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Solar Energy

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by Sherree Kassuba

One form of energy that has been brought to public attention is solar energy. In fact, all of the living world depends on solar energy. Solar energy is truly the oldest form of energy, and there is a good chance that it may turn out to be the most important answer to our energy problem.

This sun has been shining for billions of years and there is no reason why it should not continue. In this sense it comes closer to being an inexhaustible source than any other practical possibility. Solar energy has become increasingly popular because it is conceived as clean *and* safe.

This unit will be constructed for 9th grade science students as part of an environmental science unit. The unit will provide an awareness to the students of an energy alternative that may be more a part of our lives some *day.* There are three objectives for this unit. Upon completing the unit students will: (1) be able to define solar energy (2) explain the advantages and disadvantages of solar energy (3) realize the potential of new careers in the solar energy field.

Without the sun there would be no warmth, no gravitational pull, *no* center to keep the planets together. So it should be no surprise that the sun represents, as it always has, a limitless source of useful, clean, and extremely safe energy. The sun contributes about 99.98% of the earth's total energy; the remainder is geothermal and tidal, Therefore, solar energy is defined as energy from the sun.

We live in a world that depends on cheap energy. We use energy to replace human labor and to process cheap raw materials into substitutes for expensive ones. In the last few decades, energy demand in the United States has grown at a steadily increasing rate. World energy needs are rising too. The developing nations in particular will need large amounts of energy to raise their standards of living. The problem is that the traditional sources of energy, coal, oil, and natural gas, are becoming more expensive and harder to find, and it is possible to imagine a day when they will run out altogether.

The only long term answer to the energy problem that we can depend on, then, is to develop alternate sources of energy. One source is sunlight, and we know it will not run out. Critics point out that solar energy will have little effect before the year 2000. But increasing awareness of the problem and rising energy costs are already causing more money and research effort to be devoted to speeding the development of solar energy as an alternative source.

We can expect the energy problem to be a powerful influence on our lives. We must all give more thought to

how we use energy if we are to achieve a future that we will want to live in.

Some people say solar energy won't work. But we all know sun all our lives. Think of a sun porch—how warm it gets and how flowers grow so beautifully in a greenhouse during the cold winter months. It is only natural that thousands of people are turning to solar energy to heat their homes,

Solar heating and cooling does not have to be complicated and expensive. Passive solar heating and cooling works well as energy conservation to almost totally eliminate heating and cooling bills. Passive solar energy does not use sophisticated control systems: much work can be done using standard building materials and basic construction skills. The structure itself is sited and landscaped so that it becomes in effect a large solar collector. A home faces south. In winter, the sun's heat is captured through large double-glazed windows, and the heat is retained by the walls during the night. One of the most important reasons why passive is so economical is that most designs last as long as *the rest* of the house with little or no maintenance or repair.

To most people, energy conservation lacks the glamour of solar energy, but it is always a winner in saving energy. In any climate where heating or cooling is a "big thing", solar design done in combination with energy conservation works best. Conservation always pays off in savings faster than any other energy strategy. A tight energy-conservation, passive home may reduce energy costs by 50% to 90%, depending on climate.

In terms of costs, energy conservation measures fall into three categories: free, cheap, and economic. Some free heating energy conservation measures include; lowering thermostat settings, adding water-saving shower heads, closing chimney dampers and blocking off unused fireplaces, shutting off unused rooms, turning off lights, and wearing heavier clothing. For cooling, get used to slightly warmer temperatures or turn the air conditioner off altogether and open windows. When these measures are used in combination, 20% savings is easily obtainable at no cost.

Among the "cheap" energy conservation measures are maintaining the efficiency of your heating system through service checkups, caulking and weather stripping windows and doors to seal infiltration cracks, and adding sheets of plastic to windows that are big heat losers. For cooling, shades, awnings, and trellises with plant growth to block out the sun. Fans are much less expensive to run than air conditioners.

"Economic" energy conservation measures include adding *extra insulation in attics* and walls and around foundations, adding windows and doors or replacing old ones, replacing an old inefficient furnace or burner can be economic or consider a woodburning furnace or stove.

Besides being conservative there are also passive systems that complete the process. There are five systems of passive solar energy, they are:

1. Solar windows. When the sunlight enters your house directly through the windows and turns into heat. Some of the heat is used immediately, floors, walls ceiling, and furniture store the excess heat.
2. Solar chimneys. As air it touches a solar heated surface. The warmed air rises and cooler air is drawn to replace it. *This is* what happens in The process of natural convection can occur in a continuous loop between your house and a solar collector attached to its south wall. As the air in the solar collector is heated, it expands, rises and enters the house. Cooler house air is drawn into the collector to take its place.
3. Solar walls. When the mass for absorbing the sun's heat is located right inside the glass, you

have a solar wall. The wall is painted a dark color, heats up as the sun passes through the glass and strikes it. Heat is then conducted through the wall and into the house.
4. Solar roofs are like solar walls. Most solar roofs use water in large black plastic bags to absorb heat during the day. *The water* ponds store the heat, which in turn is conducted through the ceiling and radiated to the house below. Insulating panels cover the ponds at night to reduce heat loss.
5. Solar rooms such as greenhouses, sun porches and solariums are possibly the favorite passive solar system. They give the house extra solar heated living space and act as buffer zones between the house and outdoor weather extremes.

Active solar heating and solar hot water are variations on the same system, differing principally in cost and scale. In general there are two types of solar heating systems available: those based on liquid type collectors and storage, and those based on air-type collectors and storage.

The advantages of the liquid-type systems are their double use, to supply both domestic hot water year round and winter space heating, and the relative efficiency of water as a heat transport and storage medium, Disadvantages of the liquid collectors are the possibility of freezing if controls or antifreeze provisions are not properly used, and the possibility of corrosion and leaks.

Air-type collectors hare no freeze-thaw problems and corrosion problems are minimal. There are advantages to air type systems, since the heated air from the collectors or from storage is passed directly to the house interior. The possible disadvantages of air systems are the requirements for large ducts and storage space and the difficulty of moving heated air long distances.

An important aspect of active solar energy is the design of the house. An architect from Yale University, Donald Watson, designs homes to fit the local climate. Each locale has a predictable need for heating, cooling, humidity and precipitation control that distinguishes one climate zone from another. In cool climates such as we live in, Watson believes a house should have maximum thermal retention, maximum radiant heat gain, and minimum wind resistance. In cool climates, the collector area requirement is greatest with the most attention given in design to minimize heat loss through windows and the building envelope and cold. In less severe conditions, the greenhouse could become a natural, self heating element.

A solar heating system does not completely eliminate the need for conventional sources. A typical system supplies one half to two thirds of heating needs, which means that a backup conventional heating periods of sustained cloudiness. And conventional electrical power is needed for lighting and appliances.

No matter how much we turn coal into oil and gas, fossil fuels will run out. The sun is a large continuing source of domestically available energy, it is widely distributed, and its use does not add to the earth’s overall heat inventory.

Unlike most forms of energy, solar energy is well distributed across the nation and is available in relatively low concentrations. The technologies needed for solar energy conversion are relatively abundant. There is

generally no resource restraint on the amount of solar energy that can be captured and used.

Although no technology is completely free of environment and public health impacts, solar energy technologies appear more benign than the conventional sources of energy, proved to be more safe and environmentally sound. Public attitudes toward solar energy development are almost without exception positive. This is in striking contrast to the other forms of energy, where public opposition to some new facilities must be a major consideration in planning.

Solar energy systems tend to attain optimum performance in modules that are smaller in scale than those common in other energy forms: for example coal or nuclear electrical generating plants, or the proposed coal conversion plants. As a consequence, the time necessary to begin operating a solar energy facility can be much shorter than for other types of energy production facilities.

The use of solar energy for applications such as space and water heating is relatively simple, easy to understand and implement. Therefore, many individuals with adequate training and instruction will be capable of acquiring and using the simpler and less complex solar technologies.

The United States Congress has provided for substantial federal tax credits to encourage the individual to invest in energy-conserving measures and alternate energy tax breaks can result in substantial savings for solar investments.

As the solar heating industry grows, it will offer employment opportunities to thousands of workers in new careers. Some new careers for high school students to start thinking about are: solar equipment technicians and solar-heating salespersons will be needed to be trained to understand this hardware. Solar heating specialists, mostly solar-heating engineers or solar engineers and solar-heating scientists, will be the backbone of this new and growing industry. In addition to the solar engineers, who will devote all their time and energies in helping the homeowner’s and industry with their heating problems. There will be an ever increasing need for solar heating technicians trained in solar technology to assist the solar engineers.

Other existing skilled workers such as carpenters, cement masons, crane operators, electricians, plumbers, sheet-metal workers, and miscellaneous factory workers, will enter the solar heating field and acquire the additional knowledge and skill which will be required of them. Real-estate personnel of varied types will also enter *this* field after becoming knowledgeable about solar heating.

Like other technological revolutions, the fate of solar energy use in the United States is directly linked to the presence of consciously instituted incentives and the removal of barriers. A political consensus recognizing the value of solar energy must develop soon and lead us away from an energy base established on the shaky capital of oil, coal, natural gas and uranium.

The average person would probably be more receptive to the use of solar if the federal government would conduct a vigorous promotional campaign. Most Americans have been convinced that solar energy is a dream that won’t come true before the 21st century, if then. The major energy corporations have told us for some time that “we’re doing our very best to develop natural energy technology,” but for now “It just isn’t realistic.” People feel even if energy corporations are conducting solar research it is more in their interest to protect their multi-billion dollar investment in atomic power than in revolutionizing energy generation. Advertisers have so persuasively sold the vision of a fossil or nuclear fueled America that decentralized renewable energy technologies are generally looked upon with a mixture of suspicion, doubt or apprehension. The sun’s potential to influence our lives is all but ignored or disbelieved.

A massive educational and marketing effort should be undertaken by the government, in conjunction with state and law making bodies and utilities. Consumers should be given free estimates of the cost and performance of various solar energy systems and demonstrations of various solar technologies should be easily accessible. Exhibits should be straight forward and very visible. City halls, libraries, schools, federal buildings and shopping centers should display the renewable energy alternatives, making plain that their time is now, not in the year 2020. The advertisements that have recently preached the importance of digging deeper and drilling further should be matched by equally persuasive campaigns which would familiarize people with solar technology. Television and radio announcements, ads in subways and buses, billboards, and post office posters are only a few of the other mechanisms so well exploited in the past.

Solar energy has different economic requirements from other energy forms. Instead of paying continuous operating expenses, solar energy consumers incur an initial capital expense for equipment purchase. Since the fuel is free, solar energy may be the cheapest way to provide electricity or heat over the life of a building. But the high first cost of materials represents a severe deterrent to its selection by homeowners, and this barrier must be overcome if national solar development is to progress.

Federal loan and mortgage agencies must develop policies and programs which help offset the purchase and installation expenses. A Federal Solar Bank devoted to making low-interest loans on solar energy could serve as a model for other agencies only recently acquainted with solar loan grants should be federal government for low-income persons or nonprofit institutions that found loans insufficient to permit solar purchase. It should also be noted that electrical utilities have historically taken a dim view of total solar energy systems in this although it is a major form of energy distribution in Europe. This may present a major institutional barrier for total solar energy systems.

Laws which govern public *and private utility* companies are incredibly complicated in addition to varying from *one* state to the next. There is no question, though, that and regulations can either help or hurt the development of solar heating.

For any solar energy use we must face the problem of energy storage. the flow of solar energy is interrupted by the earth’s rotation and by clouds, we will need to store the heat energy. Solar buildings can store enough heat for three days in large insulated containers of water or pebbles. In the future solar energy will probably be counted on for daytime peak loads and supplementary power sources will be used nights and cloudy days.

Zoning laws can cause a tremendous amount of problems for both sides, people with solar energy collectors and those without. Some problems may stem from the “looks” of the collectors, to preventing someone from putting up the structure, of another home owner. Current law in the United States has established the fact that the owner of a property has a right to light from the area of the sky directly above that property, but has no right to receive it from across his neighbors’ land.

Activities

1. Study the insulating characteristics of various materials, including the new solar shield, by obtaining manufacturers’ brochures and/or samples.

2, Determine how this following factors are related to conductive heat loss thorough a wall:

(a) temperature difference

(b) wall thickness

(c) resistance to heat flow

(d) area of wall

3. Make up solar energy slogans.

4. Speaker on Solar Energy—Bill Duesing of Energy Outreach has put together a slide program on the use of solar energy, active and passive, in Connecticut. The program and speaker are free to school groups. Bill can be reached at Energy Outreach, 649 Howard Avenue, New Haven, CT, 06519: 789-7136.

5. Scale Model Solar Homes Demonstration. Two working scale model passive solar homes are available for display and demonstration, as part of the solar energy education project at the University of Connecticut. Contact Dr. Thomas B. Goodkind, University of Connecticut, U-33, Storrs,CT, 062685 486-4113.

6. Questions to be brought up throughout the unit.

1. energy?

2. Why is solar energy important today?

3. What is the difference between active and passive solar system?

4. Why is the study of solar energy worthwhile in our schools today?

5. Describe a house with a passive and active solar Which kind of house do you prefer? Why?

6. List the limits and problems of solar energy.

7. Would you prefer to live in a world in which the main source of energy is the sun? Give reasons for your choice.

Curriculum Materials—Films

Energy Curriculum materials available free from.

The Technical Information Center

U.S. Department of Energy

P.O. Box 62

Oak Ridge, TN. 37830

Films and slide shows about solar:

Solar Energy Information Center

Solar Energy Research Institute

1617 Cole Boulevard

Golden, Colorado, 80401.

DOE File Library

P.O. Box 62

Oak Ridge, TN 37830

Solar Energy

Audio Visual Materials

P.O. Box 1607

Rockville, MD 20850

Organizations to write to:

National Solar Heating and Cooling Information Center

P.O. Box 160?

Rockville, MD 20850

Solar Energy Research Institute

1617 Cole Boulevard

Golden, Colorado 80401

National Science Foundation

1800 6th St. N.W.

Washington, D.C. 20550

National Solar Energy Education Campaign

10762 Tucker St.

Beltsville, M.D. 20705

(Figure available in print form)

HOW LONG DOES IT TAKE TO COOK A HOT DOG WITH THE SUN?

MATERIALS: hot dog, cardboard boxes, aluminum foil, coat hanger, thumbtack, pencil, two small nuts and bolts, rubber cement.

(Figure available in print form)

1. Poke holes for nuts and bolts. Cut the top and front out of a cardboard box to make a frame for your solar cooker.
(Figure available in print form)
2. Make 2 large cardboard circles. Cut on dotted lines. Measure the radius of the circle, and make a mark halfway. This is the focal point of your solar cooker.
(Figure available in print form)
3. Now, glue 2 pieces together to make one that's twice as heavy. Do this with both circles you cut.
(Figure available in print form)
4. Put the two curved pieces together like this:
Tape another piece of cardboard to the curved edges of the 2 half circles you glued together, the width of the piece of cardboard should be slightly less than the width of the box you cut to make a frame.
Then, cover the inside of this piece with aluminum foil, use rubber cement.
(Figure available in print form)
5. Put an unpainted coat hanger through the focal points, then cook the hot dog on it. Nuts and bolts to hold the frame and solar cooker together.
Adjust the cooker so that you can see the sun's rays cross at the focal points. How long does it take to cook a hot-dog? Think of some other foods you can cook in your solar cooker?

HOW TO DRY FRUIT USING SOLAR ENERGY?

MATERIALS: cardboard box, paper towel tube, tape, cardboard, screen.

Dried fruit can be stored for long periods of time without losing its food value. Many fruits and are sun-dried commercially.

1. Make an incubator with shelves. Place the fruit on the screen shelves,
2. Place the incubator in an attic or warm closed area. Time the incubator until the fruit is dry.

(Figure available in print form)

HOW TO BUILD A SOLAR GREENHOUSE?

MATERIAL: corrugated cardboard,clear plastic, flat black white spray paint, plastic. wrap (grocery store), tape, string or thread, tin cans, rubber bands, insulation material.

(Figure available in print form)
Insulation material can be styrofoam, cardboard, newspaper, etc.
1. Cut out these pieces from the cardboard. Spray the outside of the greenhouse white before adding plastic.
2. Add insulation to back, top, & and sides. Cover front with plastic. Add cardboard panel for stability.
(Figure available in print form)
3. Spray the cans flat black. Fill with water and cover tightly with plastic wrap bands . Stack them in the solar greenhouse.
(Figure available in print form)
4. Face the solar greenhouse directly into the sun.
What kinds of plants can you grow in the greenhouse?
Try putting in another type of insulation besides
the water.
Measure the temperature inside the different times of the day.

Teacher Bibliography

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