Unit 2: Home and School Energy

Unit Objectives and Standards

At the end of this unit the students will be able to:

- Know that energy from the sun (and derivatives like wind and hydropower) is available indefinitely and that other sources don't renew or renew slowly.
- Know that electrical energy can be produced from a variety of energy sources.
- Understand that different forms of energy have different environmental and climate-related consequences.
- Understand strategies for reducing home and school energy related climate impacts.
- Collect, organize and display sufficient data to support analysis. **(Science Standard)**
- Clarify key aspects of an event, issue, or problem through inquiry and research. **(Social Studies Standard)**
- Examine the various characteristics, causes, and effects of an event, issue, or problem. **(Social Studies Standard)**

Unit Background

In the last unit we learned about the role of greenhouse gases in climate change. We also began to look at the sources of the three main greenhouse gases: carbon dioxide (CO_2), nitrous oxide (NO_2) and methane (CH_4). In the next four units we will explore how we individually and collectively contribute to the increased concentration of these gases in the atmosphere. We will also look at an array of actions we can take to reduce their emission. This unit will focus on our home and energy use and how it is related to greenhouse gas (GHG) emissions.

After transportation, which accounts for approximately 33% of emissions, household emissions rank second at about 17% of total U.S. green house gas emissions. According to the United States Environmental Protection Agency, approximately 4 metric tons of carbon dioxide equivalent (CO_2e), almost 9,000 pounds per person per year are emitted from people's homes. Conserving energy by turning off lights, appliances, hot water, heaters, and air conditioning when you're not using them is one excellent way to reduce your greenhouse gas emissions. Although low or no-emissions energy supplies, like wind, solar or hydropower, may provide the cleanest supply of electricity, minimizing the energy we need is still an important first step.

The lessons in the unit will cover the following in greater detail:

- Electricity is a secondary energy source, the majority of which is generated by burning fossil fuels.
- Even if your energy source is "clean," like hydropower, utility providers buy electricity off the "grid" during peak energy times. This power is often fossil fuel generated.
- Fossil fuels are non-renewable and produce GHG emissions.
- There are many simple ways to reduce your consumption of electricity at home and in school.
- Renewable energy sources provide GHG-free electricity and are becoming less expensive and more commonly available.
- Home and school energy reduction will help mitigate GHG emissions but ultimately a larger effort will be needed in order to reduce the nation's total emissions.

Lesson 2A—Understanding Energy

Objectives

- Students will understand the basic concepts and vocabulary of electricity generation.
- Students will begin to understand the connection between electricity use and greenhouse gases.
- Students will develop an understanding of what appliances are using energy.
- Students will learn ways to reduce electricity use in their home.

Materials

- A small electrical appliance such as a microwave, toaster or hair dryer
- Pencil
- Classroom set of the Student Worksheet
- Calculator

Suggested Timeframe

(60 minutes)

- 10 minutes—Introduction to unit
- 15 minutes—Lesson discussion and demonstration
- 15 minutes—Student worksheet
- 20 minutes—Post-worksheet discussion

Teacher Information

When you drive to the store, take a shower or turn on a computer, you're using energy. Electricity is the most common form of energy we use at home and at school. It is a secondary energy source, which means that we get it by converting other sources of energy, such as coal, oil, natural gas, uranium (for nuclear energy), biomass, water, wind or sunlight into electricity.

To produce electricity, power plants use a primary energy source for heating water to produce steam. Then the steam turns a series of blades on a turbine connected to a generator. As the turbine rotates, spinning bundles of copper wire in the generator create a magnetic field that causes electrons to move from atom to atom. This movement of electrons makes an electric current.

While electricity is itself a clean source of energy, the majority of electricity in the United States is generated from power plants that burn fossil fuels (coal, natural gas, and less frequently, oil). These power plants emit large amounts of carbon dioxide, carbon monoxide, nitrogen oxides, sulfur dioxide, and other emissions that affect air quality and/or the climate. Fossil fuels are referred to as non-renewable sources of energy because they cannot be quickly replenished. Fossil fuels formed from the fossilized remains of plants and animals that lived millions of years ago. Uranium, an ore, is also nonrenewable, but is not a fossil fuel and does not result in greenhouse gas emissions when converted into electricity. However, power plants using uranium produce radioactive wastes that will be dangerous for 300,000 years.

Electricity is measured in units of power called watts. The amount of electricity we use over a period of time is measured in kilowatt-hours (kWh). A kWh is the energy of 1000 watts acting for one hour. For example, if you use a 100-watt light bulb for ten hours, you use 1000 watt-hours of energy, or 1 kilowatt-hour. Likewise, if you use ten 100-watt light bulbs for one hour, you use 1 kilowatt-hour.

Energy conservation means reducing unnecessary energy use. Consuming less energy reduces the amount of carbon dioxide and other pollutants released into the atmosphere when that energy comes from fossil fuels. There are many simple ways that students and their families can conserve energy at home and at school, including using energy efficient appliances and electronics, adjusting the heating or air conditioning thermostat, using compact fluorescent bulbs or natural light when possible, caulking doors and windows to minimize drafts, lowering the temperature setting of the water heater, and turning off lights and appliances that are not in use. Finally, purchasing renewable power from your local utility can minimize the impact of the energy that you do use. Find out whether your utility offers a renewable energy program and share with students how their families can sign up for it.

Discussion

This outline highlights the key points to be shared with students.

1. Electricity is a secondary energy source.
2. The majority of electricity in the US is generated from power plants that burn fossil fuels.
   a. These fossil fuels are non-renewable
   b. Burning fossil fuels produces carbon dioxide and nitrogen oxides, both major greenhouse gases.
3. Unless you are using a renewable energy source such as solar, hydro, or wind power, every time you consume electricity you are adding greenhouse gases to the atmosphere.
4. Basic electricity vocabulary
   a. Kilowatt (kW)
   b. Kilowatt-hour (kWh)
5. Conserving energy not only reduces the amount of greenhouse gas emissions, but saves money as well.

Lesson

1. Use an electrical appliance to complete a task. Examples include microwaving a bag of popcorn, toasting a piece of bread or using a hair dryer to blow-dry a wet spot on a cotton shirt.
2. Describe what appliance you will be using to the class. Ask the students what they think is needed in order to complete the task; make sure that "energy" is included in the list.
3. Explain that electrical consumption is stated in kilowatt-hours. Most electrical devices list power consumption in watts. Define kilowatt (kW), kilowatt-hour (kWh), and if you choose to, ampere (or "amps") and volt:
   a. Kilowatt (kW) - One thousand watts. A watt is a measure of power that an appliance uses. It is calculated by multiplying the voltage by the current.
   b. Kilowatt-hour (kWh) – A measure of electrical energy calculated by multiplying the number of kilowatts an appliance uses by the time in hours an appliance is used.
   c. Ampere – The measure of the flow of electricity through an appliance.
   d. Volt – The amount of "push" being applied through an appliance. The standard voltage in the US is 110 or 120 V.
4. Find out the cost of a kWh from your local electricity provider (a rough approximation is $0.10). (See the graphic in Teacher Information for an explanation.)
5. Ask the students what information would be needed in order to determine the cost of energy used. (Answer: the amount of time the appliance is used, wattage of appliance and the cost per kilowatt-hour used)
6. Have students guess how much the energy needed to complete the task will cost.
7. Have a student examine the appliance and locate its power consumption information in watts.
8. Distribute Student Worksheet then pop the popcorn, toast some bread, or use the hair drier to dry something. As a class, use the calculation on the worksheet to determine what the cost of the demonstration was.
9. Now ask the students to fill out the Home Appliance List and, using the Appliance and Energy Use Table as a reference, determine the amount of energy some common household appliances use and how much it costs to operate these appliances. Students should list what appliances they have in their home and estimate the time of use. Some students may ignore items like water heaters; you may have to prompt them and help them determine the amount of time these "unseen" appliances are used.
10. Go through a sample calculation with the students. Use the plasma TV example or do one of your own. Check for understanding to ensure that the students are doing their math correctly.

Discussion Questions

Check results with the students and discuss the comparisons among the energy costs for each activity. Ask some or all of the following questions:

- How are electricity costs related to greenhouse gases?
- How are greenhouse gases related to climate change?
- What are some obvious ways you could reduce your energy costs (and therefore your GHG emissions)?
- Who do you think is responsible for reducing energy use in your home? Why?
- How does home energy consumption relate to global climate change?

Example 1: Use one 100-Watt light bulb for 10 hours:

100 Watts x 10 hours = 1000 Watt-hours = 1 kilowatt-hour = 1 kWh

Example 2: Use ten 100-Watt light bulbs for 1 hour:

10 bulbs x 100 Watts each = 1000 Watts. 1000 Watts x 1 hour = 1000 Watt-hours = 1 kWh

Source: *Dan Morehouse, Eugene Water and Electric Board, http://www.eweb.org/Public/documents/energy/Energy_Smart_Operations_Tips.pdf*

Brainstorm

Now that you know where energy is being used and how much it costs, come up with other ways that students and their families could reduce energy use in their homes. Possible answers might include:

- Lowering the temperature by two degrees when present and ten degrees at night or if the house is empty
- Turning down the water heater to 120 degrees
- Turning off computers when not in use
- Turning off lights when not in use
- Hanging out washing to dry in the summer
- Washing clothes with cold water
- Taking shorter showers
- Keeping the fridge door closed
- Waiting until the dishwasher is full before running it on a short cycle
- Bigger changes, like adding insulation to the walls and roof and sealing drafts

Optional Extra Credit

What changes do you plan to make? Try to be as specific as possible. Assign the students to work with their family to create an energy-reduction action-plan. The students could bring in a list of three concrete steps they and their family pledge to do. Have their parents or guardians sign the plan as proof to their commitment.

Supplementary Information on Energy Production

In this discussion, make sure the students understand how electricity is produced in their community, and that burning coal or natural gas to produce electricity means that every time you use electricity, you are emitting GHGs. Even if your community uses primarily hydro electricity, at peak times the electrical utility is probably supplementing it with electricity generated using coal or natural gas. Likewise, the use of natural gas for cooking, heating, and hot water heating, while more efficient than converting that gas into electricity and the using it, is a fossil fuel and still results in the release of GHGs. The result is that your home energy use is likely to increase GHG emissions unless you are using 100% renewable energy.

Student Worksheet

Name:_____

Use the following calculations to determine the amount of energy used during the demonstration.

Calculation:

STEP 1

(_____ X _____) /1,000= _____ kWh (energy used)

Watts Ave X Daily use (hrs)

STEP 2

(_____ X .10) = $_____ Daily cost

kWh (from step one) X cost per kW

STEP 3

(_____ X 365) = $ _____ Annual cost

Daily cost (from step two) X days in a year

Now try to calculate how much it costs to run all of the appliances in your home over the course of a year.

1. Start by listing all of the appliances that you know are used in your home using the Appliance and Energy Use Table provided. If your appliance is not on the list and you have access to a computer, use this link to look it up: *http://www.eere.energy.gov/consumer/your_home/appliances/index.cfm/mytopic=10040.*
2. Use the calculations above to estimate how much it costs to run each of these annually. Fill in the Home Appliance List with this information. Then, add up the annual cost for each item to get a total annual cost.
3. For some helpful advice on reducing your energy costs visit: *http://www.consumersenergy.com/apps/pdf/More-100-ways-save-on-bill12-06.pdf.*

Home Appliance List

Appliance	**Watts**	**kWh** (Watts x hours of use ÷1000)	**Daily Cost** (kWh x0.10) $	**Annual Cost** (Daily cost x 365) $
Example: **TV (Plasma)**	340w	340w x 3h ÷1000 = 1.02kWh	1.02 kWh x $0.10 = $.102	$.102 x 365 = $37.23

Appliance and Energy Use Table

How Much Energy Used in an Hour?

Item	Average Watts	Item	Average Watts
Clothes dryer	5060	Electric kettle	1500
Electric Oven	4400	Older fridge (pre-1994)	460
Wall Heater	1500	Newer fridge	250
Electric Furnace	6250	Coffee Maker	900
Clothes washer	1400	Range burner	800
A/C (window, medium sized)	1000	Clock Radio	4
Box fan	100	Microwave	1350
Ceiling fan	75	Toaster	1200
Hair dryer	1300	Dishwasher (no water heater)	900
Iron	1200	Dishwasher (with water heater)	3600
Halogen floodlight	300	Computer/printer	215
Regular (incandescent) light bulb	100	Laptop	45
Compact Fluorescent bulb	20	Cell Phone Charger	2
Nightlight	5	HD Cable Box	45
TV (CRT)	89	Xbox 360	185
TV (Plasma)	340	PS2	30
TV (LCD)	210	Nintendo Wii	18

Source: *http://michaelbluejay.com/electricity/howmuch.html*

Lesson 2A Assessment

Aspect	Expert (4)	Practitioner (3)	Apprentice (2)	Novice (1)	Score
Communication/ Brainstorming Session	Clearly communicates subject understanding during class discussion.	Clearly communicates some subject understanding during class discussion.	Communicates minimal subject understanding and needed to be called upon during class discussion.	Shows no subject understanding and did not participate in class discussion.	
Worksheet	Worksheet is complete with all entries showing thoughtfulness.	Worksheet is complete with most entries showing thoughtfulness.	Worksheet is incomplete and lacks thoughtfulness.	Worksheet is not attempted.	
				Total Score	/8

Objective Check:

1. What is a kilowatt-hour? (the amount of power in watts x the time used)
2. How does home electricity use relate to greenhouse gas emissions? (electricity is a secondary source of energy, which is often generated by burning greenhouse gas emitting fossil fuels.)
3. Name three ways you can reduce the amount of energy consumed in your home: (Answers will vary. Ex. Turn off lights when you leave a room, lower your thermostat, unplug appliances when not in use…)
4. What are three high-energy use appliances found in your home? (Answers will vary. Refrigerator, freezer, furnace, water heater, dryer, etc.)

Lesson 2B—School Lighting Audit

This lesson has been adapted from Benchmark Guide for An Integrated Sustainable Energy Education, by Managenergy, *http://www.managenergy.net/tg_education.html*

Objectives

- Students will learn one way that schools use energy and the associated costs.
- Students will learn problem-solving skills in addressing ways the school can reduce its lighting use.

Suggested Timeframe

(75 minutes)

- 15 minutes—Discussion
- 30 minutes—Data collection
- 30 minutes—Data analysis/discussion

Materials

- Pencil
- Paper
- Calculator

Teacher Information

School activities need appropriate lighting. Lighting accounts for 20-25% of schools' total energy use, with a cost of thousands of dollars per year. Yet schools typically operate during daylight hours and many classrooms have large windows that could offer sufficient lighting (daylighting).

The analysis of lighting in the school can be broken down into the following categories:

- Classrooms (general lighting and specific task lighting).
- Corridors and passageways.
- Special purpose areas such as toilets, the library, cafeteria, the gym, shops and the office.
- Indoor and outdoor security lighting.

Discussion:

This outline highlights the key points to be shared with students

1. Review: Electricity use and GHG emissions.
2. School lighting accounts for 20-25% of total school energy use.
   c. Costs thousands of dollars a year.
   d. Classrooms often have windows that make electric lighting excessive.
5. School Lighting
   a. Classrooms
   f. Corridors
   g. Special purpose areas
   h. Indoor and outdoor lighting
4. Ideas for reducing lighting in the school

Preparation

- Photocopy a class set of Student Table—School Lighting Audit worksheets.
- Prepare a way of recording and presenting class data (poster, overhead, computer projector—class data form).

Lesson

1. Evaluate lighting in the school by assigning groups to different rooms in the school. The students should complete the Student Table—School Lighting Audit for as many classrooms, hallways, and other locations in the school. (*Alternatively, if this is not practical, choose a typical classroom and multiply by the number of similar classrooms in the school.)* **Record the:**
   - Number of light bulbs or tubes.
   - Type of lights (incandescent or fluorescent).
   - Size of lights (number of watts). Most lights in the school are a single wattage. Find out from the custodian a typical fluorescent tube's wattage in order to help the students.
   - Type and size of curtains (if present at windows).
   - Estimate the daily hours of usage of lights.

- Try to observe the rooms:
  1. Before school.
  2. During morning classes.
  3. At recesses and lunchtimes.
  4. During afternoon classes.
  5. After school.
  6. Night time (for optional extra-credit: find a volunteer to stop by the school after hours in order to count the number of rooms with lights still on).

  Ask the janitor how long lights are on during cleaning and whether they are turned off afterwards.

  An example of the calculations is given on the first line.

2. When the students are finished with their audit, have them return to the classroom and record their data on the class data form.
3. Determine how much the school spends on lighting for a day, a week, and a school year. (The $0.10 cost for kWh is an estimate, so contact your local utility provider to get a more accurate figure).

Discussion Questions

Discuss some or all of the following questions:

- Is there enough natural light to turn off the lights during part of the day?
- Are all the lights in a room necessary to keep the room sufficiently illuminated?
- Are there incandescent lights that could be replaced by fluorescent lights?
- What plan could be implemented to ensure that the lights are turned off when not in use? If lights are left on at night for security, could fewer be left on?
- What uses of technology could be justified to reduce lighting bills? (Are motion detectors worth the investment? Note: They typically are worthwhile in public buildings.)
- How would the school benefit from reduced lighting?
- What steps would we have to take to make these changes in our school?
- What other uses of energy in your school could be audited in this way?
- How does reducing electricity costs relate to GHGs?

Optional Activity: Get Involved In Your School Community!

This activity should be looked as supplementary to the core climate change curriculum. The process can be long and at times, frustrating. However, the payouts could be tremendous and the students will learn a great deal about local politics.

Many school districts are looking for ways to cut costs and making ends meet. Budget experts have determined that American schools spend more money on heating and lighting than they do on textbooks. In the 1990s, German schools had come to the same conclusion and they started the 50/50 program. (For more information see: *http://tve.org/ho/series1/reports_13-18/5050_Germany.html*). For schools that embarked upon energy conservation initiatives, this program returned half of the savings back to the general fund for each participating school. This gave the schools an incentive for imaginative ways of cutting electrical consumption and therefore GHGs.

Have the students develop a plan to develop a similar program in your school. Have them discuss the steps that would be necessary to start a pilot program. Keep in mind that the students would have to contact the school district, petition the school board, and get broad community support for their program. They would need to explain to the decision-making body that there would be some initial investment in energy monitoring equipment but those costs would be offset in the long run.

Student Worksheet—School Lighting Audit

Name:_____

Room	Number of lights (N)	Light Wattage (w)	Total Watts Used (N x W)	Kilowatts (total Watts + 1000)	Operating time/day (hrs)	Daily Consumption (kWh)
Total						

Total kW*hr x $0.10 (cost/kW*hr) = **Total Cost=**

Lesson 2B Assessment

Aspect	Expert (4)	Practitioner (3)	Apprentice (2)	Novice (1)	Score
Data Collection	Raw data is recorded appropriately.	Some raw data is recorded.	The wrong raw data is recorded.	No raw data is recorded.	
Communication/ Discussion of results	Clearly communicates subject understanding during class discussion.	Clearly communicates some subject understanding during class discussion.	Communicates minimal subject understanding and needed to be called upon during class discussion.	Shows no subject understanding and did not participate in class discussion.	
Get Involved/ Participation	Active engagement in discussion on energy reduction plan. Contributes regularly.	Engagement in discussion on energy reduction plan. Contributes occasionally.	Attempts to contribute to discussion but lacks engagement.	Does not participate in discussion. Not engaged.	
				Total Score	/12

Objective Check:

1. What ways could your school reduce its lighting costs? (Answers will vary. Examples include turning off the lights when not in use, decreasing the number of lights used for security, changing incandescent lights to fluorescent)
2. How would you try to encourage others to reduce the amount of money the school pays on lighting? (Answers will vary. Examples include writing letters to your principal or school board, asking parents to write letters, create a petition to be signed by other students, etc.)
3. Name two positive consequences to reducing lighting use at school (lower GHG emissions, saves school money that can be used for more needed purposes).

Lesson 2C—What is Renewable Energy?

Objectives

- Students will learn about the different types of renewable energy sources.
- Students will learn the advantages and disadvantages of these energy sources.

Suggested Timeframe

(60-90 minutes)

- 10 minutes—Discussion
- 15 minutes—Students work on their summaries
- 10 minutes—Students present information
- 15-30 minutes—Energy in the Round Game
- 10 minutes—Unit Summary

Materials

- Computer with PowerPoint
- Renewable Energy Sources Handout
- Butcher paper or easels with chart paper.
- Markers

Teacher Information

Individuals are looking for ways to lower energy costs for their businesses, homes, schools, and transportation. Our primary energy sources today are fossil fuels, which result in GHG emissions and other forms of pollution both in combustion and extraction. Another concern is the depletion of fossil fuels. According to researchers at the University of Michigan, if consumption continues at the current rate, the fossil fuel supply could be gone before the end of the century. (Source: *http://www.umich.edu/~gs265/society/fossilfuels.htm*) Finally, because many of our fossil fuels are imported from politically unstable countries, there are socio-political risks associated with our use of fossil fuels. In short, we are at a crossroads. Americans must use and develop alternate forms of energy to help us power our homes, automobiles, and businesses into the future without destroying the earth's environment for ourselves, future generations and other species. Exploring the use of renewable and alternative energies is a necessity in today's world.

Use of renewable energy is an important step towards becoming independent from fossil fuels and decreasing our dependency on energy sources from outside our borders. However, it is important to remind the student that the most significant and cost-effective step they can take is to reduce their own consumption of energy. Reduce first, and then use renewable energy for the power we cannot currently do without. Keep in mind that even if your energy source is "clean," like hydropower, the utility provider needs to buy electricity off the "grid" during peak energy times. This electricity is often fossil fuel generated. The bottom line is that every kind of energy, no matter how clean, has some impact on the environment.

Discussion

This outline highlights the key points to be shared with students.

1. Burning fossil fuels to produce electricity results in GHG emissions.
2. Fossil fuel supplies could be gone before the end of the century (non-renewable)
3. Conservation/efficiency paired with the use of renewable or alternative energy sources allow us to become independent from fossil fuel sources.
4. Types of renewable energy sources
   a. Hydropower
   b. Biomass/Bioenergy
   c. Geothermal Energy
   d. Wind Energy
   e. Photovoltaic Cells/Solar
   f. Unit summary

Preparation

- Photocopy a class set of the Renewable Energy Sources Handout.
- Set up five easels with one title on each: Hydropower, Biomass/Bioenergy, Geothermal Energy, Wind Energy, and Photovoltaic (PV) Cells/Solar.
- Make cards for the Energy In the Round game.

Lesson

1. Write the five categories of renewable energy on different charts. You will need one chart per type of energy. Divide the students into groups representing each energy source: Hydropower, Biomass/Bioenergy, Geothermal Energy, Wind Energy, and Photovoltaic (PV) Cells/Solar.
2. Give the groups 15 minutes to read the section of the handout on their renewable energy source and summarize their findings on the chart paper for all to see:
   a. An explanation of the energy source.
   b. Examples of the energy source.
   c. A cost per kWh (if available).
   d. Examples of how this renewable energy source could be used in their home or school (if applicable).

   (If there is time and access to a computer, allow the students more time to find additional information.)
3. Have a spokesperson for each group take 1-2 minutes to present their information to the class, highlighting the important facts.
4. After all groups have had the opportunity to discuss their charts start the Energy In the Round Game. See 2C—Energy In The Round Game for instructions.

Student Handout— Renewable Energy Sources

Hydropower

Hydropower (or hydroelectricity) is currently the most widely used renewable source of energy in the world. Worldwide hydropower represents 19% of total electricity production. The US is the fourth largest producer of hydroelectricity in the world and it accounted for 7.1% of the nation's electricity production in 2006. In 2008, there were 78,000 Megawatts of hydroelectricity being produced, enough to meet the residential needs of more than 14 million people.

Converting flowing water into usable energy produces hydropower. Most of this water comes from rivers and is released through turbines to produce energy. Although this power source does not release pollution or greenhouse gases, it is expensive and time consuming to build, is rain dependent, can harm fish and wildlife, displace people, and alter the quality of water. Finally, the die-off of plants and organic matter beneath the water surface results in methane emissions, a potent greenhouse gas. The impact of these emissions is under debate.

Sources:

USGS, http://ga.water.usgs.gov/edu/wuhy.html

US Energy Information Administration, http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/table3.html

Bureau of Reclamation, http://www.usbr.gov/power/edu/pamphlet.pdf

Biomass/Bioenergy

Biomass energy is derived from three distinct energy sources: wood, waste, and alcohol fuels. Wood energy is derived both from direct use of harvested wood as a fuel and from wood waste streams. The largest source of energy from wood is pulping liquor or "black liquor," a waste product from processes of the pulp, paper and paperboard industry. Waste energy is the second-largest source of biomass energy. The main contributors of waste energy are municipal solid waste (MSW), manufacturing waste, and landfill gas. Biomass alcohol fuel, or ethanol, is derived almost exclusively from corn.

Waste from paper mill operations is the main source of fuel for biomass energy production in the United States. Alternatively, Europe draws its main source of fuel for biomass energy from wood and wood waste. Finally, developing nations make timber their main source of fuel for biomass energy.

In 2008, biomass produced about 11,000 Megawatts of renewable electricity in the United States (approximately 1.1% of the electricity generated in the US.) Worldwide, according to statistics from the International Energy Agency, 11% of energy (but not electricity) generated is from biomass.

Sources:

US Energy Information Administration, http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/table4.html

European Biomass Industry Association, http://www.eubia.org/about_biomass.0.html

Geothermal Energy

Geothermal energy is contained in underground reservoirs of steam, hot water, and hot dry rocks. In electric generating facilities, hot water or steam extracted from geothermal reservoirs in the Earth's crust is supplied to steam turbines at electric utilities that drive generators to produce electricity. Moderate-to-low temperature geothermal resources are used for direct-use applications such as district and space heating. Lower temperature, shallow ground geothermal resources are used for geothermal heat pumps to heat and cool buildings.

In 2008, geothermal energy's electricity capacity in the US is about 2,244 Megawatts (approximately 0.23 percent of electricity generated in the US.)

Sources:

US Energy Information Administration, http://www.eia.doe.gov/cneaf/solar.renewables/page/geothermal/geothermal.html

http://tonto.eia.doe.gov/energy_in_brief/renewable_energy.cfm

Wind Energy

The sun's uneven heating of the atmosphere, irregularities of the Earth's surface, and the rotation of the Earth create winds. As a result, winds are strongly influenced and modified by local terrain, bodies of water, weather patterns, vegetative cover, and other factors. Wind turbines use two or three long blades to collect the energy in the wind and convert it to electricity. The

blades spin when the wind blows over them. The energy of motion contained in the wind is then converted into electricity as the spinning turbine blades turn a generator. To create enough electricity for a town or city, several wind turbine towers need to be placed together in groups or rows to create a "wind farm." Wind-based electricity generating capacity has increased markedly in the United States since 1970, although it remains a small fraction of total electric capacity. (24,000 Megawatts in 2008 or 1.6 percent of total US electrical generation).

Areas with the best wind resources include portions of the following states: North Dakota, Texas, Kansas, South Dakota, Montana, Nebraska, Wyoming, Oklahoma, Minnesota, Iowa, Colorado, New Mexico, California, Wisconsin, and Oregon. In general, wind is consistent and strong enough in the Great Plains states and mountain passes in the various mountain ranges throughout the United States to generate electricity using wind turbines. The Rocky Mountain and Great Plains states have sufficient wind resources to meet 10 to 25 percent of the electric power requirements of these states.

Sources:

US EPA, http://www.epa.gov/RDEE/energy-and-you/affect/non-hydro.html#wind

US Energy Information Administration, http://www.eia.doe.gov/cneaf/solar.renewables/page/wind/wind.html

Photovoltaic (PV) Cells (Solar Power)

Photovoltaic devices use semi-conducting materials to convert sunlight directly into electricity. Solar radiation, which is nearly constant outside the Earth's atmosphere, varies with changing atmospheric conditions (clouds and dust) and the changing position of the Earth relative to the sun.

Solar resources are available everywhere in the United States, although some areas receive less sunlight than others, depending on the climate and seasons. The greatest solar resources are located in the Southwestern states, where sufficient solar energy falls on an area of 100 miles by 100 miles to provide all of the nation's electricity requirements.

In 2008 the US generated 514 Megawatts of electricity using Solar Power (approximately 0.04 percent of electricity generated in the US).

Sources:

US EPA, http://www.epa.gov/RDEE/energy-and-you/affect/non-hydro.html#wind

US Energy Information Administration, http://www.eia.doe.gov/cneaf/solar.renewables/page/solarphotv/solarpv.html

Energy in the Round Game

(Adapted from the "Energy in the Round" game developed by The National Energy Education and Development Project; *www.need.org)*

Energy in the Round is a quick, fun game to reinforce information about energy sources, forms of energy, and general energy information.

1. Copy one set of the Energy in the Round cards onto card stock and cut into individual cards.
2. Distribute one card to each student. If you have cards left over, give some students two cards so that all of the cards are distributed.
3. Have the students look at the bold words at the top of their cards.
4. Choose a student to begin and give the following instructions:
5. Read Question 1 on your card: The student with the correct answer will stand up and read the bolded answer, "I have _____."
6. That student will then read Question 1 on his/her card, and the round will continue until the first student stands up and answers a question, signaling the end of the round.
7. Continue the game with Rounds 2 and 3.
8. If there is a disagreement about the correct answer, have the students listen to the question carefully (forms versus sources, for example) and discuss until a consensus is reached about the correct answer.
9. More topics and cards can be found on the website at *www.need.org*.

I HAVE PROPANE.

1. Who has the energy source converted directly into electricity using PV cells?
2. Who has the sector of the economy that uses about 36 percent of the nation's energy?
3. Who has the processes of surface, deep, underground, room-and-pillar, and longwall?

I HAVE BIOMASS.

1. Who has the energy sources that are replenished in a short time?
2. Who has the transportation fuel that can be made from biomass?
3. Who has the group of nonrenewable energy sources used most in the U.S.?

I HAVE SOLAR.

1. Who has an energy concept based on efficiency and conservation?
2. Who has the process during which precipitation replenishes oceans, rivers, and lakes?
3. Who has the alcohol made by adding yeast to biomass?

I HAVE RENEWABLE.

1. Who has the energy source that generates more than half of the nation's electricity?
2. Who has the number one state for producing natural gas?
3. Who has the gas that becomes a liquid under moderate pressure or when cooled?

I HAVE LIGHT.

1. Who has the sector of the economy that makes the goods and materials we use every day?
2. Who has the energy source two-thirds of which is imported from other countries?
3. Who has the energy carrier that may become a significant transportation fuel in the future?

I HAVE COAL.

1. Who has a renewable fuel often made from corn that costs more than gasoline, but burns cleaner?
2. Who has what can use many different fuels to produce most of the electricity in the U.S.?
3. Who has the type of bulb that includes compact fluorescents?

I HAVE ENERGY SUSTAINABILITY.

1. Who has the energy source transported by one million miles of underground pipeline?
2. Who has the resource that fuel cells use to generate electricity?
3. Who has the energy source that produces volcanoes and hot springs?

I HAVE ETHANOL.

1. Who has another word that describes thermal energy?
2. Who has what can be changed into other forms, but cannot be created or destroyed?
3. Who has the process in which atoms are split apart, releasing energy as heat and radiation?

I HAVE NATURAL GAS.

1. Who has the energy source that makes renewable methane gas?
2. Who has a secondary source of energy defined as moving electrons?
3. Who has the state that is number five in coal production?

I HAVE HEAT.

1. Who has the energy source caused by uneven heating of the earth's surface?
2. Who has the process in which water, carbon dioxide and sunlight are turned into glucose and oxygen?
3. Who has the energy source that requires the earth's gravity to work?

I HAVE URANIUM.

1. Who has the resources that can be categorized as either renewable or nonrenewable?
2. Who has the type of energy sources used mainly to make electricity?
3. Who has the energy source that consists mostly of methane?

I HAVE ENERGY SOURCES.

1. Who has the production facility where electricity is generated?
2. Who has the portable energy source used in barbecue grills and hot air balloons?
3. Who has the energy sources whose supplies are limited?

I HAVE NUCLEAR FISSION.

1. Who has another word for radiant energy from the sun?
2. Who has the effect that traps heat in the atmosphere?
3. Who has the renewable energy source that produces most of its electricity in California?

I HAVE TEXAS.

1. Who has the process of evaporation, condensation, and precipitation?
2. Who has the energy source that is produced in the Ring of Fire in the Pacific Ocean?
3. Who has the nuclear combining process that gives off radiant energy?

I HAVE ENERGY.

1. Who has the process green plants use to change radiant energy into chemical energy?
2. Who has the process nuclear power plants use to produce electricity?
3. Who has the energy source of which most is refined into gasoline?

I HAVE THE WATER CYCLE.

1. Who has the process used to reach energy sources buried underground?
2. Who has the type of energy sources in which fossil fuels are grouped?
3. Who has the sector of the economy that uses natural gas and propane the most?

I HAVE PHOTOSYNTHESIS.

1. Who has the number one petroleum producing state?
2. Who has the form of energy plants transform and store in their leaves and roots?
3. Who has the energy source whose waste products will soon be stored in Nevada?

I HAVE MINING.

1. Who has the energy source Dr. Walter Snelling discovered in 1911?
2. Who has the process in which helium atoms are made by combining hydrogen atoms?
3. Who has the gases that are more than 97 percent water vapor?

I HAVE POWER PLANT.

1. Who has the energy source that comes from the earth's core?
2. Who has the belief that every generation should meet their energy needs without compromising the energy needs of future generations?
3. Who has another word for thermal energy?

I HAVE INDUSTRY.

1. Who has the ability to do work or make a change?
2. Who has the energy source that is transported chiefly by train?
3. Who has the type of energy source that includes biomass, solar, geothermal, hydropower, and wind?

Lesson 2C Assessment

Aspect	Expert (4)	Practitioner (3)	Apprentice (2)	Novice (1)	Score
Chart/ Explanation of the Energy Source	Clearly communicates what the energy source is and how it works.	Shows a basic understanding of the energy source and how it works	Struggles to show a basic understanding of the energy source.	Shows no understanding.	
Chart/Examples	Clearly communicates examples	Shows basic understanding of examples.	Struggles to show examples.	No examples are given.	
Chart/Cost per kWh	Has the correct cost per kWh	Has a reasonably close cost per kWh	Has the incorrect cost.	No cost given.	
Chart/Examples of use in home or school.	Gives multiple uses for home and school.	Gives some uses for home and school.	Gives one use for home or school.	Gives no use for home or school.	
Game/Energy in the Round	Actively participates in the game. Shows understanding of the rules.	Some participation of the game. Does not show a clear understanding of the rules.	Does not understand the game nor participate without guidance.	Does not participate.	
				Total Score	**/12**

Objective Check

1. Name four types of renewable energy. (Answers will include hydropower, biomass/bioenergy, geothermal energy, wind energy, and photovoltaic (PV) cells/solar)
2. Choose one type of renewable energy and list one advantage and one disadvantage of using this energy. (Answers will vary. Example: Solar, advantage: unlimited clean energy source, disadvantage: high cost.)

Unit 2: Home and School Energy Quiz

Name:_____

Multiple Choice: Read all possible responses and select the best answer.

1. **Which of the following sources produces the most electricity in the US?**
   a. Hydro
   b. Biomass
   c. Solar
   d. Wind

2. **What steps can you take to help reduce energy costs around the house?**
   a. Locate and seal up drafts around doors, windows, and baseboards with caulk or weather-stripping
   b. Add insulation to the attic and walls
   c. Turn off heating and air conditioning system when you're away
   d. All of the above

3. **True or false; the capacity of electrical generation from renewable sources is increasing.**
   a. True
   b. False

4. **Making your home more energy-efficient will have which of the following environmental benefits?**
   a. Reduce water pollution
   b. Help protect endangered species
   c. Lower greenhouse-gas emissions
   d. All of the above

5. **On average, which is the "cleaner fuel" in terms of emissions of the greenhouse gas CO_2?**
   a. Electricity from a coal-fired power plant
   b. Natural gas
   c. Electricity from a hydroelectric power plant
   d. Wood

6. **Energy efficient appliances are often more expensive than non-efficient ones. How can you justify spending more on the efficient ones?**
   a. You cannot justify buying the more expensive one.
   b. Your electricity bills will be smaller and eventually your savings will be greater than the difference in costs.
   c. The more expensive one is probably a better brand.
   d. Simply on looks.

7. **What is an action your school could take to reduce its electricity bills?**
   a. Install motion detectors in hallways so lights go off when no one is in the hall.
   b. Instruct custodians to turn off all unnecessary lights after school hours.
   c. Do a lighting audit to make sure there are not too many lights in a single room.
   d. All of the above.

8. **Which of the following items consume the most electricity?**
   a. Clothes dryer
   b. Oven
   c. c. Light bulb
   d. Old fridge

9. **Which of the following actions will save the most electricity over time?**
   a. Hang your laundry on a clothesline instead of using a clothes dryer
   b. Use a microwave oven instead of a regular oven
   c. Replace a regular light bulb with a compact fluorescent bulb
   d. Replace an old fridge with a brand new one

10. **Which of the following is NOT a renewable source of energy source?**
    a. Solar
    b. Wind
    c. Coal
    d. Biomass

Short Answer

11. **Name a form of renewable energy:**

12. **What is an advantage to using that energy source?**

13. **What is a disadvantage of using that energy source?**

14. **Name four strategies that you can do to reduce your home-related greenhouse gas emissions:**

    1.
    2.
    3.
    4.

Unit 2 Quiz Key

1. A
2. D
3. A
4. D
5. C
6. B
7. D
8. A
9. A
10. C
11. Answers will vary
12. Answers will vary
13. Answers will vary
14. Answers will vary but could include:
    - Turn off lights when not in use
    - Turn down the thermostat
    - Turn down the water heater
    - Air-dry clothes.Unit Quiz Key

Home and School Energy Appendix

1. For a number of energy-based activities, readings and games see the National Energy Education Development Project's website: *http://need.org/*

2. Another nice collection of energy-based lesson plans are provided by the Bonneville Power Administration's Energy Smarts Team Training Manual *http://www.bpa.gov/corporate/kr/ed/energysmarts/homepage.htm*

3. The Institution of Energy and Technology's Faraday program has an interesting role-playing lesson plan built around debating renewable energy sources. *http://faraday09.theiet.org/teachers/sb/Renewable-energy-role-play.pdf?type=pdf*

4. The American Forest Foundation has a lesson plan designed to identify ways to save energy in our daily lives and understand how that will reduce air pollution. Waste Watchers can be found at (permission required for reproductions): *http://apps1.eere.energy.gov/education/lessonplans/pdfs/efficiency_wastewatchers.pdf*

5. The Earthday Network and Redefining Progress have a lesson plan focused on the history of energy use and renewable energy sources. They provide suggestions for a discussion/debate regarding renewable sources. *http://www.earthday.net/lesson%20plans/Renewable%20Energy.pdf*