Lesson Plan: Energy Sources and Systems

(7-8 days if done completely)

Concepts

1. Most of our energy is originally derived from the sun.
2. Environmental impacts differ depending upon the energy source and conversion process.
3. Energy sources can be classified as renewable, nonrenewable or inexhaustible resources. Currently, society is strongly dependent upon nonrenewable energy resources.
4. An energy source can be considered renewable if it is replenished within a short period of time.
5. The world's supply of nonrenewable resources is limited and their use can negatively affect our environment.
6. Different energy sources have different costs.
7. A system is made up of a sequence of conversions.
8. In the conversion of energy a significant fraction of that energy can be "lost" from the system (in the form of heat, sound, vibration, etc). This energy is not really lost, it is just not converted to the desirable or intended form).
9. Systems can be divided into inputs, processes, outputs, and feedback.
10. The components of an energy system must work together to transform energy into a form that can be used in our society.
11. Energy use and supply can be expressed quantitatively.
12. Scientific modeling is an important tool used by scientists, mathematicians, and engineers to explain complex topics.

Key Questions

1. Where does energy come from?
2. Is our supply of energy infinite or finite?
3. How can we classify energy sources as renewable, nonrenewable or inexhaustible?
4. How can we show the trends of our fossil fuel consumption and supply?
5. What are the most significant environmental impacts associated with our most widely used energy sources?
6. What is the input and output of each energy system?
7. What forms of energy losses can occur during an energy conversion?

Student Learning Objectives
Students will be able to identify at least five sources of energy.
Students will be able to explain why an increased dependence on renewable energy sources is an inevitable part of our future.
The student will be able to state that the depletion of fossil fuels is a serious global issue.
The student will be able to graphically represent data and explain the trends.
The student will be able to use and explain a mathematical model of a real life phenomenon.
Students will be able to identify and describe the parts of an energy system.

Educational Standards

- NSES Science (5-8): A1.4, A1.5, A1.8, A2.3, B3.1, B3.4, B3.5, B3.6, E2.4, E2.6, E2.7, F3.2, F3.3, F4.4, F5.1, F5.3
- ITEA Tech: 4, 5,16
- NCTM Math (6-8): A1.1, A1.4, A3.4, B3.1, B4.1, E1.2, E3.1, I3, J3

Anticipatory Set

- Students have learned about energy, work and power.
- They will start with a power point presentation on energy sources and learn about (or review) the difference between renewable and non-renewable energy sources.
- We currently are highly dependent on fossil fuels for most of our energy supply – this energy is instrumental for maintaining our current society
- Our supply of non-renewable energy sources is being depleted and may even reach a point where the limited supply adversely affects their lives.
- Renewable resources that will be introduced include solar, wind (including offshore), hydro (including micro-hydro), geothermal and biomass.
- Non-renewable sources that will be introduced through pictures include nuclear energy and fossil fuels.
- A basic description of an energy conversion is: Energy from a source provides input to another system component, which converts the form and/or state of energy and provides output to another system component.
- A basic description of an energy system is a sequence of energy conversions.

Key Terms

Biomass energy	Energy released from plants (wood, corn, etc) through combustion or other chemical process
Energy System	An energy system is made up of a sequence of conversions with inputs and outputs that transform an energy resource into a form usable for human work or heating
Fossil Fuel	A non-renewable energy resource that began to form millions of years ago from the remains of once living plants and animals. Its current forms include petroleum, coal and natural gas.
Geothermal Energy	Heat energy from the earth
Hydropower	Transformation of the energy stored in a depth of water into electricity
Non renewable energy	Resources, such as fossil fuels that cannot be replaced by natural processes at the same rate it is consumed
Peak oil	The point at which the rate that a non-renewable resource (oil) can be produced declines due to the limitations of extraction processes and the availability of the resource.
Photovoltaic	A chemical process that releases electrons from a semi-conductor material in the presence of sunlight to generate electricity.
Renewable energy	Resources, such as wind and water, that can be recycled or replaced at a rate faster than they are consumed.
Solar Energy	Energy from the sun; often captured directly as heat or as electricity through a photovoltaic process.
System Component	One process in a system comprised of many processes or components
Uranium	An element that releases heat as it undergoes radioactive decay
Wind energy	Energy transferred with the motion of air in the lower atmosphere that arises from differential heating of the earth. The energy in the wind can be extracted as mechanical energy to do work such as grind grains (a wind mill) or generate electricity (wind turbine)

Teaching Plan:

This is a multi-day lesson that includes an introduction to energy sources, an activity to understand the value of renewable energy resources, and research on specific sources and their conversions.

Day 1: Intro to Sources

- Sources Brainstorm
    - "Where does the energy we use come from?"
    - Lead them into saying the obvious: "Energy comes from an energy source."
    - Write a heading of "Sources" on the board and brainstorm with the class for examples of energy sources. As this is occurring, pass out the worksheet.

- Worksheet and Presentation
    - Begin the PowerPoint presentation on energy sources.
    - As each source's slide is presented, have the students record the source's name in the appropriate spot on the worksheet
    - For each source, have a student try to briefly explain what they think it is and how it works. Correct accordingly and complete the picture of what each source is (very briefly, they'll be doing source research later) before moving on to the next.
    - Emphasize that many of our energy sources were originally derived from solar energy.

- Review the Forms and States
    - Go over the forms and states of energy again. Have the students fill these in on the Sources and Conversions worksheet
    - Go over what form of each source
        - Fossil Fuels – Chemical
        - Uranium – Nuclear
        - Biomass –Chemical
        - Geothermal –Heat (thermal, generated from nuclear processes within earth)
        - Hydropower –mechanical
        - Wind –mechanical
        - Solar Power –radiant (light) (really – electromagnetic broader term to use here since there are non-visible wavelengths of importance also)
    - Can we use this energy in its form? For example, can sunlight be directly used to power a radio? No, a solar panel needs to be used for energy conversion.
    - Ask, "So How do we convert energy?" State that we use an **energy system**. Reiterate that energy can neither be created nor destroyed; it can only be converted form one form to another (although some can be considered "lost" because it is converted into a form that we can not effectively utilize). Close the class by saying that we'll explore sources and systems in the next classes.

Day 2: Renewable vs non-renewable energy sources

- Review sources and categorization by renewable/nonrenewable. The goal of today's class is to understand the real long-term value of renewable resources
- Recall that scientists are predicting that petroleum production will begin to decline within the next few years or decades.
    - This is because petroleum is a non-renewable resource.
    - Discuss how petroleum was made (not from dinosaurs! See details http://fossil.energy.gov/education/energylessons/coal/coal_howformed.html)
    - Introduce term Peak Oil (order free copy of Peak Oil poster - http://www.oilposter.org/)

- Fossil fuels take millions of years to make, we are using them much more rapidly. Thus, they are not being "renewed." Define non-renewable
    - a resource that we use at a rate faster than it can be created.
- What is the opposite?
    - A renewable resource "a resource that we use at a rate that allows it to be replenished by natural means" Do you know of any renewable energy resources? (expect solar or wind)
- The objective of today's class is to experience how long a renewable resource can be used in comparison with a non-renewable resource.
- Complete the Renew-a-bead Activity.[1]
- At the end of the first day assign the fossil fuel graphing homework

Day 3: Discuss the results of the renew-a-bead activity

- What happened to the black beads? Relate this to the importance of renewable energy as present reserves of fossil fuels will decline in the future.
- Looking ahead – one possible solution to our current energy situation would be the use of more renewable resources rather than mostly just non-renewable energy resources.
- Also discuss that the renew-a bead activity is an example of scientific modeling. Talk about how modeling is used in your research or classes.
- Review Fossil fuel graphing homework as a class
- Go over the graphs and results as a class
- Discuss the inevitable demand/ supply problem that we will face with fossil fuels because they are Non-renewable
- Discuss uncertainties – we do not know when we will face these problems – but it will likely be in their own lifetimes.

Day 4: Energy Sources Research Activity

- Review semester project – we want to change … (depends on which project used). One way to change is to consider a different source of energy. But we need to learn more!
- We've introduced several different energy resources. We now want to learn more in depth about each one. If you were to consider implementing a different energy source and conversion process, what would you want to know about it? (class brainstorm)
    - How it really works
    - Cost
    - Environmental impact
    - How it can be used in your home
    - Etc.

[1] Renew-a-bead activity adapted from "Renew-a-bean" activity originally published in:
R.E.A.C.T. Renewable Energy Activities – Choices for Tomorrow Teacher's Activity Guide, National Renewable Energy Laboratory Education Programs, Golden, Colorado (http://www.nrel.gov/docs/gen/fy01/30927.pdf)

- Think about how these various energy alternatives might be utilized in your project as we go through this research.
- Hand out the research packets and activity sheets (note – two versions available, one as HW and one as in-class group activity)
- The research packets consist of each energy sources fact sheet
- Split the students into small groups (3 or 4 students)
- Assign each group one of the 7 research questions (If there are less than 7 groups choose just a few questions, preferably how it works, one economic question, one environmental question, etc.)
- Each group will answer that one question for all 7 energy sources
- Explain to the students that they will become experts on the specific aspect of energy sources (for example, they will be experts on the environmental effects of energy sources)
- Each group will make a decision based on the specific aspect they researched, as to which source is best.
- This may take more than one day, students who finish early can move on to the next step outlined in the following day

Day 5: Energy Sources Research Handouts

- Finish research as needed
- Have each group prepare a one page handout summarizing their findings
  - Give each group a blank piece of regular printer paper and markers
  - Have each group make a handout including the information they researched. They should include the most important or interesting facts, the ones they made their decision based on, for each energy source.
  - In preparation for next day class, make copies of each handout for each student. Make a transparency of hand out for the group to use for their presentation

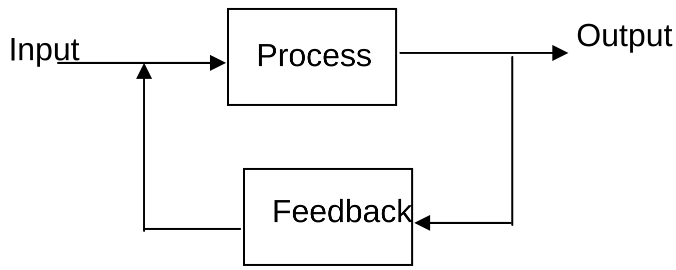
Day 6: Energy Sources Research Presentations

- Have each group present their handout to the class.
- Write on the board which energy source each group felt was best.
- Discuss the pros and cons as a class and decide which ones are most feasible for a home.
- Lead the students to Wind, Solar, and Hydro
- Relate this to semester project – how might you use this information to address the question posed at the beginning of this energy unit?
- Tell them that in the next class we will look at the systems for those sources.
- If there is extra time you can use the Energy Trivia PowerPoint to review the facts they researched.

Day 7: Energy Systems

- Review Energy Systems

- Explain that all system have an input, process, output, and possibly feedback. Draw the following flowchart on the board to illustrate that concept.



- Energy System Diagram Activity
  - Teacher prep – print and cut apart system cards. Print system diagram posters – large is best – and post around the room. (we laminate them for repeated use in different classes and years)
  - Go over the system diagram for one of the systems the class will not be doing. (reviewing coal combustion relating to sterno/pinwheel demo would be appropriate)
  - Explain that the students will have to match the system component and its description with its location on the diagram they are given
  - They will also have to draw a block diagram for their system, identifying the starting and ending form and state for each system component,
  - Divide the class into groups of 3-5 students
  - In most classes we only used the Wind, Solar, and Hydro Diagrams but other diagrams can also be used.
  - Go around and assist each group as needed.
  - Once all the students have figured out their diagrams have each group present it to the class. They can do the block diagram on the board.
  - Pass out the completed handouts for each system. (optional)
- Close with overall assessment of what an energy system is and its general attributes (input, output, conversion process, efficiency).
- Discuss again how this overall lesson on sources can be used for your semester project.

Day 8:

- Energy Sources, Systems, and Conversions Assessment (quiz)

Resources

Included below:

Sources and Conversions Worksheet

Activity - Renew-a-Bead
Fossil Fuel Graphing Homework
Activity-Energy Sources Research
Homework-Energy Sources research (alternative to above activity)
Activity-Energy System Diagrams
Energy Sources, Systems, and Conversions Assessment
Energy Sources, Systems, and Conversions Assessment Solutions
Energy Sources Fact Sheets
Energy System Diagram Handouts

Separate files
Energy Sources Power Point

URL

All lesson plans in this unit are included at
http://www.clarkson.edu/highschool/k12/project/energysystems.html

This URL has been included in the Engineering Pathways web site (http://www.engineeringpathway.com/ep/index.jhtml) and can be found with a search on "energy choices."

Owner

Office of Educational Partnerships, Clarkson University, Potsdam, NY

Contributors

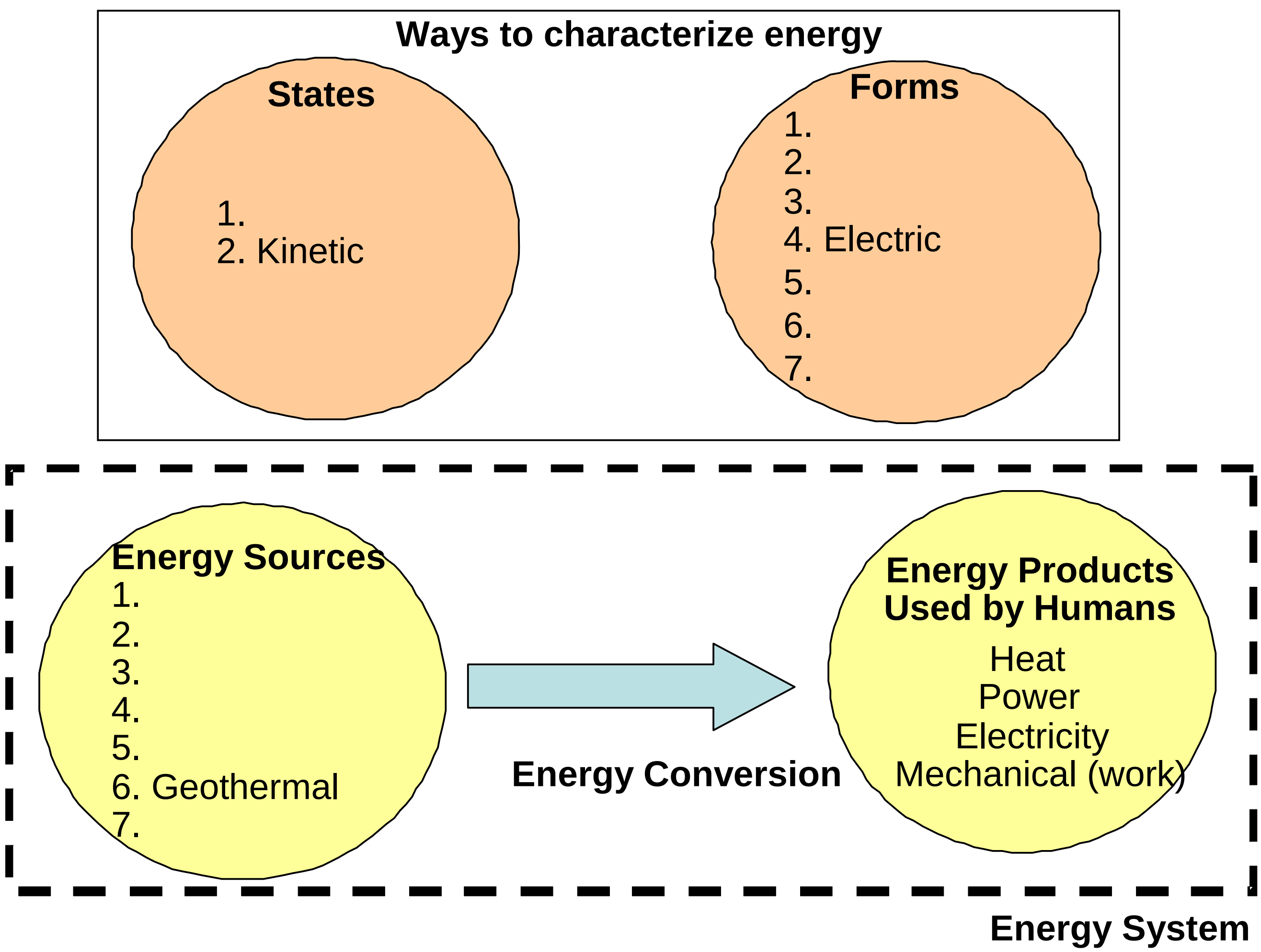
Susan Powers, Jan DeWaters, and a number of Clarkson and St. Lawrence students in the K-12 Project Based Learning Partnership Program. This unit was developed under National Science Foundation DTS and GK-12 grants No. DUE-0428127 and DGE-0338216. These contents do not necessarily represent the policies of the National Science Foundation, and you should not assume endorsement by the federal government.

Copyright

Version: December 2008

Energy Sources and Conversion Worksheet

Fill in blanks as discussed in class



Activity: Renew-A-Bead

Purpose

The sources that provide the energy we use every day can be divided into two different groups: Renewable and Non-Renewable. Renewable energy sources are those that are continuously replenished in a reasonable time frame. Non-renewable energy sources are those that are used and cannot be recreated in a short period of time.

In this activity you will be given a bag of "energy beads." Each bag contains energy provided by both renewable (white beads) and non-renewable (black beads) sources. You will "use" the energy provided by both types of sources by randomly picking beads from a bag – some of the "energy" you use will be renewable, some will be non-renewable. You will see what happens to the renewable/non-renewable energy sources that remain after many years of energy use.

Equipment

- One plastic bag containing 100 beads. The black beads represent non-renewable energy resources and the white beads represent renewable energy resources. (The ratio of white beads to black beads will vary depending on group)
    1. Group 1= 90 black beads and 10 white beads
    2. Group 2= 80 black beads and 20 white beads
    3. Group 3= 70 black beads and 30 white beads
- Small Cloth
- Extra plastic bag
- Calculator
- Pencil

Procedure

1. Split into groups of 2-3 students.
2. Collect all equipment and materials necessary to conduct the activity.

Part 1: Simulate the annual consumption of energy - constant rate of energy use

3. Have one person from each group pick out 10 "energy beads" from the bag, without looking. These 10 beads represent the energy that is used in one year.
4. Count the black and white beads and record the number on the attached data collection sheet for Year 1.
5. The black beads represent energy from non-renewable energy sources, so when a black bead is picked it cannot be returned to the bag (place it in the extra plastic bag). The white beads are renewable energy beads, so they should be put back into the bag each turn after counting them.

6. Let another person from the group pick 10 beads to represent energy use in Year 2. Fill in the number of black and white beads on the chart, and return the white beads as in step 5.
7. Repeat the process, returning all white beads to the bag after each person's turn, until 20 years have passed or until all the black energy beads are gone.

Part 2: Simulate the annual consumption of energy - increasing rate of energy use

8. Consider the increasing use of power and energy over time. Repeat steps 3 through 7, but increase the amount of energy use by picking out 5 additional "energy beads" each year (pick 10 beads in year 1, 15 beads in year 2, 20 beads in year 3, etc.). Record information on the attached data collection sheet.
9. Complete the discussion questions.

Discussion Questions

1. How many years did it take for the non-renewable energy sources to run out when you used 10 energy beads per year? How many years did it take for the non-renewable energy sources to run out with you increased the rate of consumption each year (part 2)? What conclusion can you draw from this about our energy use habits?

2. What are some examples of renewable and non-renewable energy sources?

3. What does this activity demonstrate about our consumption of resources - what will happen if we keep using non-renewable resources?

4. Describe what happens to the proportion of renewable vs. non-renewable energy sources that remain available, as energy is used over time.

5. Compare the results from teams with different energy mixes. If each bag represents a country, what can you say about countries that currently use a greater fraction of renewable energy? Will they be able to continue to provide for their country's energy needs?

.

Data collection for renew-a-bead –
Part 1: 10 energy beads used each year

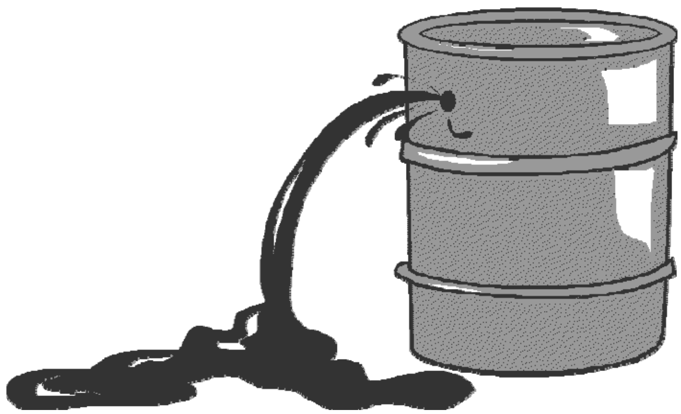
Year	Total beads removed	Number black beads	Number white beads	Percent of beads that are renewable $\frac{white\,beads}{total\,beads} x100\%$	Number of beads remaining
1	10				
2	10				
3	10				
4	10				
5	10				
6	10				
7	10				
8	10				
9	10				
10	10				
11	10				
12	10				
13	10				
14	10				
15	10				
16	10				
17	10				
18	10				
19	10				
20	10				

Data collection for renew-a-bead –
Part 2: Increasing use of energy each year

Year	Total beads removed	Number black beads	Number white beads	Percent of beads that are renewable	Number of beads remaining
1	10				
2	15				
3	20				
4	25				
5	30				
6	35				
7	40				
8	45				
9	50				
10	55				
11	60				
12	65				
13	70				
14	75				
15	80				
16	85				
17	90				
18	95				
19	100				
20					

Name: _______________

Homework: Fossil Fuel Use



Backround

As a society, we are very dependent on fossil fuels, especially petroleum products. A primary use of petroleum is gasoline, which we use to power our automobiles. We also use petroleum products to heat our homes, lubricate machinery, and to make plastics. Because petroleum is a FOSSIL FUEL, it is a NON-RENEWABLE ENERGY SOURCE. This means that there is a limited supply and we will run out over time. This situation is worsened by the fact that the rate at which we are consuming these fossil fuels is increasing as Americans are buying more and more cars and SUVs with low fuel efficiciency. This means that we will run out these fossil fuels even faster.

Purpose

You are to examine the projected rates of fossil fuel production and consumtion over 23 years in order to arrive at conclusions about our current state of affairs and offer suggestions on how to change.

Instructions

Graph the data points given below in BAR GRAPH format in the area provided. The first graph will be the estimated crude oil <u>production</u> through 2025. The second graph will be the estimated <u>consumption</u> through 2025. Answer the accompanying questions.

Data

Crude Oil Production (Quadrillion Btu per Year)						
YEAR	**2002**	**2003**	**2010**	**2015**	**2020**	**2025**
OIL	**12.2**	**12.0**	**12.8**	**11.6**	**11.0**	**10.0**

Crude Oil Consumption (Quadrillion Btu per Year)						
YEAR	**2002**	**2003**	**2010**	**2015**	**2020**	**2025**
OIL	**38.4**	**39.1**	**44.8**	**48.1**	**51.3**	**54.4**

Graphs

TITLE ____

TITLE ____

Questions:

1. Identify the dependant and independant variables from the Crude Oil Production Chart.

   Year: Oil:

2. Was there in increase or decrease in the projected oil production through 2025? Why do you think this is?

3. Was there in increase or decrease in the projected oil consumption through 2025? Why do you think this is?

4. How old will you be in 50 years? What do you think will happen in 50 years to your life and our general society based on the trends shown in these graphs?

5. Give one example of a change that we can make to avoid a possible oil shortage crisis.

Data obtained from http://www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf

Homework-Energy Sources Research

Purpose

Although most of the energy consumed in the United States comes from fossil fuel sources, there are many other potential sources of energy available. In all cases, there are pros and cons to our use of these sources. Some of the energy sources are limited by their availability or environmental impact; others need technological improvements before they can become widely used. For scientists and engineers, research is the best way to learn about unknown topics.

This assignment calls you to examine information about energy sources and how those sources are used to produce electrical energy. You will begin to become an expert on one source of energy and report your findings back to the class. Then, you will meet with a group to discuss the various pros and cons that affect our use of different energy sources.

Procedure

1. You will choose or be assigned a source of energy to research
2. Use the provided information packet or alternate resources to find the answers to the questions about your energy sources
3. After this portion of the assignment in completed you will be assigned to a group to fill in the energy sources chart.
4. Once you have filled in the chart, answer the two discussion questions.

Sources

Biomass
Fossil Fuels
Geothermal
Hydropower
Uranium
Solar
Wind

Research Questions

Energy Source: ____

1. What is your energy source? Where can it be found?

2. How do we obtain this energy? (How does it work?)

3. Are there different types or uses of this source? If yes, what are the differences?

4. What are the environmental impacts of your energy source?

5. What are the economic impacts of your energy source? How much does it cost per kWh?

6. What countries frequently use this source of energy? What percentage is it used in the United States?

7. What are the most common applications for this energy source? (at farms, in industry etc) Could this source be used in a family home?

Source Chart

While listening to the students in your group present their information, list some “pros” and “cons” of using that energy source to solve the energy problem.

Energy Source	“pros”	“cons”
Biomass		
Fossil Fuels		
Geothermal		
Hydropower		
Uranium		
Solar		

Discussion Questions

1. If you had to choose an energy system to tell your community about based on the listed pros and cons, which system would you choose? Why?

2. Why do we as a nation depend so much on fossil fuels? What do you think we could do to reduce this dependence on fossil fuels?

Activity-Energy Sources Research

Purpose

Although most of the energy consumed in the United States comes from fossil fuel sources, there are many other potential sources of energy available. In all cases, there are pros and cons to our use of these sources. Some of the energy sources are limited by their availability or environmental impact; others need technological improvements before they can become widely used. For scientists and engineers, research is the best way to learn about unknown topics. Today we will examine information about energy sources and how those sources are used to produce electrical energy. We can use this information to help us understand the various pros and cons that affect our use of different energy sources. In this activity, each group of students will begin to become an expert on one aspect of each source of energy and report their findings back to the class.

Procedure

1. Break into a group of 2-3 students.
2. Choose or accept an assignment to research one particular question about each source of energy.
3. Using the provided information packet, find the answer to your question for all seven energy sources.
4. Once you have answered your question for all seven sources, answer the two conclusion questions.
5. As a class we will fill in the energy sources chart based on your findings.

Research Questions

1. What is this energy source? Where can we find it?
2. How do we harness the energy? (How does it work?)
3. Are there different types or uses of this source? If yes, what are the differences?
4. What are the environmental impacts of your energy source?
5. What are the economic impacts of your energy source? How much does it cost per kWh?
6. What countries currently use this source? What percentage is used in the United States?
7. How is this energy source currently used? For example: At farms, in industry etc. Could this source be used in a family home?

Research Answers

Your Energy Question: ____

1. Biomass

2. Fossil Fuels

3. Geothermal

4. Hydropower

5. Uranium

6. Solar

7. Wind

Discussion Questions

3. If you had to choose an energy system to tell your community about based only on the aspect you researched, which system would you choose? Why?

4. Why do we as a nation depend so much on fossil fuels? **AND** What do you think we could do to reduce this dependence on fossil fuels?

While listening to the other groups in your class present their information, list some "pros" and "cons" of using their energy source to solve your problem.

Energy Source	**"pros"**	**"cons"**
Biomass		
Fossil Fuels		
Geothermal		
Hydropower		
Uranium		
Solar		

Biomass Fact Sheet

- Biomass is any organic matter that can be used as an energy source. This includes wood, crops, seaweed, and animal wastes.
- Biomass ultimately gets its energy from the sun since all organic matter contains stored energy from the sun. Photosynthesis is the process where plants gather energy from the sun and use it.
- Biomass is a renewable energy source because its supplies are not limited. As long as we plant trees and crops we will have resources. Animal waste will always exist as long as the animals exist.
- Until the mid-1800s wood provided 90% of the Unites States' energy. Today, biomass provides 2.9% of this country's energy.
- Industry is the biggest user of biomass. 61% of biomass energy is used by industry. 17% goes to the production of electricity, and 13% is used in homes and the rest going to other applications.
- Biomass contains little sulfur and nitrogen so it does not produce the pollutants that cause acid rain.
- Growing plants for biomass fuels may help keep the earth's carbon dioxide levels balanced.
- Developing a strong biomass industry in the United States will have tremendous economic benefits including trade deficit reduction, job creation, and strengthening of agricultural markets.
- Biomass energy currently costs $0.09/KWh, but could eventually be as low as $0.05/KWH.
- Biomass energy is currently used all around the world, especially in rural and developing nations.
- Types of Biomass
    - Wood and Agricultural
        - Most biomass that is used today is home-grown energy. Wood accounts for 71% of biomass energy.
        - Other biomass sources include agricultural waste like fruit pits and corn cobs.
        - California produces more than 60 million tons of biomass each year. Of this total, five million tons is now burned to make electricity. If all of it was used, the 60 million tons of biomass in California could make close to 2,000 megawatts of electricity for California's growing population and economy. That's enough energy to make electricity for about two million homes!
    - Landfill gas
        - Landfill gas is another type of biomass energy. A substance called methane gas is produced as waste decays in a landfill.
        - The government requires that landfills collect this gas for safety and environmental reasons.
        - Methane gas is odorless and colorless but can cause fires or explosions if it leaks into home and ignites.
        - Landfills can collect the methane gas, purify it, and use it as an energy source.

    - One landfill in Alabama collects 32 million cubic feet of methane a day and pumps it into their natural gas pipelines.
    - Methane is a more powerful greenhouse gas than carbon dioxide. It is better to burn landfill methane than to release it into the atmosphere.
- Anaerobic Digesters
    - Methane is also produced when we chemically break down animal waste.
    - Anaerobic digesters are airtight containers or pits lined with steel or bricks. Wastes that are placed in these containers are broken down by enzymes, the same way food is broken down in your stomach. Methane gas is produced that is then burned to make electricity.
    - Anaerobic digesters are inexpensive to build and maintain and can be built for a family home or for a whole community.
    - For developing countries, anaerobic digesters may be one of the best answers to many of their energy needs.
    - Anaerobic digesters can help reverse the deforestation caused by wood burning and can reduce air pollution, fertilize over-used fields, and produce clean, safe energy for rural communities.

How it works – Burning landfill or digester gas to make power

Burn Fuel → heat water to make steam → steam turns turbines → turbines turn generators → electrical power sent around country

Anaerobic Digester-Farm Size

Engine-generator

Information gathered from:

The NEED Project Secondary Energy Infobook

http://www.andgardigester.com

http://www.nrel.gov/documents/biomass_energy.html

http://www.darvill.clara.net/altenerg/biomass.htm

http://www.eere.energy.gov/biomass/environmental.html

http://www.eere.energy.gov/biomass/economic_growth.html

Fossil Fuels Fact Sheet

- Coal, Oil and Gas are called "fossil fuels" because they have been formed from the fossilized remains of prehistoric plants and animals.
- Fossil fuels are a nonrenewable energy source since they take millions of years to form.
- Fossil fuels ultimately get their energy from the sun. The plants that turned into fossils stored energy from the sun by photosynthesis.
- 85.6% of all energy consumed in the U.S. comes from fossil fuels.
- The average U.S. Household pays about 8 1/2 cents per KWH and uses 10,000 KWH per year.
- Types of Fossil Fuels
  - **Coal**
    - Coal is the most abundant fossil fuel in the United States.
    - Coal is a hard, black colored rock-like substance formed when dead plants were subjected to extreme heat and pressure for millions of years. It is made up of carbon, hydrogen, oxygen, nitrogen and varying amounts of sulfur.
    - There are two ways to mine coal: Surface mining and underground mining
    - Coal often costs more to transport than other fuels.
    - Different types of coal have different amounts of carbon. The more carbon present, the more energy it contains.
    - Coal deposits can be found in 38 states. Montana, Illinois, and Wyoming are the top coal states.
    - Coal from the west has less sulfur content which means it produces fewer pollutants.
    - The federal government owns a majority of the nation's coal reserves.
    - Coal generates 50.2% of the electricity used in this country.
    - Coal industries are required to monitor the amount of pollutants they release into the air, and to reclaim land damaged by surface mining.
    - Clean coal technologies that do not hurt the environment are currently being researched by scientists and engineers.
  - **Natural Gas**
    - Natural gas was formed from the remains of tiny sea animals and plants that died millions of years ago. The gas then became trapped in layers of rock like water in a wet sponge.
    - Raw natural gas is a mixture of different gases. Its main ingredient is methane.
    - The strange smell of natural gas (like rotten eggs) comes from a chemical natural gas companies add called mercaptan. This is added so leaks are easily detected.
    - Natural gas was first used in America in 1816 to light the streets of Baltimore.
    - Natural gas accounts for 23.7% of the energy in the U.S.

- Natural gas is found more than 6,000 ft. under the earth's surface. Drilling can cost up to $100/ft so sites must be chosen carefully. Only 48% of the sites we drill actually produce natural gas.
- Natural gas is produced in 32 states. The top 3 are Texas, Oklahoma, and New Mexico.
- Natural gas is transported by pipeline. More than one millions miles of pipelines link natural gas fields to major cities in the U.S.
- Industry is the biggest consumer of natural gas, using it as a heating source and often as an ingredient in the products they produce.
- 60% of homes use natural gas for heating.
- Natural gas can be used in any vehicle with a regular internal combustion engine, although the vehicle must have a special carburetor and fuel tank.
- If we continue to use natural gas at the current rate, we will only have 30-50 years worth.
- Natural gas is the most environmentally friendly fossil fuel.

- **Oil (Petroleum)**
  - Oil was formed from the remains of tiny sea animals and plants that died millions of years ago. The organic material was then broken down into hydrogen and carbon atoms and a sponge-like rock was formed, full of oil.
  - Only 44% of wells that are drilled for oil actually produce it.
  - The average oil well produces 11 barrels of oil per day.
  - State and federal governments regulate oil drilling and production.
  - Texas, Alaska, and California are the top three oil producing states.
  - Oil cannot be used as it is when it is taken from the ground. Oil refineries clean and separate the oil into various fuels and by-products. The most important of these is gasoline.
  - Gasoline and other petroleum products are transported through pipelines. There are about 230,000 miles of pipelines in the U.S.
  - Petroleum supplies 37.2% of the energy used in the U.S.
  - Americans use about 18 million barrels of oil every day.
  - 67% of oil is used for transportation.
  - The U.S. is becoming increasingly dependent on other countries for oil. We import about 2/3 of the oil that we consume in the U.S. from other countries. Some of these countries include: Iran, Russia, Mexico and, Canada. The biggest imports of crude oil to the U.S. come from Canada.
  - The outer continental shelf (off the coasts of California and Alaska and in the Gulf of Mexico), contain rich deposits of petroleum and natural gas but offshore production is very costly.
  - Petroleum production, distribution, and consumption can contribute to air and water pollution.

- Drilling for oil can disturb fragile ecosystems, especially when there is a spill. Leaking underground storage tanks pollute the groundwater and create toxic fumes. Even burning fuel in our cars emits pollutants.

- The Clean Air Act of 1970 helped us make advances in protecting our environment. Oil refineries had to reduce emissions and new technologies have been developed.

- This year the price of crude oil hit an all-time high of $66 per barrel. Companies that transport materials and products have been forced to increase their price just to keep up.

- **How does it work? – Making power from fossil fuels**

Burn Fuel → heat water to make steam → steam turns turbines → turbines turn generators → electrical power sent around country

Information gathered from:

The NEED Project Secondary Energy Infobook

http://www.energyquest.ca.gov/story/chapter08.html

http://www.eere.energy.gov

http://www.energy.gov

http://www.tvakids.com/electricity/fossil.htm

http://www.darvill.clara.net/altenerg/fossil.htm

http://www.ecoworld.org/energy/EcoWorld_Energy_Resid_KWH_Prices.cfm

☺ **A silly old man is a fossil fool.** ☺

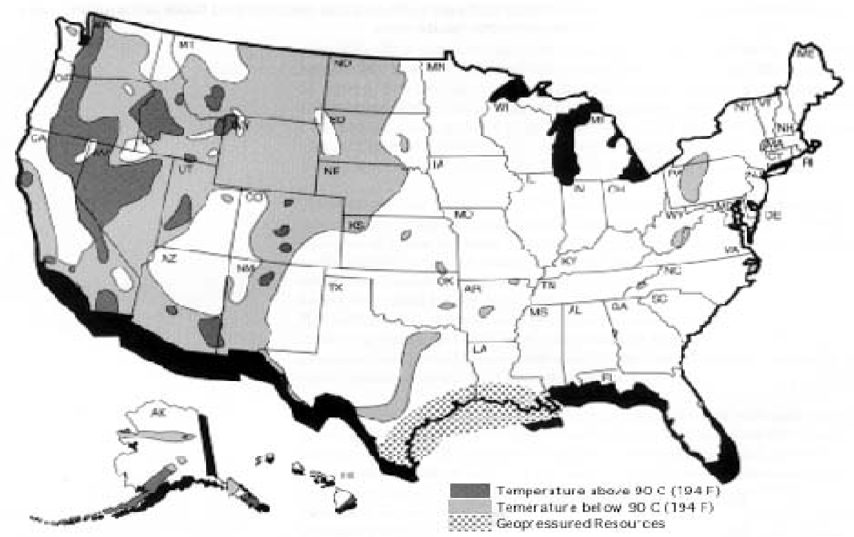
Geothermal Fact Sheet

- Geothermal energy comes from the heat within the earth. The word geothermal comes from the Greek words *geo*, meaning earth and *therme*, meaning heat.
- The outermost layer of the earth, the insulating crust, is broken into pieces called plates. These plates drift apart and push against each other in a process called plate tectonics. This process can cause the crust to become cracked or thinned, allowing plumes of magma to rise up into the crust. The magma can reach the surface (volcanoes) but most stays under the surface as geothermal heat.
- The underground heat can take 1000 to 1 million years to cool.
- In areas where there is underground water, the magma heats the water and creates either hot springs or underground reservoirs.
- Geothermal energy is renewable because water is replenished with rainfall and heat is continuously produced within the earth.
- Geothermal energy is harnessed by drilling wells into the underground geothermal reservoirs. The steam and heat is used to drive turbines in electric power plants.
- The water and steam from these reservoirs range in temperature from 250 to 700 degrees Fahrenheit.
- The hottest geothermal regions are found along major plate boundaries where earthquakes and volcanoes are concentrated. Most of the world's geothermal activity occurs in an area known as the Ring of Fire, which rims the Pacific Ocean bounded by Indonesia, the Philippines, Japan, the Aleutian Islands, North, Central and South America.
- Geothermal energy accounts for 0.3% of the energy in the U.S. That is enough to provide power to 3 million households.
- It costs 4.5 to 7 cents per kWh to produce electricity from the average geothermal system.
- Geothermal steam and hot water contain naturally occurring traces of hydrogen sulfide and other gases that can be harmful in high concentrations. Sometimes these gases are extracted and used to make marketable products like liquid fertilizer.
- Geothermal plants release only 1% of the carbon dioxide emitted by comparable fossil fuel plants.
- The earth has no shortage of geothermal activity, but not all geothermal resources are easy or economical to use.
- Today there are geothermal power plants in 21 countries, providing electricity to 15 million people.
- There are four types of geothermal power plants.
    - Flashed Steam Plants
        - Most geothermal power plants are flashed steam plants.
        - Hot water from production wells explosively boils, or flashes, into steam when it is released from the underground pressure of the reservoir. The force of that steam is then used to spin the turbine-generator.

- Dry Steam Plants
  - The steam from the geothermal reservoir shoots directly through a rock-catcher into the turbine-generator.
  - The rock-catcher protects the turbine from small rocks that may be carried along with the steam from the reservoir.
  - The Geysers dry steam reservoir in California has been producing electricity since 1960 and produces enough electricity to supply a city the size of San Francisco.
- Binary Power Plants
  - Binary power plants transfer heat from geothermal hot water to other liquids to produce electricity.
  - Geothermal water is passed through a heat exchanger, which transfers the heat to a working fluid (isobutane or isopentane) which boils at a lower temperature than water. The vapor is then used to spin a turbine-generator. This way electricity can be produces from lower temperature reservoirs.
- Hybrid Power Plants
  - Flash and binary systems are combined to use both the steam and the hot water from a reservoir.
  - A hybrid system provides about 25% of the electricity to the big island of Hawaii.

- Water from geothermal reservoirs is used in many places to warm greenhouses that grow flowers, vegetables, and other crops.
- Heat from geothermal water is used worldwide for dying cloth, drying fruits and vegetables, washing wool, manufacturing paper, pasteurizing milk, and drying timber products.
- In Klamath Falls, Oregon, hot water is piped under sidewalks and roads to keep them from freezing in the winter.
- Geothermal Energy for heating and cooling
  - The most widespread use of geothermal resources is to heat buildings.
  - In the capital of Iceland, 95% of the buildings use geothermal heat.
- Geothermal systems at home
  - Use the Earth's constant temperatures to heat and cool buildings. These heat pumps transfer heat from the ground to buildings in the winter and vice versa in the summer.
  - Geothermal systems cost more to install than conventional heating and cooling systems but they can reduce heating costs by 50-70%. Over the lifetime of the system, the average homeowner can anticipate saving about $20,000.
  - Today more than 300,000 homes and building in the U.S use geothermal heat exchange systems
  - The U.S. Environmental Protection Agency has rated geothermal heat pump systems among the most efficient heating and cooling technologies.

- The most important economic aspect of geothermal energy use is that it's homegrown — using geothermal energy reduces our dependence on foreign oil, creates jobs here in the U.S., and more favorably balances our global trading position.



Information gathered from:

The NEED Project Secondary Energy Infobook
http://www.eere.energy.gov
http://www.energy.gov
http://www.ucsusa.org/clean_energy/renewable_energy
http://www.darvill.clara.net/altenerg/geothermal.htm

Hydropower Fact Sheet

- Hydropower is energy that comes from the force of moving water.
- Hydropower can be found anywhere water moves from high ground to low ground. The force of moving water can be extremely powerful.
- There are 3 major ways in which we can capture hydropower for our use:
    - An impoundment facility uses a dam on a river to store water in a reservoir. Water is released from the reservoir through a turbine which activates a generator and produces electricity.
    - A diversion facility channels a section of a river through a canal which also goes through a turbine generator in order to produce electricity.
    - Micro-Hydroelectric Systems- Small turbine generators can be placed in a stream in order to generate electricity.

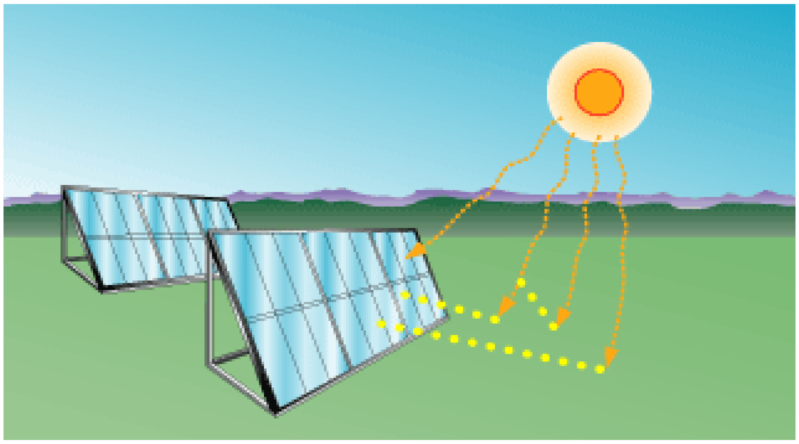
A diversion facility at Idaho Falls.

- Hydropower plants cause no air pollution because they don't burn fuel. However, damming rivers may disrupt wildlife and natural resources. Hydropower plants may also affect water quality by churning up dissolved metals that may have deposited in the water by industry long ago.
- Hydropower is the cheapest way to generate electricity today because, once a dam has been built and the equipment installed, the energy source (water) is free. This can help to reduce our dependence on foreign oil and strengthen our economy.
- The first hydroelectric plant was built at Niagara Falls in 1879.
- The top country using hydropower is Canada, generating around 325 billion kilowatt-hours per year. Other countries that use hydropower are the United States, Brazil, China, Russia, Norway, Japan, India, Sweden, and France.
- Today, hydroelectric power provides 2.7% of the energy used in the U.S.
- It costs about $0.01/KWh to produce electricity at a typical hydro plant.
- In general, hydropower is used to supply electricity to towns and cities through a power grid.
- People who have streams or waterfalls flowing on or near their property can use a micro-hydroelectric system to either power their house or sell back to the electric company

Information gathered from:
The NEED Project Secondary Energy Infobook
http://www.DOE.gov (U.S. Department of Energy)
http://hydropower.intel.gov (Idaho National Laboratory)
www.energy.state.or.us (Oregon Department of Energy)

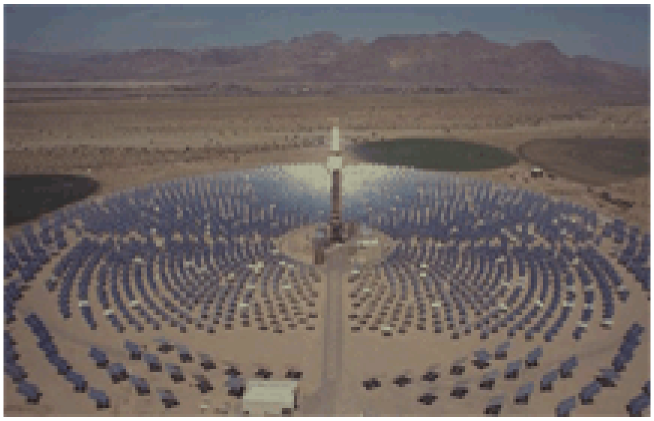
Solar Energy Fact Sheet

- Solar energy is the light and heat provided by the sun. The energy comes from the center of the sun where hydrogen atoms combine to form helium in a process called nuclear "fusion" (in nuclear "fission" atoms split instead of combining).
- Solar energy can be found in many places.
  - You can find solar energy provided as heat in the hot seat belt when you return to a parked car in a sunny parking lot.
  - A plant uses the solar energy provided as light during photosynthesis.
  - We use the solar energy provided as heat to warm our water and homes.
  - We use the solar energy provided as light by turning it into electricity.
- There are 3 major ways in which we can capture solar energy for our use:
  - Photovoltaic- A solar cell collects the light from the sun. The light may be reflected, absorbed, or may pass through the cell. Some of the energy absorbed can move electrons in the solar cell material which creates electricity. Solar cells are connected together to create solar panels.



Photovoltaic Solar Panels

  - Concentrating Solar Power Technologies- Curved reflectors are used to direct the sun's energy to a single point in a tower. The heat produced at this point is used to heat a fluid. The steam produced turns a turbine which produces electricity.



Hundreds of curved reflectors focus the sun's energy to a central tower.

- Solar Heating can be as simple as using a window facing the sun to heat your bedroom. Solar collectors can be used to heat hot water pipes.

- Solar energy is one of the cleanest forms of energy as it produces no air or water pollution. However, the manufacturing and disposing of solar cells produces some waste products.
- The Solar cell industry can help to reduce our trade deficit and create new jobs which will strengthen the U.S. economy. Solar energy can protect the economy by keeping businesses open during power outages.
- Solar energy has been in use since 212 B.C. when the Greeks used mirrors to reflect the sun's energy to light torches. The first Solar cells were invented in United States in 1883. They are now used in the U.S, Japan, France, Great Britain, parts of Africa, Antarctica, and even outer space.
- Today, solar energy in the form of electricity provides 0.1% of the energy used in the U.S.
- In general, solar energy costs about $0.30/KWh, but the world's largest solar dish is capable of producing energy at $0.05/KWh.
- Today, solar energy is used to provide heating and electricity for homes and businesses. In the last decade, solar energy has also been used to power earth-orbiting satellites, cars, and even planes.

The Helios prototype flying wing is shown near the Hawaiian Islands during its first test flight on solar power. (Credit: NASA, Dryden Flight Research Center Photo Collection)

Information gathered from:

The NEED Project Secondary Energy Infobook

http://www.DOE.gov (U.S. Department of Energy)

http://pubs.acs.org/subscribe/journals/esthag-w/2003/dec/tech/kb_energy.html

(Energy Science and Technology online news)

☺ The foolish gardener planted a light bulb and thought he would get a power plant. ☺

Wind Power Fact Sheet:

a. Wind power is a source of solar energy

b. It is caused by the uneven heating, terrain, and bodies of water of the earth.

c. Wind power is used for grinding grain, pumping water, or generating electricity.

d. Historically windmills were used for propelling boats across the Nile, pumping water, and producing food.

e. Wind Power is a renewable source because the source (wind) can never be fully used up. *See Figure 2*

f. Wind starts in the kinetic form and is converted to the mechanical energy form (grinding grain, pumping water, etc…), or to the electromagnetic form (electricity).

g. Countries such as Denmark and Northern Germany generates up to 20% of their electricity through wind power.

h. India and many European countries are planning for major wind facilities.

i. There are 3 sizes/types of wind turbines: small (residential), medium (average size homes), and large (commercial).

j. Wind energy does not have any output pollutants which makes it a very favorable means of electricity.

k. Some concerns of wind turbines are their blades because they can kill some birds as they turn.

l. They are also seen as a visual and auditory nuisance.

m. Wind Turbines are the mechanism used to harness the wind energy.

n. Wind power plants or Wind Farms are a collection of many wind turbines to generator energy.

o. These winds farms are usually not public utility companies; rather they are private corporations that sell the electricity produced.

p. Wind farms require a lot of land; each turbine needs approximately 2 acres.

q. The good part about wind farms is that crops can be grown around the mechanisms as soon as the installation is complete.

r. There are 2 types of wind turbines: the traditional horizontal-axis turbine with the blades and the vertical-axis turbine called the Darrieus Design. *See Figure 5*

s. The most common type used today is the horizontal-axis turbine because it is more stable at greater heights where the wind is more turbulent. *See Figure 4*

t. Wind turbines are made up of a rotor, which includes the blades and the hubs they are attached to, a nacelle, which is the frame for the gearbox and generator, and a tower; this is usually a large steel tubular structure. *See figure 1*.

u. The blades of the wind turbines are very often made of fiberglass or other high-strength materials.

v. The gears inside the turbine are important because they allow the turbine to turn slowly while the electric motor turns extremely quickly.

Commercial-scale Turbine:

- 3 blades
- Tubular tower

- Hub height 164-262 ft
- Diameter 154-262 ft
- Power ratings in U.S. 660 KW-1.8 MW

Residential-scale Turbine (30kW and below)

- 3 blades
- Hub Height 18-37 m
- Diameter 1-13
- ~21,000 kW/year

w. The best places for wind production in the U.S. include California, Alaska, Hawaii, the Great Plains, and mountainous regions.

x. It is thought that there is enough wind in 37 states to produce electricity.

y. Average wind speed of 14 mph must be kept for wind energy to be converted to electricity economically.

z. The average wind speed in the U.S. is 20 mph.

aa. Anemometers are used to measure how fast the wind is blowing at a particular site.

bb. Wind energy converts 30-40% of the wind's kinetic energy into electricity.

cc. The cost of electricity by wind power is ~5 cents per kWh.

dd. For a Grid Internie System in which the wind turbines energy can make up for the grid electricity, the general cost of a turbine is ~$40,000.

ee. The turbines themselves cost ~$25000. This is for a home system and not for a commercial sized wind turbine.

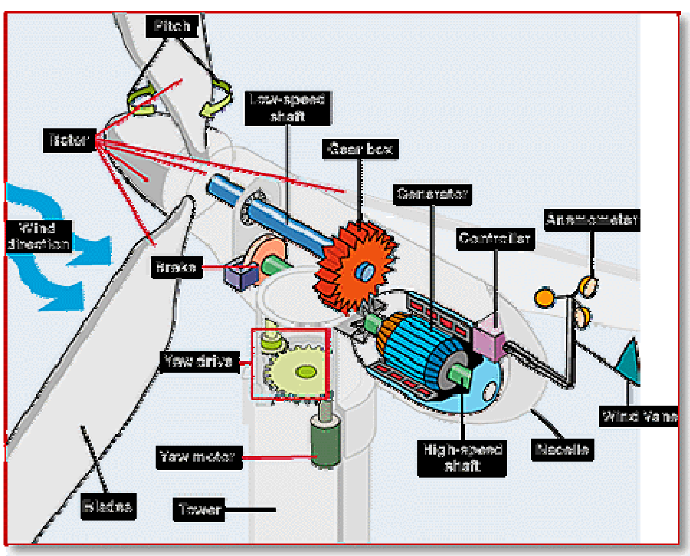


Fig. 1 The components of a common horizontal-axis turbine

Fig.2 Traditional Windmill

Fig. 3 Horizontal-axis turbines

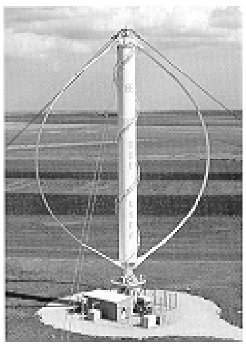


Fig. 4 Vertical-axis turbine (Darrieus design)

Information compiled from:

1. The NEED Project Secondary Energy Infobook
2. Energy Efficiency and Renewable Energy http://www.eere.energy.gov/consumerinfo/
3. Department of Energy http://www.doe.gov
4. National Renewable Energy Laboratory
5. http://www.nrel.gov/
6. EERE, "How Turbines Work," http://www.eere.energy.gov/windandhydro/wind_how.html, August 2005.
7. Eggleston, Eric. "What are Vertical-Axis Wind Turbines?", http://www.awea.org/faq/vawt.html, August 2005
8. "Wind Energy Systems" http://www.energy.iastate.edu/renewable/wind/wem/wem-07_systems.html, August 2005.
9. EERE,"Sizing Your Wind System", http://www.eere.energy.gov/consumerinfo/makeelectricity/eval_wintrb_size.html, August 2005.
10. Renewable Energy Research Laboratory, http://www.ceere.org/rerl/, August 2005.

☺ **Wind Power is very popular because it has a lot of fans.** ☺

Uranium Fact Sheet

- Uranium-238 has 238 protons and 238 neutrons in each atom. This type of uranium splits easily. When the atom splits, nuclear "fission" occurs and energy is produced (In nuclear "fusion", atoms combine instead of splitting).
- Uranium can be found in rocks all over the world. Rocks that contain a lot of uranium are called uranium ore.
- There is a process in which we can create nuclear energy from uranium:
  - <u>Mining</u>- Workers mine uranium ore much like coal miners mine coal, in deep underground mines or in open pits.
  - <u>Milling</u>- The uranium ore is crushed and mixed with an acid. The uranium dissolves and forms a yellow powder called a "yellow cake".
  - <u>Conversion</u>- The yellowcake is converted into the gas, uranium hexafluoride (UF6).
  - <u>Enrichment</u>- The UF6 gas contains a mix of different types of uranium. Some of the unwanted uranium is filtered out while the uranium-238 atoms are kept. After this is done, we have "enriched uranium".
  - <u>Fuel Fabrication</u>- The enriched uranium is made into "fuel pellets". A fuel pellet is about the size of your fingertip but can produce as much energy as 120 gallons of oil. The fuel pellets are sealed in 12-foot metal tubes called "fuel rods".
  - <u>Nuclear Reactor</u>- The fuel rods are hit with neutrons, causing a nuclear reaction. The nuclear reaction produces heat which boils water. The steam from the boiling water is used to turn a turbine which produces electricity.
- Nuclear power plants produce radioactive waste. The amount of waste produced is much less than fossil fuel waste, but it is far more dangerous. If the power plant isn't safe and the radioactive waste leaks, serious illness and death can occur. However, if the power plant is safe, there is very little impact on the environment. There is no air pollution, and the waste is recycled.
- The cost of uranium is cheap, but the power plants are expensive to build. Uranium is still an abundant natural resource and could provide us energy for many years – estimates range from 50 years to 500 years at current consumption rates. If we convert the uranium into plutonium (an even better fuel), we could have enough energy for millions of years.
- There are plenty of uranium mines in the United States. This can help to reduce our trade deficit and create new jobs which will strengthen the U.S. economy.
- Nuclear power plants can be found in the United States, France, Japan, and Germany. France generates 75% of its electricity with nuclear power.
- Today, energy produced from uranium provides 8.3% of the energy used in the U.S.
- Nuclear energy costs about $0.02/KWh.
- Today, there are 65 nuclear power plants in the United States. No new power plants are planned in the U.S because of safety concerns and building costs.

World's First Large-Scale Nuclear Power Plant in Shippingport, Pennsylvania

Information gathered from:

The NEED Project Secondary Energy Infobook

http://www.DOE.gov (U.S. Department of Energy)

Q: What do nuclear physicists do on their spare time?

A: They go fission.

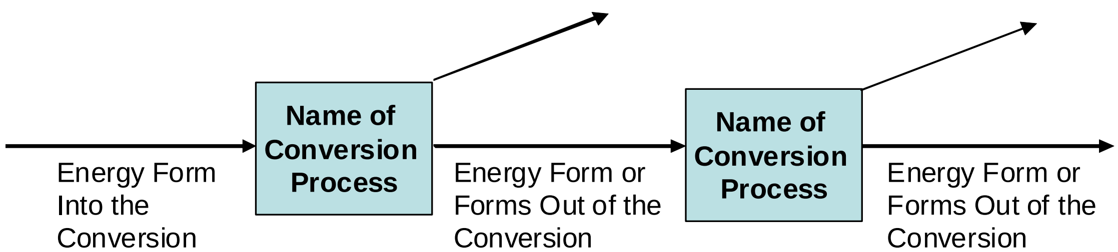
Activity: Energy System Diagrams

Purpose

In order to use an energy system, you need to know how your system works. In this activity, you will use system diagrams to discover how your assigned energy source is used to produce electrical energy. You should then be able to identify and name the components of the energy system. Using this knowledge, you will draw a flowchart to show the path of energy conversions through the system.

Procedure

1. Break into your energy system groups.
2. Each student will be given a card with either the name of a system component, or a description.
3. Someone else in the room has the description for the word you are given and vice versa. Now you must find that person.
4. Once you have found your partner go to your system diagram poster and place your word and description in the spot pointing to that component.
5. **Draw a flowchart, using the following template as a guide:**



Discussion Questions

1. Is all the energy available from your source used? If not, what components contribute most to this loss?

2. **We will discuss this question as a class.** After looking at all the system diagrams, which components are common to most of the systems? Why?

Resources for Energy System Diagram Activity

Labels for Anaerobic digestion poster – cut apart and distribute to students
See energy_system_diagram_posters.pdf for pictures

Manure
The input to the system, this is produced as waste once animals have consumed plant products.

Anaerobic Digester
A chamber containing chemicals that can break down plant and animal waste into various gasses such as methane.

Methane
The useful output from the anaerobic digestion process, this is a flammable gas.

Burner
This burns methane to create heat, which can be used directly or to make steam that can turn a steam turbine and generator to get electricity.

Carbon Dioxide
This gas that plants use as an input is a byproduct of the burning of methane.

Labels for Biomass burning poster – cut apart and distribute to students

Biomass
Wood residue, grasses, corn stalks, etc. that can be burned. This is the input to the system.

Stack
A tower that emits exhaust from the combustion process.

Boiler
This device heats water to produce steam.

Steam
Produced when water is boiled. It is the vapor phase of water.

Turbine
Spinning blades in this device are turned by steam and spins the generator.

Generator
This part is turned by the turbine, generating electromagnetic energy.

Electricity
This is the final output of the system. It can also be described as electrons in motion.

Labels for coal power plant poster – cut apart and distribute to students

Coal
Carbon based substance formed over time from fossilized plants. This is the input to the system.

Stack
A tower that emits exhaust from the combustion process.

Boiler
This device heats water to produce steam.

Steam
Produced when water is boiled. It is the vapor phase of water.

Turbine
Spinning blades in this device are turned by steam and spins the generator

Generator
This part is turned by the turbine, generating electromagnetic energy.

Electricity
This is the final output of the system. It can also be described as electrons in motion.

Labels for Geothermal system poster – cut apart and distribute to students

Geothermal Energy
Energy due to the internal heat of the earth. This can include hot rocks, magma, or hot springs.

Heat Pump
This transfers the heat from the earth to heat water and produce steam.

Steam
Produced when water is boiled. It is the vapor phase of water.

Turbine
Spinning blades in this device are turned by steam and spins the generator

Cooling System
A set of parts designed to reduce the heat in the geothermal system

Generator
This part is turned by the turbine, generating electromagnetic energy.

Electricity
This is the final output of the system. It can also be described as electrons in motion.

Labels for Hydro system poster – cut apart and distribute to students

Reservoir
This is where the input of the energy system (water) is stored.

Dam
This makes sure water in a river or lake is held in a reservoir.

Control Gate
This controls the amount of water (flow rate) that reaches the turbine.

Penstock (Pipeline)
This allows water to flow through a dam and past a turbine.

Turbine
This has blades on it that spin a rotor when water passes over them.

Generator
Connected to the rotor, part of it spins to create electricity.

Electricity
This is the final output of the system. It can also be described as electrons in motion.

Labels for Nuclear energy system poster – cut apart and distribute to students

Reactor
This is where the fission nuclear reaction of Uranium being split occurs.

Control Rods
These pieces of metal are inserted into the reactor to control how fast the nuclear reaction takes place.

Steam Generator
It is here that heat from the nuclear reaction boils water.

Turbine
This has blades on it that spin a rotor when steam passes over them.

Generator
Connected to the rotor, part of it spins to create electricity.

Electricity
This is the final output of the system. It can also be described as electrons in motion.

Labels for solar energy system poster – cut apart and distribute to students

Sun
The star that provides light energy as a source for the solar energy conversion system, this is the input to the system.

Photons
Electromagnetic particles that strike the solar panel surface exciting the silicon atoms in the panel.

Electrons
Atomic particles with a negative charge that are released from the solar panel.

Silicon Solar Cell
Primarily made from silicon, this converts the sun's energy into useable electromagnetic energy.

Electricity
This is the final output of the system. It can also be described as electrons in motion.

Labels for wind energy system poster – cut apart and distribute to students

Wind
This flows over the blades causing a lifting force. It is caused by the sun's uneven heating of the earth. It is the input to the system.

Blades
Usually there are 2 or 3 that rotate and turn a shaft. They are designed to "cut" through the air.

Rotor
Includes the blades and a central hub. It rotates and turns a shaft.

Gear-Box
This part increases the rotational speed of the turbine. It includes at least two parts that work together as a "package".

Generator
Consisting of a magnetic field that rotates with the shaft and rotor, it makes electricity.

Electricity
This is the final output of the system. It can also be described as electrons in motion.

Name: ___________________________

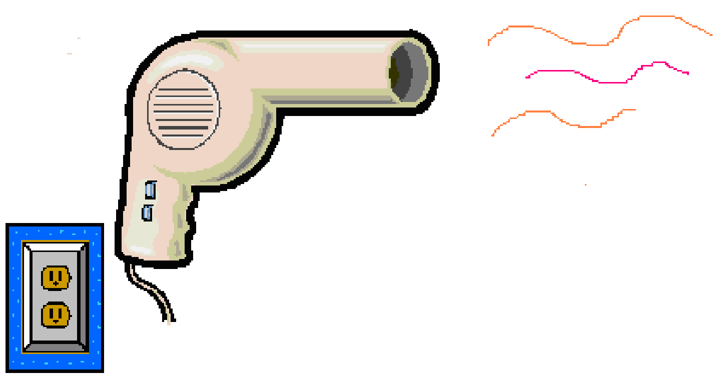
Energy Sources, Systems, and Conversions Quiz

You have 25 minutes to finish this quiz. Please make sure to fill in all blanks.

1. What does “SCREAM Today” stand for?

2. Why is wind a *renewable* source?

Answer the next question using the picture below



3. The energy is converted from the ___________ form to the ____________ form.

4. Energy can be produced and lost. True or False? (please circle the correct answer) and explain

5. What is kinetic energy?

6. Draw the energy forms and conversion block diagram for a light bulb.

7. ___________ is a biomass material that can be used to produce electricity.

8. What is one interesting fact that you learned while doing the energy source research.

Name: ________________________

Energy Sources, Systems, and Conversions Quiz

You have 25 minutes to finish this quiz. Please make sure to fill in all blanks.

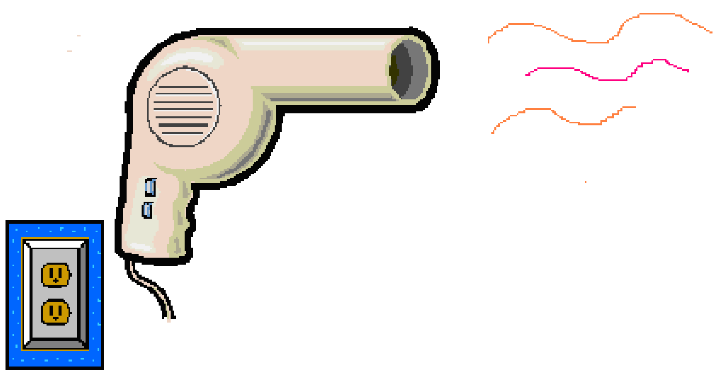
1. What does "SCREAM Today" stand for?

Primary Energy Forms – sound, chemical, radiant, electric, atomic, mechanical

2. Why is wind a *renewable* source?

The supply of wind can never be depleted-- we will never run out of wind.

Answer the next question using the picture below



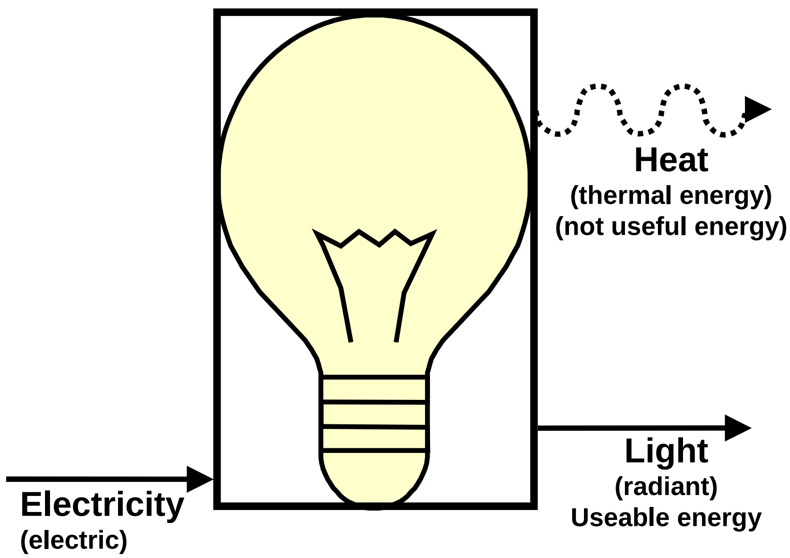
3. The energy is converted from the ***Electric*** form to the ***heat (thermal) and mechanical*** form.

4. Energy can be produced and lost? True or ***False*** (please circle the correct answer) and explain. ***The laws of thermodynamics say that energy is conserved. It cannot be created or destroyed, just converted from one form to another.***

5. What is kinetic energy?

Energy of motion (or in moving things)

6. Draw the energy forms and conversion block diagram for a light bulb.



7. ***Manure*** is a biomass material that can be used to produce electricity.

8. What is one interesting fact that you learned while doing the energy source research.