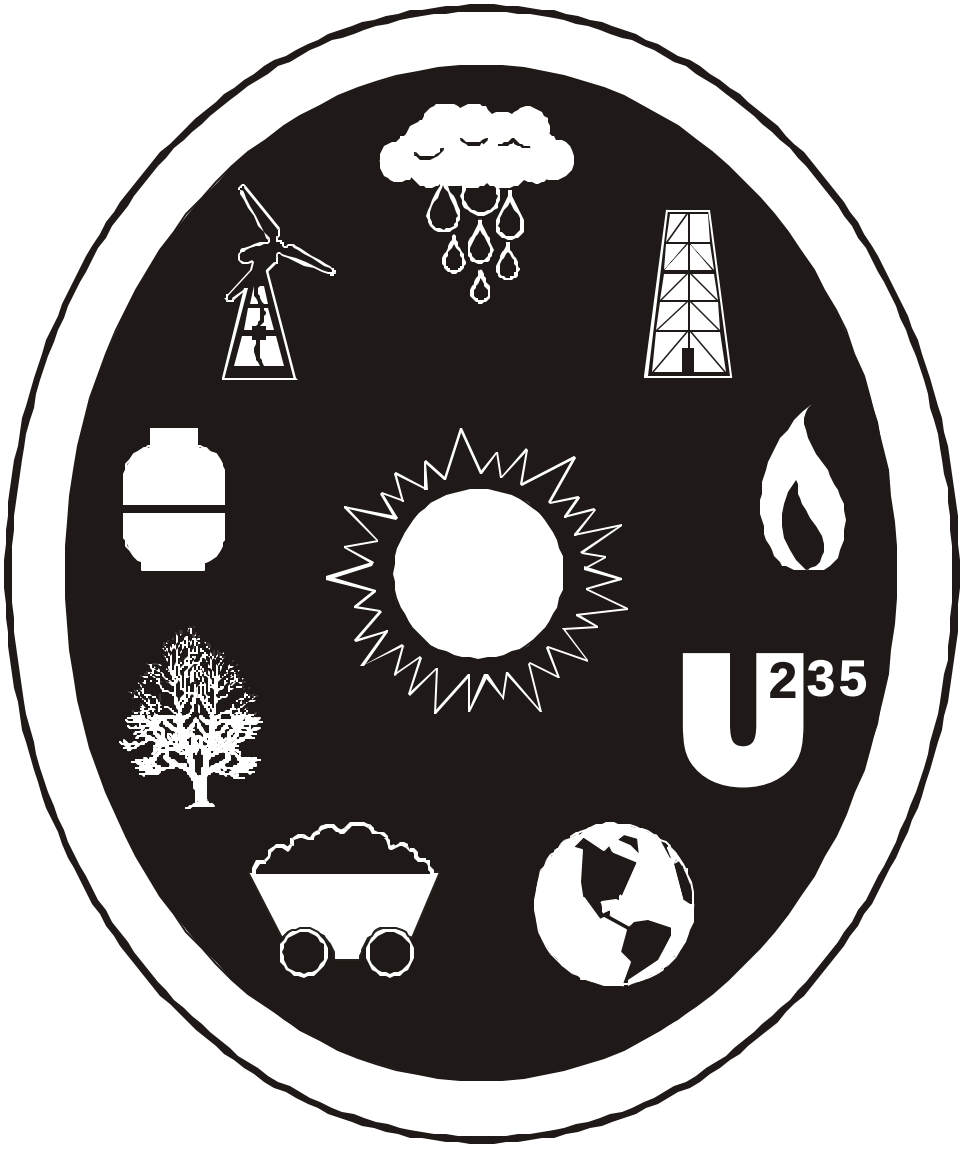
INTERMEDIATE ENERGY ACTIVITIES



TEACHER GUIDE

INTERMEDIATE ENERGY ACTIVITIES

GENERAL ENERGY

ENERGY SOURCES

A QUICK LOOK

A companion to the Intermediate Energy Infobooks––activities to reinforce general energy information and facts about the energy sources.

GRADES 5-8

- **Correlations to National Science Standards**
- **Teacher Guide**
- **Answer Sheets**

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2001–2002

Curriculum Review Committee

(bolded names comprise the Teacher Advisory Board)

INTERMEDIATE ENERGY ACTIVITIES

Teacher Guide

TABLE OF CONTENTS

National Science Standards (Grades 5-8)

INT–B: 3.a	Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical.
INT–B: 3.b	Energy is transferred in many ways.
INT–B: 3.c	Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.
INT–B: 3.d	Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection).
INT–B: 3.e	Electrical circuits provide a means of transferring electrical energy.
INT–B: 3.f	In most chemical and nuclear reactions, energy is transferred into or out of a system. Heat, light, mechanical motion, or electricity might all be involved in such transfers.
INT–B: 3.g	The sun is the major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths.
INT–C: 4.a	For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. The energy then passes from organism to organism in food webs.
INT–D: 1.a	The solid earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core.
INT–D: 1.b	Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the water cycle.
INT–D: 3.a	Gravity governs the motion in the solar system. Gravity explains the phenomenon of the tides.
INT–D: 3.b	The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle.
INT–E: 2.c	Technological solutions are temporary and have side effects. Technologies cost, carry risks, and have benefits.
INT–E: 2.d	Many different people in different cultures have made and continue to make contributions to science and technology.
INT–E: 2.e	Science and technology are reciprocal. Science helps drive technology, as it asks questions that demand more sophisticated instruments and provides principles for better instrumentation and technique. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to quantity, distance, location, size, and/or speed.
INT–E: 2.f	Perfectly designed solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance. Risk is part of living in a highly technological world. Reducing risk often results in new technology.
INT–E: 2.g	Technological designs have constraints. Some constraints are unavoidable, such as properties of materials, or effects of weather and friction. Other constraints limit choices in design, such as environmental protection, human safety, and aesthetics.
INT–F: 1.a	Food provides energy and nutrients for growth and development.
INT–F: 1.b	Natural environments may contain substances that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.
INT–F: 2.b	Causes of environmental degradation and resource depletion vary from region to region and from country to country.
INT–F: 3.a	Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats, damage property, and harm or kill humans.
INT–F: 3.b	Human activities can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal.

National Science Standards (Grades 5-8)

INT–F: 3.c Hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.

INT–F: 4.b Students should understand the risks associated with natural hazards, chemical hazards, biological hazards, social hazards, and personal hazards.

INT–F: 4.c Students can use a systematic approach to thinking critically about risks and benefits.

INT–F: 4.d Important personal and social decisions are made based on perceptions of benefits and risks.

INT–F: 5.a Science influences society through its knowledge and world view. The effect of science on society is neither entirely beneficial nor entirely detrimental.

INT–F: 5.b Societal challenges often inspire questions for scientific research, and societal priorities often influence research priorities.

INT–F: 5.c Technology influences society through its products and processes. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.

INT–F: 5.d Science and technology have contributed enormously to economic growth and productivity among societies and groups within societies.

INT–F: 5.e Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should appreciate what science and technology can reasonably contribute to society and what they cannot do. For example, new technologies often will decrease some risks and increase others.

INT–G: 2.c It is normal for scientists to differ with one another about the interpretation of new evidence. It is part of scientific inquiry to evaluate the results and explanations of other scientists. As scientific knowledge evolves, major disagreements are eventually resolved through such interactions between scientists.

Teacher Guide

BACKGROUND

Intermediate Energy Activities is a series of student worksheets designed to reinforce the vocabulary, concepts and information in the **Intermediate Energy Infobooks**.

TIME

Approximately 30 minutes for the students to read the selected infosheet and complete the worksheets.

SKILLS

- Nonfiction Reading
- Critical Thinking
- Vocabulary
- Graphing

PROCEDURE

Step One—Preparation

- Obtain class sets of **Intermediate Energy Infobooks** and **Intermediate Energy Activities**, or make copies as necessary. **Energy in the Balance** contains charting and graphing activities to further reinforce the information in the infobooks. Many other NEED activities also reinforce and synthesize the information in the infobooks, such as **Energy Jeopardy, Great Energy Debate Game, Transparent Energy, Energy on Stage, Great Energy Rock Performances, Energy Expo**, and the **Energy Carnival**.
- Decide which infosheets and worksheets you will use with your class.

Step Two—Procedure

- Distribute one **Intermediate Energy Infobook** and **Intermediate Energy Activities** workbook to each student.
- Have the students read the selected infosheet. Discuss the concepts and new vocabulary in the infosheet.
- Have the students complete the selected worksheets.
- Once students have read all of the energy source infosheets and completed the worksheets for each source, have the students complete the worksheets on pages 19-21 of the workbook. These worksheets reinforce and synthesize the information in the source infosheets. Pages 22-23 are companion worksheets to the Electricity infosheet.
- Use the Evaluation Form on page 23 of the **Teacher Guide** to evaluate the activities.

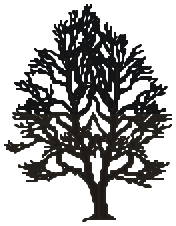
FORMS OF ENERGY

Fill in the blanks with the words at the bottom of the page. You can use words more than once.

1. Stored energy and the energy of position are ___potential___ energy.
2. Compressed springs and stretched rubber bands are stored ___mechanical___ energy.
3. The vibration and movement of the atoms and molecules within substances is called heat or ___thermal___ energy.
4. The energy stored in the center of atoms is called ___nuclear___ energy.
5. The scientific rule that states that energy cannot be created or destroyed is called the Law of ___Conservation of Energy___.
6. The movement of energy through substances in longitudinal waves is ___sound___.
7. The energy of position - such as a rock on a hill - is ___gravitational___ energy.
8. The movement of objects and substances from place to place is ___motion___.
9. Electromagnetic energy traveling in transverse waves is ___radiant___ energy.
10. Energy stored in the bonds of atoms and molecules is ___chemical___ energy.
11. The movement of atoms, molecules, waves, and electrons is ___kinetic___ energy.
12. The movement of electrons is ___electrical___ energy.
13. The amount of useful energy you get from a system is its ___energy efficiency___.
14. The energy in petroleum and coal is stored as ___chemical___ energy.
15. X-rays are an example of ___radiant___ energy.
16. Fission and fusion are examples of ___nuclear___ energy.
17. A hydropower reservoir is an example of ___gravitational___ energy.
18. Wind is an example of the energy of ___motion___.

radiant	gravitational	chemical	thermal	nuclear	electrical	mechanical
kinetic	potential	sound	motion	conservation of energy	energy efficiency	

BIOMASS



Description of biomass:

Any organic material that can be used for its energy content - wood, garbage, yard waste, crop waste, animal waste, even human waste

Renewable or nonrenewable:

Renewable

Ways we turn biomass into energy we can use:

Burning to produce heat, fermentation into alcohol fuel (ethanol), bacterial decay into methane, conversion to gas or liquid fuels by addition of heat or chemicals

Who uses biomass and for what purposes:

Industry burns waste wood to make products, homes burn wood for heat, waste-to-energy plants burn organic waste products to produce electricity, gasohol is used as a fuel

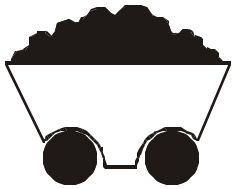
Effect of using biomass on the environment:

Burning biomass can produce air pollution and does produce carbon dioxide, a greenhouse gas. It can also produce odors. Burning biomass is cleaner than burning fossil fuels.

Important facts about biomass:

Biomass gets its energy from the sun through the process of photosynthesis.
Using biomass reduces the amount of organic material placed in landfills.
Fast-growing crops can be grown for their energy content.
Using biomass does not contribute to the greenhouse effect, since the amount of carbon dioxide produced equals the amount taken in during growth.

COAL



Description of coal:

Coal is a black, solid hydrocarbon (fossil fuel) formed from the remains of ancient plants in swamps millions of years ago.

Renewable or nonrenewable:

Nonrenewable

Where coal is located and how we recover it:

Coal is located underground in many areas of the country. Shallow coal seams are surfaced mined. Coal buried deep is reached through underground mine shafts.

Ways we turn coal into energy we can use:

Most coal is burned to produce heat.

Who uses coal and for what purposes:

Power plants burn most of the coal to produce electricity. Industries also burn coal to make products, especially steel and iron.

Effect of using coal on the environment:

Burning coal can pollute the air and cause acid rain. Burning coal also produces carbon dioxide, a greenhouse gas.

Important facts about coal:

Coal produces more than half of the electricity in the U.S.
The U.S. has the largest reserves of coal in the world.
Coal is found in Appalachian states and some western states.
Wyoming, West Virginia, Kentucky, Pennsylvania, and Texas are the top coal-producing states.
Coal is transported mainly by train and barge. Transporting coal is a huge expense.

GEOTHERMAL

Description of geothermal energy:

Geothermal energy is heat produced in the earth's core by the slow decay of naturally-occurring radioactive particles.

Renewable or nonrenewable:

Renewable

Where geothermal resources are located and how we recover them:

Low temperature resources are almost everywhere a few feet underground. High temperature resources are found mostly at the edges of tectonic plates, especially around the Ring of Fire in the Pacific.

Ways we turn geothermal resources into energy we can use:

We can drill wells to reach high temperature resources or lay pipes filled with fluid underground. Some geothermal resources come out of the ground naturally and we can pipe it to where it's needed.

Who uses geothermal energy and for what purposes:

Power plants use geothermal steam to produce electricity. Homes and businesses use the hot water and steam for heat.

Effect of using geothermal energy on the environment:

Very little environmental effect.

Important facts about geothermal energy:

The earth is made of layers, including an inner core of iron, an outer core of magma (melted rock), a mantle of magma and rock, and a crust. The crust is not a solid piece, but giants plates of land that move. Along the edges of the plates, geothermal resources tend to come to the surface.

HYDROPOWER

Description of hydropower:

Hydropower is the force of moving water caused by gravity.

Renewable or nonrenewable:

Renewable

Description of the water cycle:

The sun shines onto the earth, evaporating the water in oceans, rivers, and lakes. The water vapor rises into the atmosphere and forms clouds. The water vapor condenses and falls to the earth as precipitation.

Ways we turn hydropower into energy we can use:

We can harness the energy in flowing water by damming rivers and using waterfalls.

Who uses hydropower and for what purposes:

Electric utilities use hydropower dams to turn the energy in flowing water into electricity.

Effect of using hydropower on the environment:

Dams can flood land and disrupt animal and fish habitats. Hydropower doesn't pollute the air but it can churn up sediments in the water.

Important facts about hydropower:

Hydropower dams are the cheapest and cleanest way to produce electricity.
There are few places in the U.S. where new dams can be built.
Some existing dams could have turbines installed to produce electricity.

NATURAL GAS

Description of natural gas:
Natural gas is a colorless, odorless gas formed millions of years ago from tiny plants and animals. It is a fossil fuel.

Renewable or nonrenewable:
Nonrenewable, though some sources of methane are renewable - such as landfill gas

Where natural gas is located and how we recover it:
Natural gas is located in underground rock formations in sedimentary basins. We drill wells to reach it and pipe it from the ground.

Ways we turn natural gas into energy we can use:
Usually we burn natural gas to produce heat.

Who uses natural gas and for what purposes:
Industry burns natural gas to manufacture products. Homes and businesses burn natural gas to heat buildings and water and for cooking. Power plants burn natural gas to produce electricity.

Effect of using natural gas on the environment:
Natural gas is a clean-burning fossil fuel, but it produces some air pollution and carbon dioxide, a greenhouse gas.

Important facts about natural gas:
Mercaptan, an odorant that smells like rotten eggs, is added to natural gas so leaks can be detected.
Natural gas is shipped by millions of miles of underground pipelines.
Natural gas can be used as a transportation fuel if it is put under pressure and engines modified.

PETROLEUM

Description of petroleum:
Petroleum is a liquid hydrocarbon, a fossil fuel formed millions of years ago from the remains of tiny sea plants and animals. It can be thin and clear likewater or thick and black like tar.

Renewable or nonrenewable:
Nonrenewable

Where petroleum is located and how we recover it:
Petroleum is located underground in rocks in sedimentary basins. Much is under water. We drill wells to find it, then must pump it from the ground.

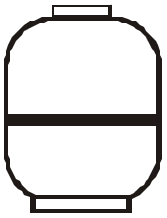
Ways we turn petroleum into energy we can use:
Petroleum is refined into many different fuels which are burned to produce heat. When gasoline is burned in vehicles, it causes small explosions that push pistons to produce motion.

Who uses petroleum and for what purposes:
Most petroleum products are used by the transportation sector to move people and goods. Industry burns petroleum to manufacture products and also uses petroleum as a feedstock to produce many products.

Effect of using petroleum on the environment:
Burning petroleum can cause air pollution and carbon dioxide, a greenhouse gas. Drilling for and transporting petroleum can cause damage to the land and water if there are leaks.

Important facts about petroleum:
We use more petroleum than any other energy source.
The U.S. does not produce enough petroleum to meet our needs. We import about two-thirds of the petroleum we use from foreign countries. The Middle East has huge reserves of petroleum.
Petroleum is moved over land mostly by pipeline, and over water by tanker.

PROPANE



Description of propane:

Propane is a colorless, odorless fossil fuel found with petroleum and natural gas. It was formed millions of years ago from the remains of tiny plants and animals.

Renewable or nonrenewable:

Nonrenewable

Where propane is located and how we recover it:

Propane is found with petroleum and natural gas deposits and is separated from both fuels during refining and processing.

Ways we turn propane into energy we can use:

We put propane in tanks under pressure to turn it into a liquid so that it is more easily moved from place to place, then we burn it to produce heat.

Who uses propane and for what purposes:

Industry uses propane to make products; farmers use propane for heat in rural areas; homes use propane for outdoor grills; businesses use propane to fuel indoor machinery and as a fleet fuel.

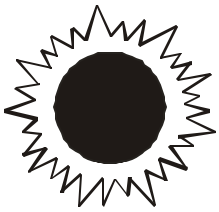
Effect of using propane on the environment:

Propane is a clean-burning fossil fuel, but burning it does produce some air pollutants and carbon dioxide, a greenhouse gas.

Important facts about propane:

Propane is an LPG - liquefied petroleum gas.
Propane is easily turned into a liquid under pressure. It takes up 270 times less space as a liquid.
Propane is stored in underground caverns and moved by pipelines and trucks.
Propane is called the portable fuel because it is easily transported as a liquid.

SOLAR



Description of solar energy:

Solar energy is radiant energy from the sun that travels to Earth in electromagnetic waves or rays.

Renewable or nonrenewable:

Renewable

How solar energy is produced and how we recover it:

Solar energy is produced in the sun's core when atoms of hydrogen combine under pressure to produce helium, in a process called fusion. During fusion, radiant energy is emitted.

Ways we turn solar energy into energy we can use:

We can capture solar energy with solar collectors than turn the radiant energy into heat or with photo-voltaic cells that turn radiant energy into electricity. We also use the visible light of solar energy to see.

Who uses solar energy and for what purposes:

We all use the visible light from the sun to see during the day. Many homes and buildings use solar collectors to heat interior spaces and water, and PV cells to produce electricity.

Effect of using solar energy on the environment:

Solar energy is very clean energy, producing no air or water pollution.

Important facts about solar energy:

Solar energy is not available all the time and is spread out so that it is difficult to harness. Today, it is expensive to use solar energy to produce electricity, but new technologies will make solar energy a major energy source in the future.

URANIUM

Description of uranium:

Uranium is a common metallic element found in rocks all over the world.

Renewable or nonrenewable:

Nonrenewable

Where uranium is located and how we recover it:

Uranium is located underground in rock formations. Mines are dug to recover it. The U.S. has plenty of uranium, but imports most used in nuclear power plants because it is cheaper to do so.

Ways we turn uranium into energy we can use:

Uranium is processed and turned into uranium fuel pellets for nuclear power plants. Uranium atoms are split in the process of fission to produce heat.

Who uses uranium and for what purposes:

Nuclear power plants use uranium to produce electricity.

Effect of using uranium (nuclear energy) on the environment:

Uranium fission produces radioactive waste that is dangerous for thousands of years and must be stored carefully. Leaks of radioactive materials pose a danger.

Important facts about uranium (nuclear energy):

Nuclear power plants produce little pollution except for radioactive waste which must be stored in special repositories. There is no permanent repository in the United States at this time and most waste is stored on site at nuclear plants. A permanent repository is planned at Yucca Mountain, Nevada, but many people are fighting it.

WIND

Description of wind energy:

Wind is the circulation of air caused by the uneven heating of the earth's surface.

Renewable or nonrenewable:

Renewable

How wind energy is produced and how we recover it:

Wind is produced when the sun shines on the earth, heating the land more than the water. The warmer air over land rises and cooler air moves in to take its place, producing convection currents.

Ways we turn wind into energy we can use:

We use wind machines that slow the motion of the wind, turning turbines to produce electricity.

Who uses wind energy and for what purposes:

Usually, independent power producers (not big utilities) build wind farms to produce electricity.

Effect of using wind energy on the environment:

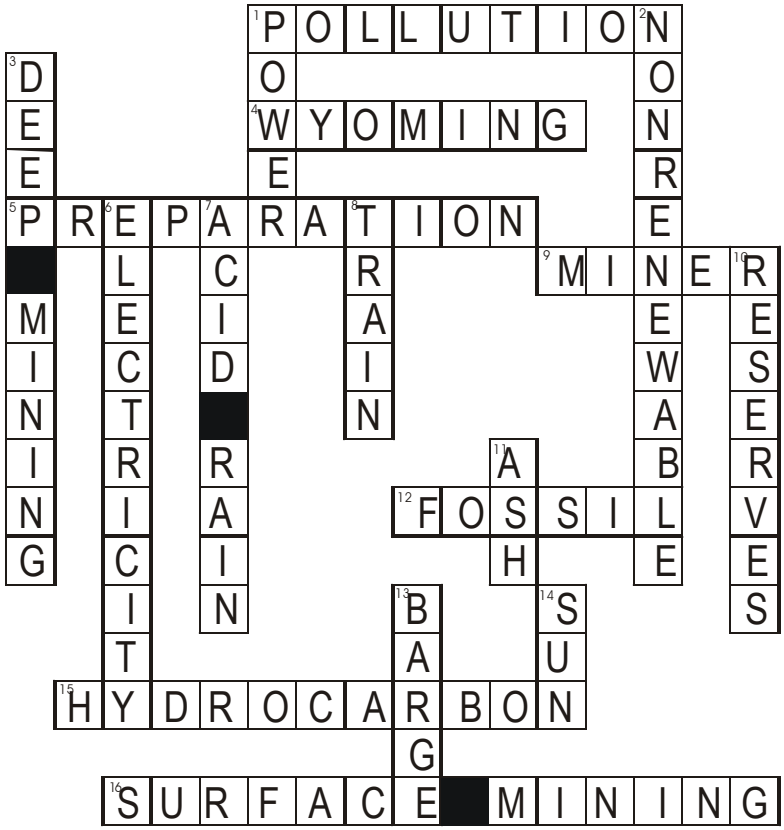
Wind machines are very clean, producing no air or water pollution. They take up a lot of land and can be very noisy.

Important facts about wind energy:

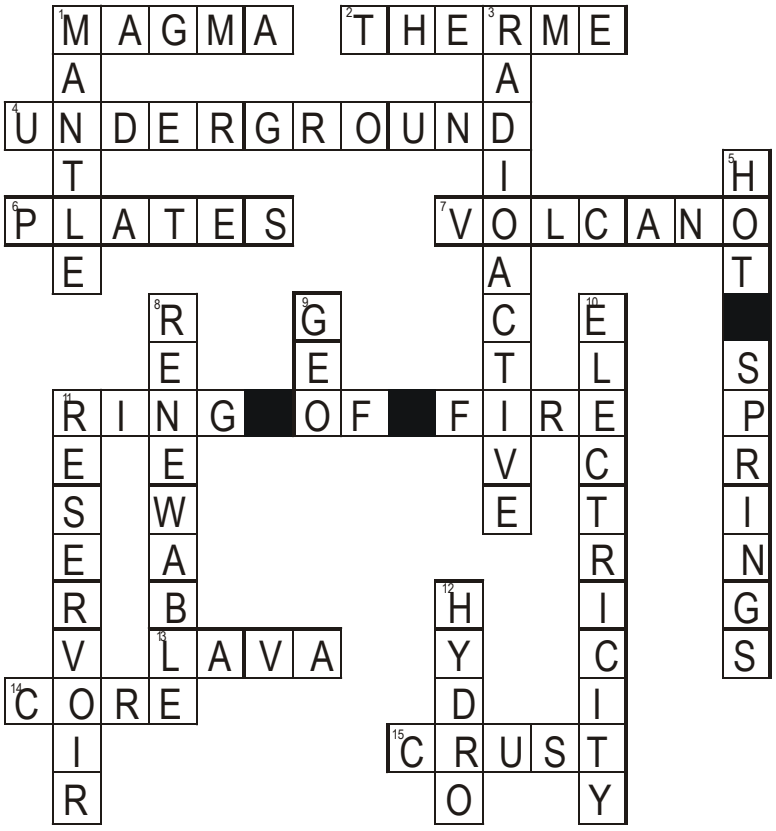
Wind machines do not produce a lot of electricity, and do not produce it all the time.
Wind machines cannot be used in many areas. There must be stable, continuous wind resources.

BIOMASS

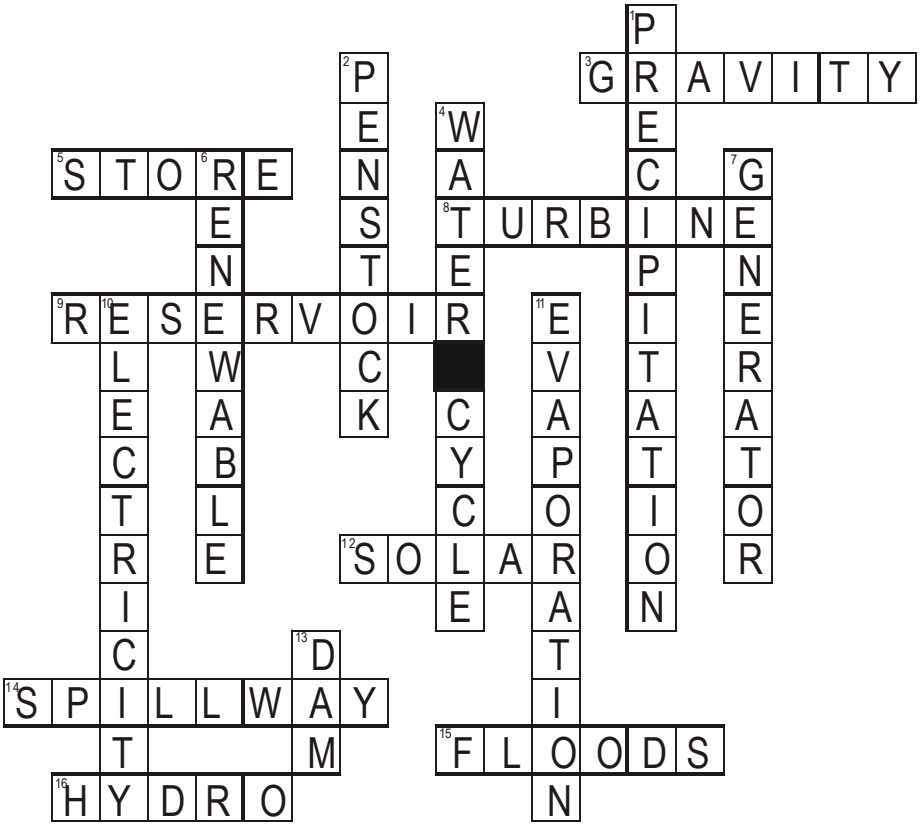
COAL



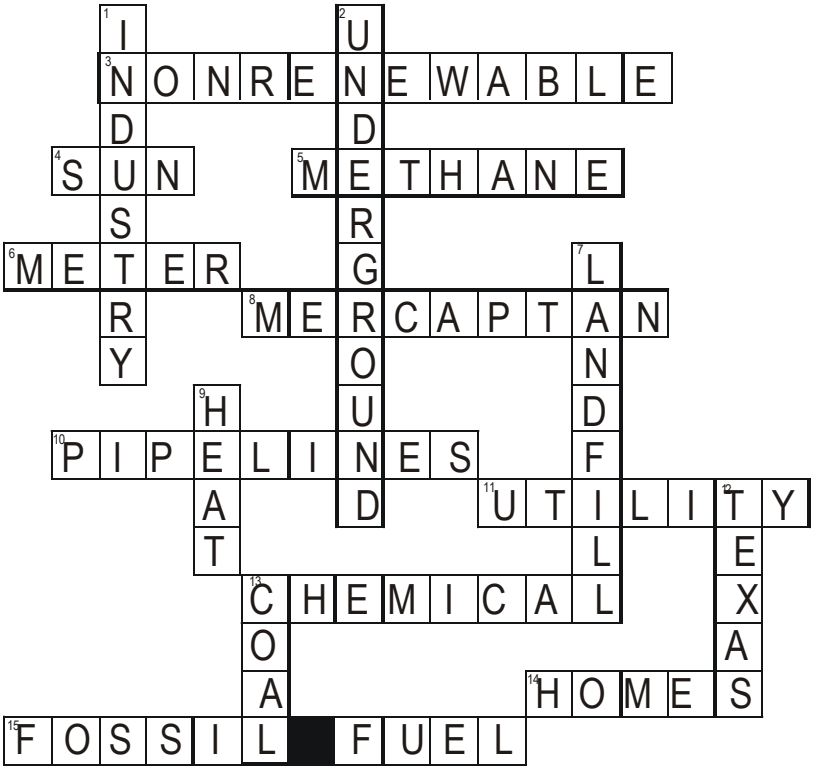
GEOTHERMAL



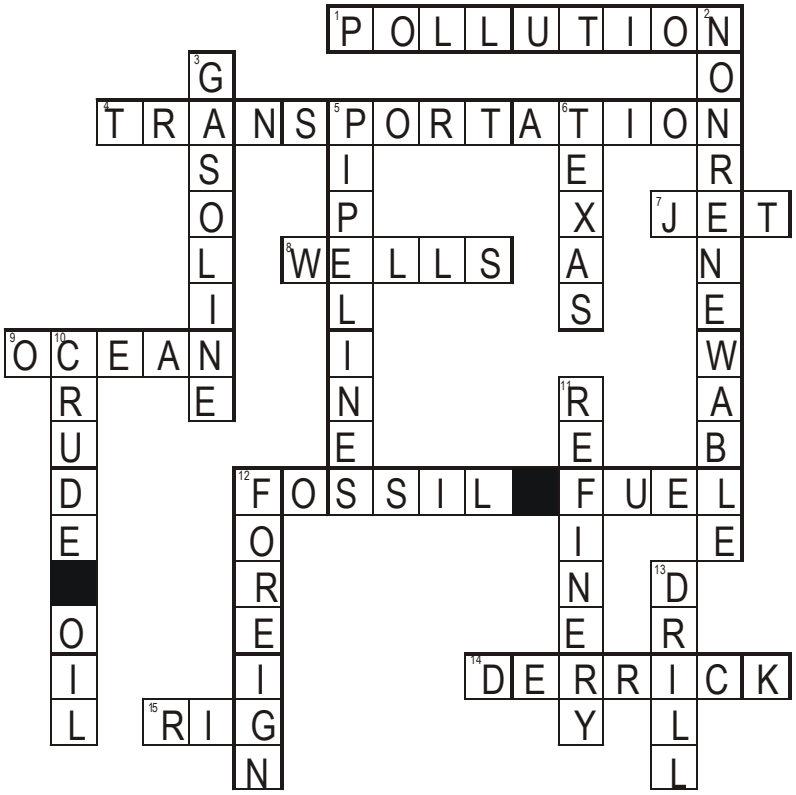
HYDROPOWER



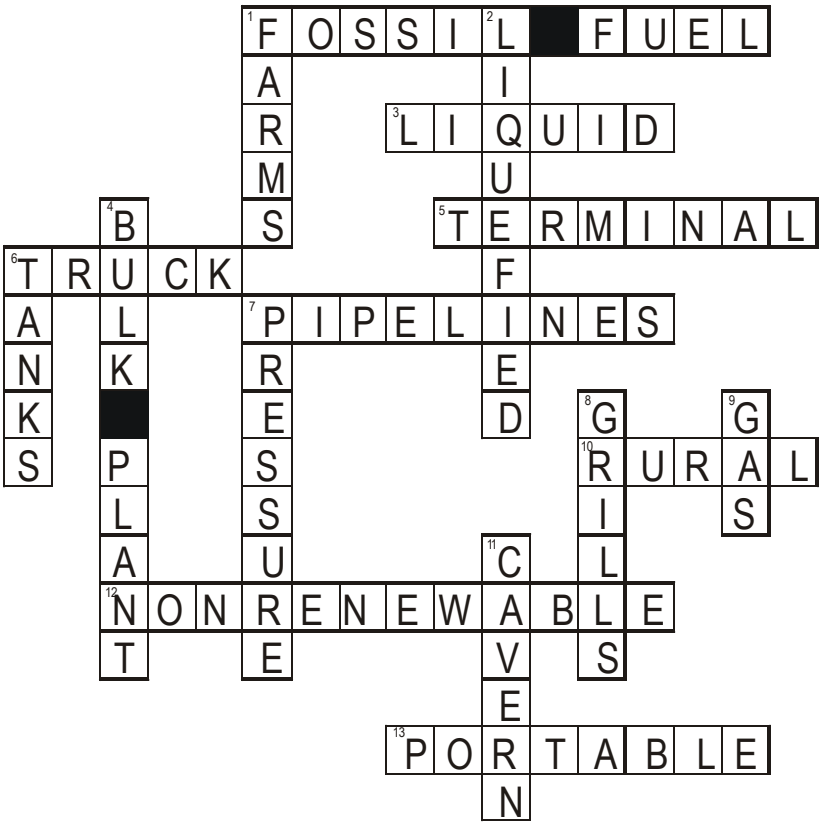
NATURAL GAS



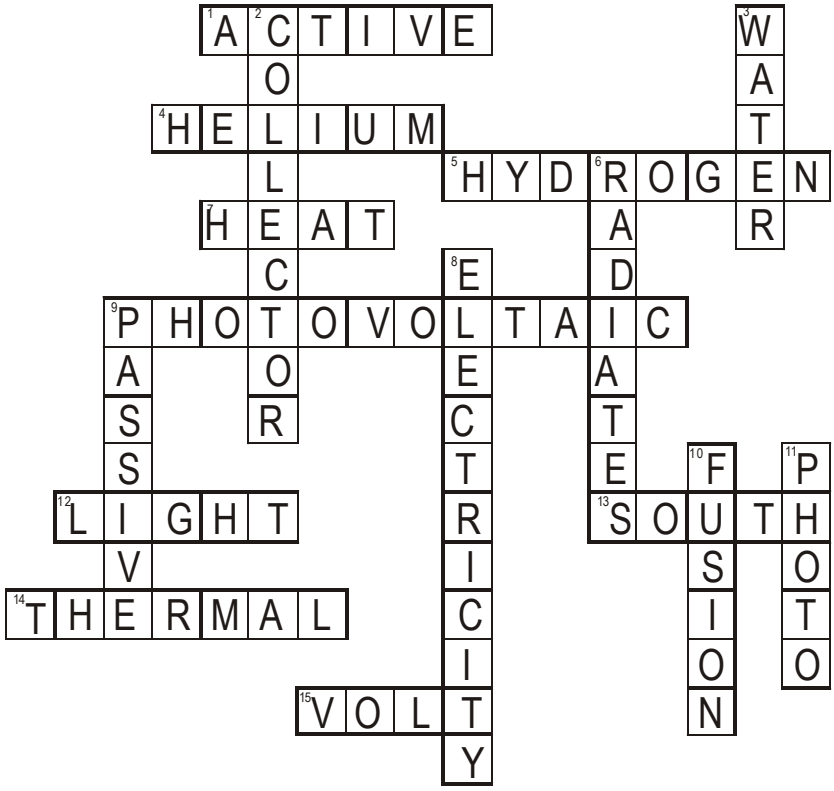
PETROLEUM



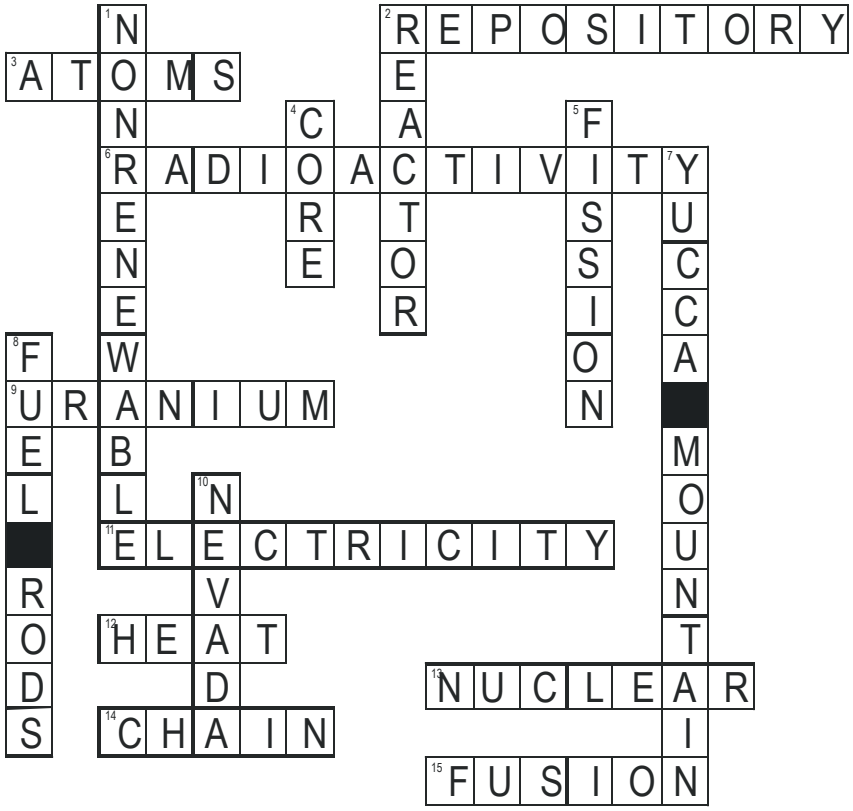
PROPANE



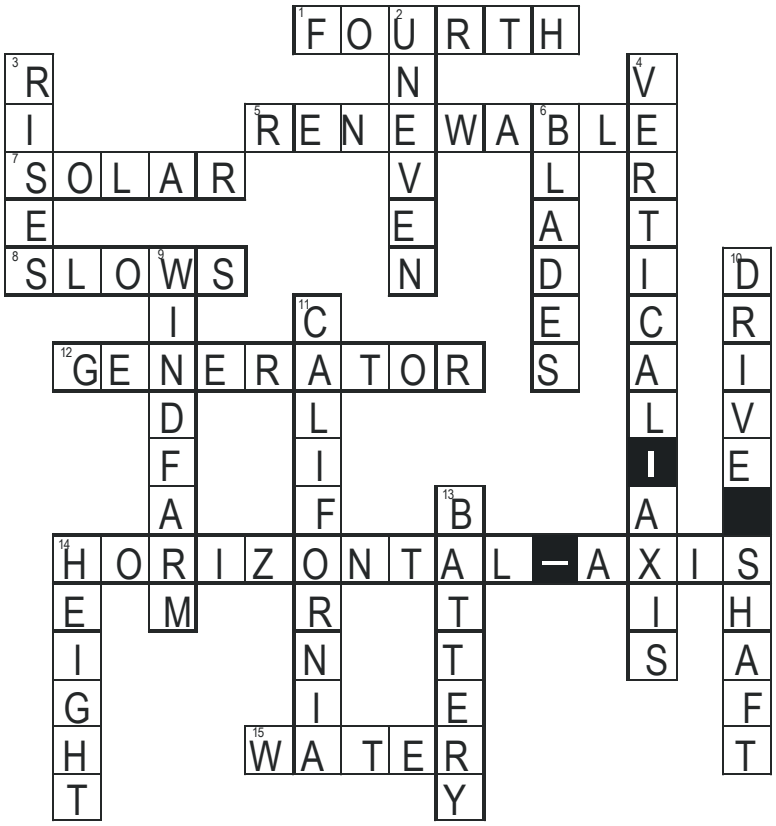
SOLAR



URANIUM



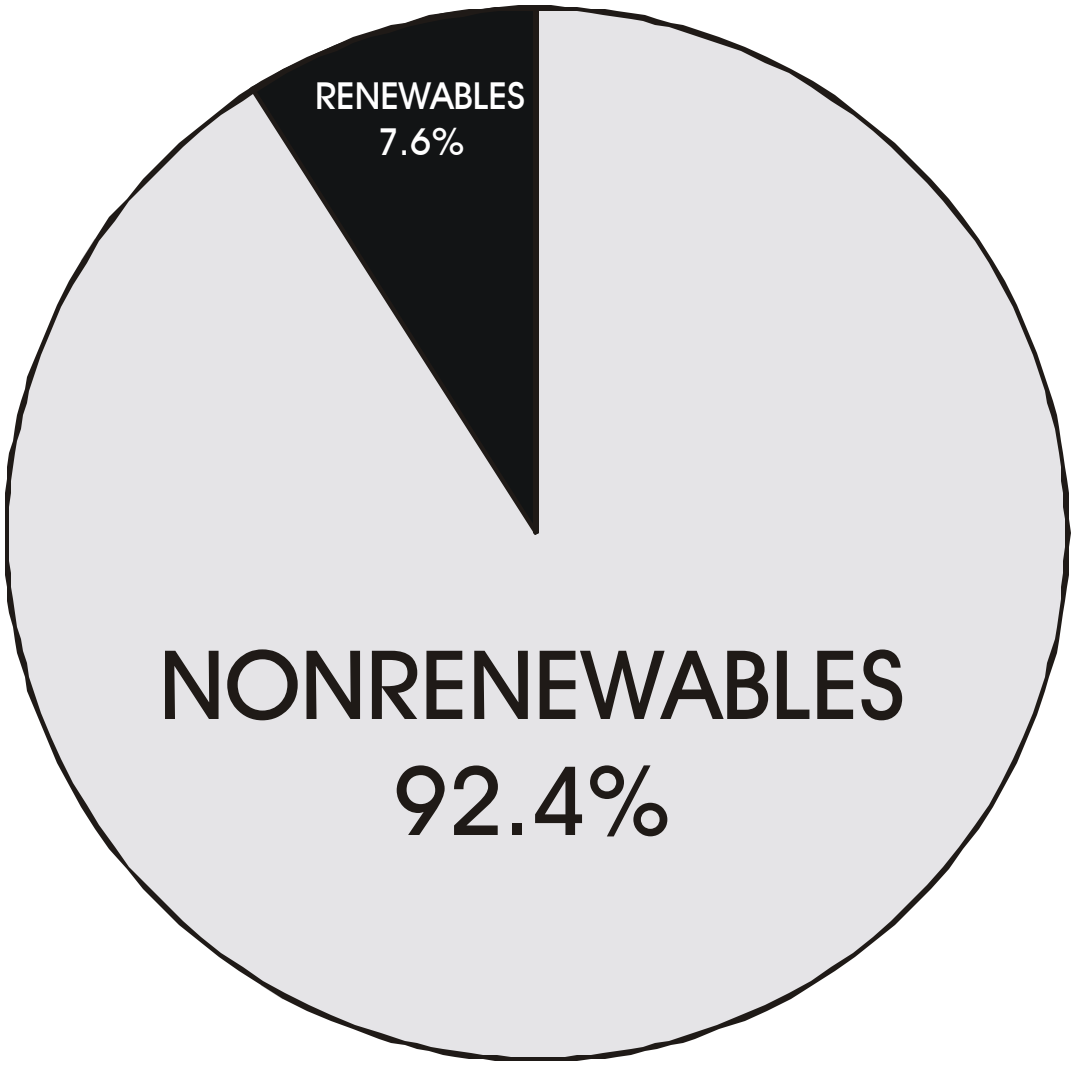
WIND



RENEWABLES AND NONRENEWABLES

Convert the quads into percentages and make a pie chart showing how much of the energy the U.S. consumed in 2000 came from renewable sources and how much came from nonrenewable sources (Q = quad or quadrillion Btu).

PETROLEUM	36.9 Q = 38.2%
COAL	21.7 Q = 22.4%
NATURAL GAS	21.3 Q = 22.0%
URANIUM	7.7 Q = 8.0%
BIOMASS	3.5 Q = 3.6%
HYDROPOWER	3.4 Q = 3.5%
PROPANE	1.7 Q = 1.8%
GEOTHERMAL, SOLAR, WIND	0.5 Q = 0.5%



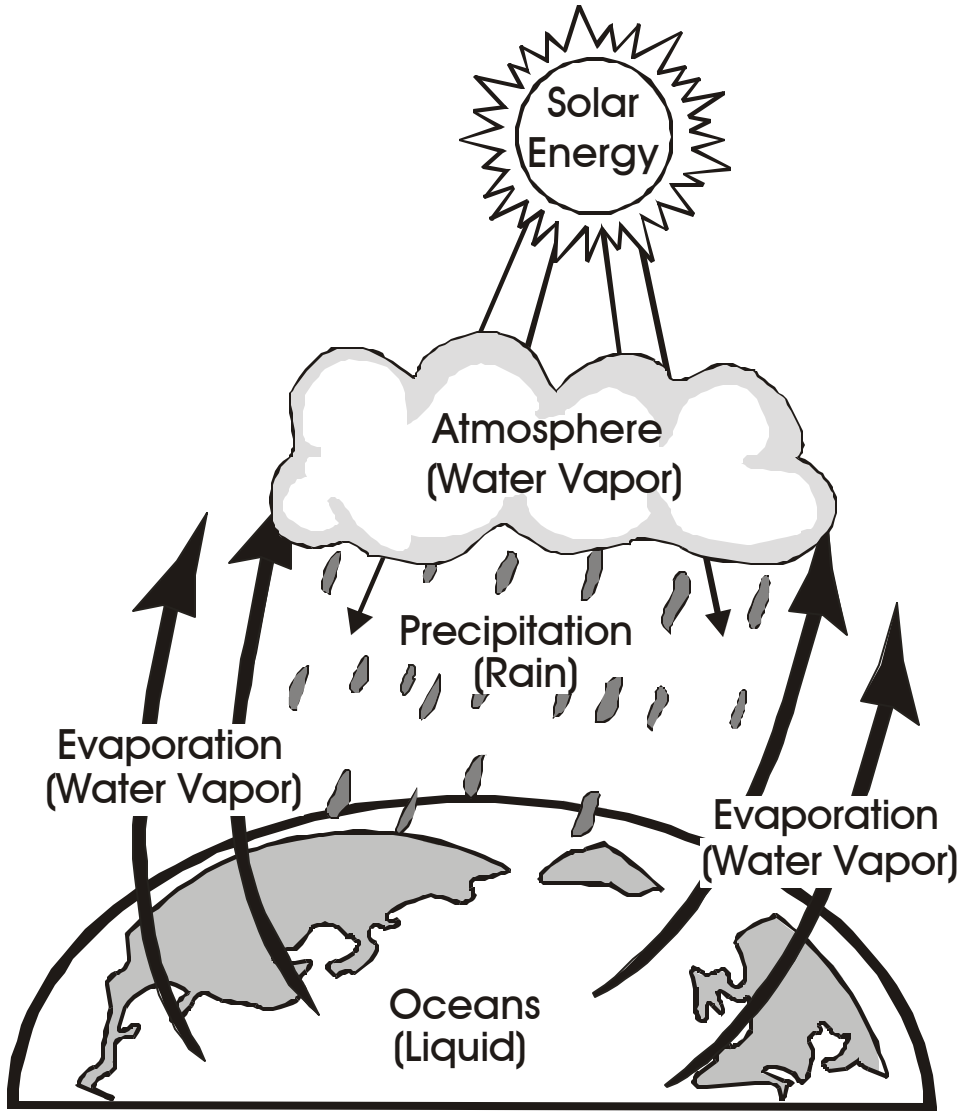
HOW WE USE OUR ENERGY SOURCES

Number the main uses of each energy source from 1 to 5, with 1 as the most important use.
Some sources may be used in only one or two ways.

	 TRANSPORTATION	 MANUFACTURING	 HEATING/COOLING	 LIGHTING	 ELECTRICITY
	4	1	2	5	3
		2			1
			1		2
					1
	4	1	2		3
	1	2	3		4
	3	1	2		
			2	1	3
					1
					1

THE WATER CYCLE

Label and describe the water cycle in the space below following the numbers on the diagram.



1. *The sun shines radiant energy onto the earth. When it hits objects, some of the radiant energy is converted into heat.*
2. *The heat warms and evaporates water in oceans and rivers.*
3. *The water vapor rises into the atmosphere.*
4. *The water vapor forms clouds in the atmosphere.*
5. *The water vapor in the clouds condenses and falls to the earth as precipitation.*

ELECTRICITY

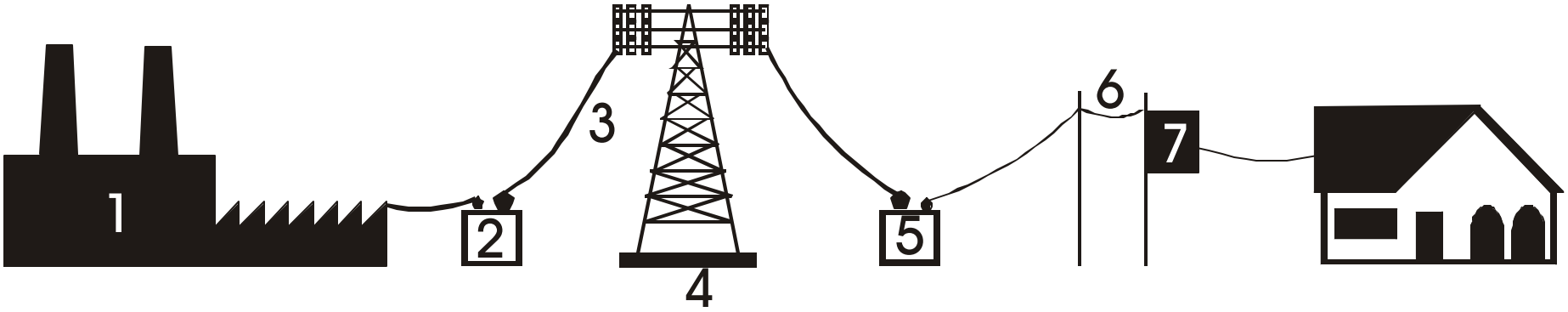
Write the correct word for each definition in the blank space.

1. A substance in which all atoms are identical. _____*element*_____
2. The center of an atom. _____*nucleus*_____
3. The negatively-charged particle of an atom. _____*electron*_____
4. The positively-charged particle of an atom. _____*proton*_____
5. The particle in the nucleus an atom with no charge. _____*neutron*_____
6. The smallest part of an element that retains the element's characteristics. _____*atom*_____
7. An electrical force within an atomic particle. _____*charge*_____
8. The bubbles around the nucleus where electrons are located. _____*shells*_____
9. The force field created between the poles of a magnet. _____*magnetic field*_____
10. Electrons that jump from object to object. _____*static*_____
11. A device that does work in an electrical circuit. _____*load*_____
12. A path through which electricity travels. _____*circuit*_____
13. How like charges or poles of a magnet respond. _____*repel*_____
14. How opposite charges or magnetic poles respond. _____*attract*_____
15. An object in which the electrons at one end spin in one direction and the electrons at the other end spin in an opposite direction. _____*magnet*_____
16. A device that converts energy into a spinning motion. _____*turbine*_____
17. A device with magnets and coils of wire that produces electricity. _____*generator*_____
18. A device that produces electricity through a chemical reaction. _____*battery*_____

nucleus	atom	element	proton	neutron	electron	shells	static
load	turbine	generator	magnetic field	magnet	circuit	battery	
attract	repel	charge					

TRANSPORTING ELECTRICITY

Explain what each of the components numbered below does to get electricity from the generator to the consumer.



1. Power plant - *generates electricity*
2. Step-up transformer - *increases voltage to reduce transmission loss*
3. Transmission line - *transports high-voltage electricity over long-distances*
4. Power tower - *carries transmission lines*
5. Step-down transformer - *lowers voltage for smaller distribution lines*
6. Distribution line - *carries lower voltage electricity to homes and businesses*
7. Neighborhood transformer - *lowers voltage to the voltage used by appliances in homes and businesses (110 & 220 volts)*

Intermediate Energy Activities

Evaluation Form

Please take a few minutes to evaluate these activities so that we can revise them to better meet your needs. Thank you.

State: _____ Grade Level: _____ Number of Students: _____

1. Did you conduct all of the activities in the workbook?	**Yes**	**No**
2. Were the instructions clear and easy for students to follow?	**Yes**	**No**
3. Did the activities meet your academic objectives?	**Yes**	**No**
4. Were the activities age-appropriate?	**Yes**	**No**
5. Were the allotted times sufficient to conduct the activities?	**Yes**	**No**
6. Was the workbook easy to use?	**Yes**	**No**
7. Were the students interested and motivated?	**Yes**	**No**
8. Was the energy content age-appropriate?	**Yes**	**No**
9. Would you use the workbook again?	**Yes**	**No**
Would you use the workbook if you didn't have a class set?	**Yes**	**No**

How would you rate the workbook overall?

How would your students rate the workbook overall?

What would make the workbook more useful to you?

Other Comments:

Please fax or mail to:

The NEED Project
PO Box 10101
Manassas, VA 20108
FAX: (703) 257-0037

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