and the stored energy could not escape. This stored energy eventually turned into oil. Native Americans living in North America skimmed oil off the top of streams and lakes. This technique was used where oil could be found on the surface of water. Then, in 1859, a man named Edwin L. Drake found oil under ground and invented a way to pump it to the surface (California Energy Commission, 2010). Today companies drill through the earth to find oil and natural gas deposits pocketed in the earth's layers. Oil and natural gas are then pumped to the surface by oil rigs. They are then usually transported through pipelines or by ships. Oil must be refined before it can be used. Oil can be found in many parts of California and Alaska. More than 50 percent of the U.S.'s oil supply comes from outside our country. Most of the outside suppliers are from the Middle East.

Oil can be used for more than just energy. Oil is made into fertilizers for farms, fibers for clothes, and plastic. Almost all plastic comes originally from oil (California Energy Commission, 2010). If we use all the oil resources for energy, we will not have it for other uses.

Natural gas is mostly made of methane. Methane is a chemical compound made up of carbon and hydrogen. Methane is one atom of carbon combined with four atoms of hydrogen (California Energy Commission, 2010). It was formed millions of years ago at the same time that coal and oil were formed. It was also trapped between layers of the earth's surface with oil. At first, people burned natural gas off of oil because they thought it was a waste. Today people use it in power plants because they realize it produces less carbon dioxide then oil. Natural gas is very flammable so when it is sent to storage tanks it is mixed with a chemical to give it a potent odor so that it is easily detected if there is a leak. This is done for safety reasons.

Fossil fuels are a great resource because they are so cheap to use. They are a material that burns very easily. Because these resources derive from living things, they are composed mostly of carbon and hydrogen. Most living things that die release these chemicals, but since these living things were trapped underground the carbon became trapped and could not release itself. Carbon makes good fuel because it burns well. However, when it combines with oxygen from the air it makes carbon dioxide. As described earlier, carbon dioxide is a greenhouse gas that acts as a blanket surrounding the earth and traps in heat from the sun's rays. This trapped heat is warming the earth's surface. Not only are fossil fuels bad because they pollute the earth and create a warmer climate when burned, but they are also limited. If we assume that the consumption of coal grows 2% each year as it has in the past, then coal will be gone by the year 2096. If the growth rate is 3.4% per year, then we will run out of coal before the year 2072 (MacKay, 2009). Fossil fuels not only produce carbon dioxide and other pollutants when burned, they also are finite and will not last long enough for our global demands. Since they were made hundreds of millions of years ago, they cannot be made again in our lifetime. Once they are gone, they are gone.

Wind Power

Wind is a natural renewable resource that can be harnessed as energy. Wind is a resource that is derived from the sun. The sun's rays heat the earth's surface. Some parts of the earth become hotter than other parts. The difference in temperature creates wind (Royston, 2008). The kinetic energy of the wind can be changed into mechanical energy or electrical energy. When a sailboat moves through the water the wind is doing work by pushing on the sail and moving the boat. In the past, windmills were used to pump water or grind wheat or corn. Today wind can be used to make electricity. The wind offers a free sustainable source of carbon-free energy.

Wind is now utilized through wind turbines. When wind blows at the blades of a wind turbine, the blades spin. Wind turbines have three blades that reach up to 300 feet long. The blades are connected to a hub that is mounted at the top of a tall hollow tower. When the hub spins the connected shaft spins as well. The shaft goes through a gear transmission box where the speed of the turning is increased. The transmission is attached to the generator that turns the spinning motion into electricity. A computer inside the hub monitors the motion of the turbine and will change the direction of the blades to get the best speed. If the speed is too strong, the computer will slow the blades down so that they do not get damaged. The electricity is transported through cables and sent through a transformer. The transformer increases the voltage to send the electricity farther through power lines.

Wind farms consist of several wind turbines. The farms can produce enough electricity to power communities. Wind farms work best in places that are windy. In order for a turbine to work efficiently, the wind's speed usually must be above 12 to 14 miles per hour. The wind must reach these speeds in order to generate electricity. Each turbine usually produces about 50 to 300 kilowatts of electricity (California Energy Commission, 2010).

Wind is a resource that will never run out and it will always cost nothing. In places where it is very windy like off the coast of an ocean or flatlands like prairies, wind farms can generate a lot of electricity. However, many communities complain that they are too large and take up too much space. People also complain that they are an eyesore and take away from the skyline view. Neighboring homes proclaim that these farms create too much noise and are a nuisance to live near. The global demands in the year 2050 will not be met through wind power only (Lewis, 2006). To generate enough electricity through wind would involve large windmill installations far offshore and the issue of transporting electricity becomes a factor. When electricity is transported long distances energy is lost. Lastly, it is uncertain if wind turbines would affect regional weather. Wind energy should be harnessed in places that have a large amount of wind. However, putting wind turbines all over the earth to capture energy will not provide a global solution to meet our energy demands.

Lesson Plans

Lesson 1: What is Energy?

Objective: Students will be able to define what energy is. Students will determine where energy sources originate from. Students will be able to provide multiple examples of when energy is being used.

Essential Questions: What is energy in your own words? Where did the energy originally come from to move the car?

Procedure Day 1:

1. Complete a K W L chart. Ask students to write down two things that they know about energy on a sticky note. Have students choose one of the two things that they know for sure to be true. Allow students to walk up to the board and place one of their notes on chart paper. Students will then write two things that they want to know about energy. Students will choose the one thing that they think is most relevant to the topic of energy. Students will walk up to a second chart paper and place one of their notes on the second chart paper
2. Arrange the sticky notes in a logical manner by categorizing them based on similarities. For example, if a few students wrote sticky notes that have something to do with the sun, then place those notes in a column under the word sun.
3. Once categories are beginning to be established, discuss with students places that some notes can go. Promote discussion by having students turn and talk to justify their thinking.
4. Once all ideas are in categories, read through each sticky note. If there are any ideas that students want to know about that are also answered in the section things students know, bring this to students attention. Otherwise, tell students that the things they want to know more about will be answered in the next few weeks.

Procedure Day 2:

1. Explain that energy can be seen all around us at any moment. Show students four different examples of energy. (Examples of showing energy can be modified depending on what the teacher has in the classroom.) Show the movement of a modeled car and push the car with your hand. Explain that they energy from your body was transferred to make the car move. Have students draw a picture of what happened and write move or change below the picture depending on what the energy did to the vehicle. Put ice under a heat lamp and show students how energy can change the ice from a solid to a liquid. Have students draw a picture of what happened and write change or move under the picture. Wind up a rubber band powered car and place the car on the ground. Let the car move across the room. Ask students if the energy moved or changed the car. Have students again draw a picture and label it. Put a pencil into a sharpener (hand powered or electric). Have students explain what happened to the pencil. Let students again draw the picture and label the drawing.
2. Promote discussion about what energy is by using the four examples previously displayed. Ask questions like "where did the energy come from to move the first car?" and "what was the same about the two cars and what was different?"

Assessment: Students will be assessed on their responses to the essential questions.

Lesson 2: Renewable and Nonrenewable Energy Sources

Objective: Students will compare and contrast renewable and nonrenewable resources. Students will identify renewable and nonrenewable energy sources.

Essential Questions: Why should renewable resources be used as an energy source? What is the difference between renewable and nonrenewable energy sources? What is the same between renewable and nonrenewable energy sources?

Procedure Day 1:

1. Introduce the lesson by holding up a picture of fossil fuels, water, and plants/trees. Explain that the earth has many resources that we use every day. Students should have a lot of knowledge about all the resources we use except for fossil fuels. Explain that fossil fuels are plants and animal matter that has been pressurized from the earth and is now drilled out of the ground and used as energy. Then ask students why and when they use water and plants during the day. Have students generate a list of what each resource can be used for.
2. Group students into four categories. One group will represent plants, one group will represent fossil fuels, another group will represent water, and the last group will represent people.
3. Pass out colored popsicle sticks to the fossil fuels, water, and plants/trees groups. Each group will get ten popsicle sticks that are all the same color. (For example, the water group will get ten blue sticks, the fossil fuels group will get ten brown sticks, and the plant group will get ten green sticks. The people group does not get any popsicle sticks.)
4. Read through the resources play (See appendix A). The play will have the people group act out a typical day of a student and all the resources they use in one day. As the person in the play uses a resource, have the people group grab one stick from that resource group. As the person in the play gives back to the resource, have the people give back a stick to the resources.
5. By the end of the play, students should see how often fossil fuels are used and are not quickly replenished.

6. End the lesson with a discussion of which resources can be sustained and which are not sustainable

Procedure Day 2:

1. Post or draw pictures of the following energy sources at work: water, fossil fuels, wind, and solar.
2. Break students into small groups and have them decide which sources are renewable and which sources are nonrenewable. Have students discuss the difference between renewable resources and nonrenewable resources.
3. Bring the class back together to share which resources are renewable and which are nonrenewable and what the difference is between the two types of resources.
4. Have students make predictions using the picture clues of how each resource is harvested to create energy.
5. Make an anchor chart showcasing how each source is harvested. Explain how a dam, turbine, solar panel, and a power plant collect the energy from each source and transform it into electricity that we can use.

Assessment: Students will be assessed on their response to the essential questions.

Lesson 3: Pros and Cons of Energy Sources

Objective: Students will research one of four energy sources. Students will determine pros and cons of one out of four energy sources. Students will share their information with group members. Students will determine which energy source will create a sustainable future.

Essential Questions: What energy source will create the most sustainable future? Why is this energy source the most sustainable?

Procedure Day 1 and 2:

1. Put students into heterogeneous groups of four students. Make sure that students will be able to support group members with reading abilities and technology abilities.
2. Each group member will be responsible for researching one energy source.
3. The students will be responsible for finding out information about their energy source and sharing it with their group member.
4. The research will cover: determining if the source is renewable or nonrenewable, the cost of the source, and the environmental or community effects of the source. They will categorize their findings into a pros and cons T-chart.
5. They will begin by using books and will continue electronically with websites (see student resource list).
6. Students will end this week by sharing with their group members so that they can all compare and contrast each source. They will then decide which source will create the most sustainable future and explain the reasons why this is true.

Assessment: Students will be scored on the research they completed. The research will be scored with a rubric. Students will also be scored on their analysis of which energy source will create the most sustainable future and why.

Lesson 4: Energy in your Home

Objectives: Students will rank appliances in their home based on their energy usage.

Students will identify which energy source currently powers their home, and which source should be used to power their home. Students will create a timeline of how this energy source can be transported to their home.

Essential Questions: How do you know what appliances use less energy? Why is it important to use as little energy in your home as possible? What is the most efficient way to transport energy to your home?

Procedure Day 1:

1. The teacher will hold up a picture of the energy star logo and explain to students that appliances all need different amounts of energy when they are being used. Explain that energy is measured in kWh, kilowatt hours. Explain that some appliances have this energy star logo and it means that they use considerably less energy. Compare ENERGY STAR quality appliances with older nonqualified appliances. (See Figure 1.)
2. Students should turn and talk about why it is important to use new ENERGY STAR appliances.
3. Students will be given a copy of OTPCO's energy usage chart. (See Appendix B.) They will look at each type of appliance and its kWh to determine which appliances use the most energy. Students will turn and talk about why some appliances use more energy than other appliances.

Homework: Students will walk around their house and list all appliances that are plugged in and being used. They will decide if the appliance is used more or less often and then will calculate how much energy their home uses per year using the energy usage chart. They will calculate the yearly cost. They will also interview their parent/guardian to find out what company and energy source supplies their home with energy.

Assessment: Students will be scored on the research they completed. The research will be scored with a rubric. Students will be scored on calculating the cost of their homes' current energy usage and costs.

Figure 1. This table shows the difference between a nonqualified top loading clothes washer and an energy star qualified front loading model. Both are the same size washer. Notice the difference in price based on a cost for electricity of $0.08 per kWh. More information can be found at http://www.oee.nrcan.gc.ca/residential/business/manufacturers/dollar-savings.cfm?attr=12.

Example One: Clothes Washer		
	Non-qualified Top-loading Washer	ENERGY STAR Qualified Front-Loading Model
Annual Energy Consumption	876 kWh	275 kWh
Annual Energy Cost	876 x 0.08 = $70	275x 0.08 = $22

Example Two: Refrigerator		
	Top Mounted (16.5-18.4 cu. ft.) Refrigerator- 1984	ENERGY STAR Qualified Top-Mounted (16.5-18.4) Refrigerator-2004
Annual Energy Consumption	1457 kWh	411 kWh
Annual Energy Cost	1457 x 0.08 = $117	411x 0.08 = $32.88

Example Three: Dishwasher		
	1990 Dishwasher	ENERGY STAR qualified front-loading model
Annual Energy Consumption	1026 kWh	422 kWh
Annual Energy Cost	1026 x 0.08 = $82.08	422x 0.08 = $33.76

Procedure Day 2:

1. Review students' homework and have students share the amount of energy their home was using last night. Have students explain why some homes used more energy and why some homes used less.
2. Allow students time to share what energy source their parents use to power their home.
3. Pass out cards with one part of the fossil fuels power plant timeline. Each part of the timeline would say one way that fossil fuels travel from the plant to a home. The timeline would include intermediate steps like power plant, transformer, and power lines.
4. Have students work in groups based on how many intermediate steps the teacher includes in the timeline. The more intermediate steps and details that are included, the more difficult the timeline will be.
5. Each group will talk together and figure out the order of the timeline for fossil fuels transporting to a home.
6. Answers should be given to the whole class to correct any errors.
7. Students will go back with their researching group from lesson three and make a timeline of how the energy source they chose in week three as being the most sustainable begins and ends at their home. They will use information learned in all lessons, the books from week three, and the websites from week three to make their timeline. Their timeline of images should mimic the one the teacher made.

Assessment: Students will be assessed on their homework and their timeline of their energy source transportation. Students will also be assessed on their response to the essential questions.

Vocabulary Words

biomass organic matter that can be used as a source of energy

coal a natural soft rock formed from fossilized plants that can be burned to create electricity in a power plant

electricity electric current

energy the ability to do work

energy efficiency using less energy than normal to perform the same function

compact fluorescent light bulb a light bulb that uses a phosphor coating to transform ultraviolet energy into visible light

fossil fuel a product of decomposition of prehistoric organisms that can be burned to create electricity in a power plant (e.g. coal, natural gas and oil)

fuel something consumed to produce energy

global warming the occurrence of warming in the atmosphere because of pollution

hydroelectric electricity captured from moving water

natural gas a mixture of hydrocarbon gases that occurs with petroleum deposits, principally methane, and is used as a fuel and in the manufacture of organic compounds

nonrenewable resource a natural resource that has a limited supply that can not be replaced quickly

pollution a material that is harmful to living things

renewable resource a natural resource from the earth that can be quickly replenished

solar power power, such as electricity, generated from the sun

sustainable energy ability to supply our energy demands today without diminishing the supply for future generations

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Student Resources

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Appendix A

Resources Play

Directions: Every time the student uses a resource the people group must take a popsicle stick from that resource group.

The student wakes up groggy and in need of some rejuvenation, so he hops into the shower. He runs downstairs for a glass of orange juice and toast. After breakfast, he brushes his teeth and washes his hands. He waves good bye to mom and dad and jumps on the bus. When the student arrives at school, he realizes he has to go to the bathroom. The student goes back to his seat takes out a book and begins reading. The day passes quickly for this student. Before he knows it, it is lunch time. The student is filled with excitement because it is taco day. The tacos are steamy hot and filled with lettuce, tomatoes, and beef. He gobbles down the food and grabs his fruit drink to wash it down. He returns back to class, sits down, and raises his hand to go to the bathroom again. Finally, it is science time. The class is learning about making biodiesel which is fuel made from plants. In order to learn about this energy source, they must plant soybeans, radishes, and sunflowers. The school day ends and the student rushes home. He is met with a plate of fresh kiwi and a glass of water. His afternoon consists of homework and then playing outside. At night, he eats all his veggies and drinks another glass of water. Before bed, he washes his face and brushes his teeth. He has one more trip to the bathroom, and then he falls fast asleep.

Appendix B

Yearly Energy Usage Chart

Appliances		Approx. average wattage	Low hours of use	High hours of use	Low kilowatt-hours	High kilowatt-hours	Low cost	High cost
Air conditioner (room)	6,000 Btu	750	120	720	90	540	$6.98	$41.90
Air conditioner (central)	8.5 SEER 2.5 ton	3,500	240	860	840	3010	$65.18	$233.58
Ceiling fan		100	15	330	2	33	$0.12	$2.56
Clothes dryer		5,000	6	28	30	140	$2.33	$10.86
Clothes washer		500	7	40	4	20	$0.27	$1.55
Computer with monitor and printer		200	25	160	5	32	$0.39	$2.48
Dishwasher		1,800	8	40	14	72	$1.12	$5.59
DVD player		40	50	200	2	8	$0.16	$0.62
Fan (portable)		115	18	52	2	6	$0.16	$0.46
Freezer (15 cubic feet)		335	180	420	60	141	$4.68	$10.92
Heater (portable)		1,500	30	90	45	135	$3.49	$10.48
Light bulb Incandescent (60w)		60	17	200	1	12	$0.08	$0.93
Light bulb Compact fluorescent (60w equivalent)		18	17	200	0.3	4	$0.02	$0.28
Microwave oven		1,500	5	30	8	45	$0.58	$3.49
Oven		3,500	10	50	35	175	$2.72	$13.58
Refrigerator - Freezer.		400	150	300	60	120	$4.66	$9.31
Television		200	60	440	12	88	$0.93	$6.83
Toaster oven		1,250	2	24	3	30	$0.19	$2.33
Video game (X-box)		100	15	75	2	8	$0.12	$0.58

Modified from http://www.otpco.com/SaveEnergyMoney/applianceEnergyUsage.asp retrieved May, 2010.