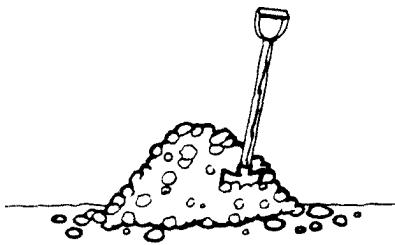


INTRODUCTION ' AND ECONOMICS 1

The sun has been giving energy to the earth for millions of years. Sunlight shining down on plants eons ago was the major cause of the coal, oil, and natural gas we use as fuels today. These fuels are called *fossil fuels* because they are the products of fossils of dead plants.

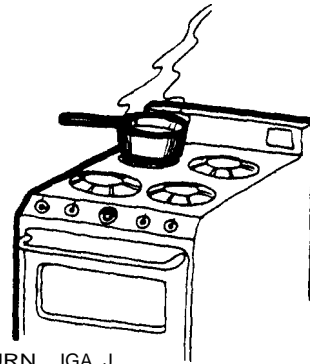
Fossil Fuels: Ancient Solar Energy



GOAL_



OIL

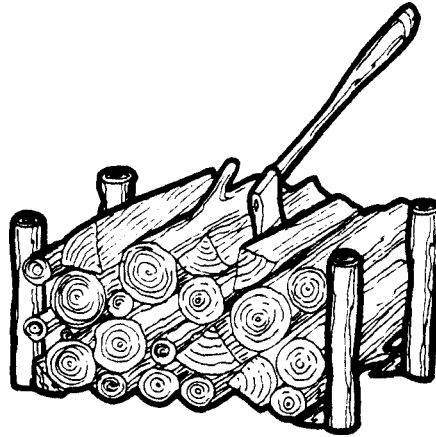


N-TURN_ IGA_J

A similar source of solar energy used today is called biomass; this term refers to the use of the sun's energy to grow plants which can be used for fuels and other purposes. For example, wood used in fireplaces is a form of biomass solar energy. Researchers are working on other ways to grow plants for use as energy. Seaweed is being grown and harvested for

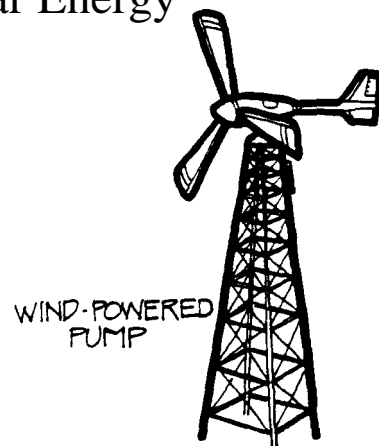
methane production (a gas-like natural gas), and trees are being grown for use in power plants to generate electricity.

Wood: Indirect Solar Energy



The sun also has a major impact on wind and ocean currents. Different parts of the earth's surface are heated differently by the sun, causing circulating currents in both the oceans and the atmosphere. Ocean currents are rivers of cold or warm water which can be tapped to run power plants; someday, these currents may be used to produce electricity. Winds have been used for centuries to power pumps and to grind grain.

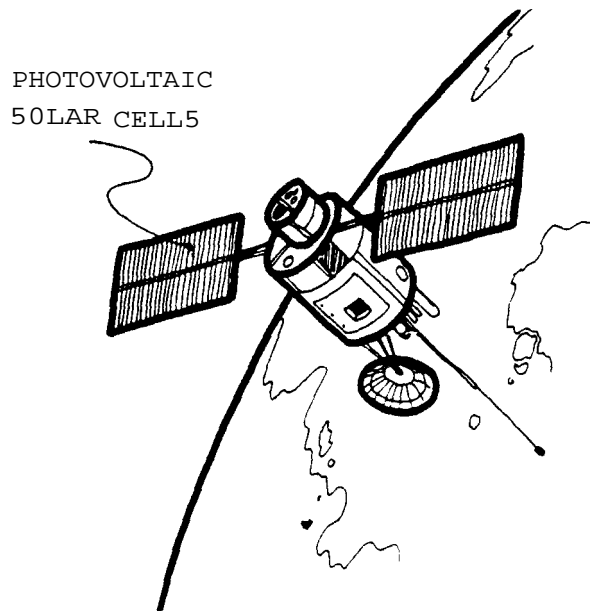
Wind Indirect Solar Energy



The sun's radiation may also be used *directly* to provide either electricity or heat; it is used directly as it comes raining down through the atmosphere rather than *indirectly* by making plants grow or causing wind or ocean currents.

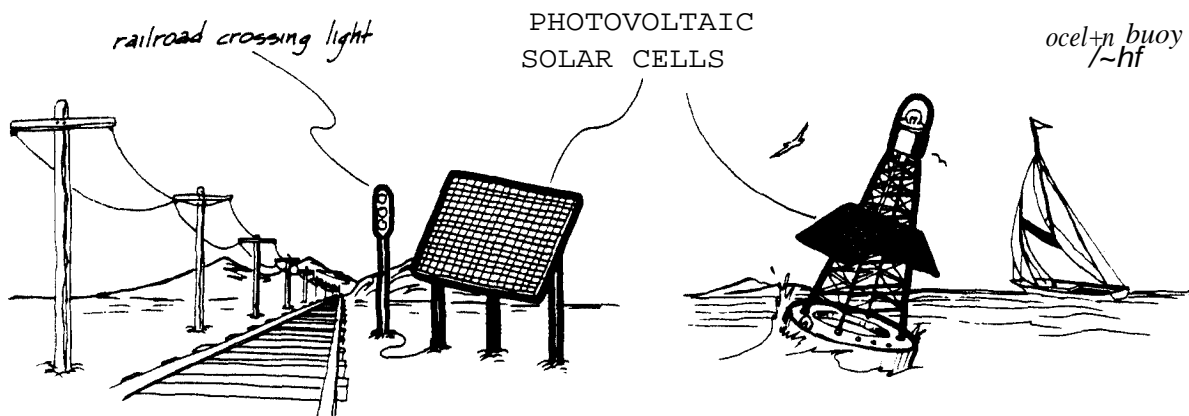
Solar cells convert sunlight directly to electricity. These cells are usually made of silicon (a mineral used in the transistors which run radios and pocket calculators). Many of the space satellites circling the earth today are powered by solar cells. Since solar cells are very expensive in terms of the amount of electricity they provide, their use to date has been mostly to provide power for remote weather stations where the cost of bringing in power lines would be prohibitive; another application has been in powering remote railroad-crossing lights and ocean buoys.

Solar Cells: Direct Solar Energy



Heating is the other example of direct use of the sun. You've probably experienced the heating effects of solar energy when walking barefoot on a tarred road on a hot, sunny day. The heat produced by solar energy can be used to power turbines to generate electricity, or it can be used to heat buildings or water. One system now being developed to generate electricity uses hundreds of mirrors which focus the sun's rays on a central tower; a boiler on the tower gets very hot and produces steam, driving a turbine that generates electricity. Although the sun's position changes from morning to evening, the mirrors move to

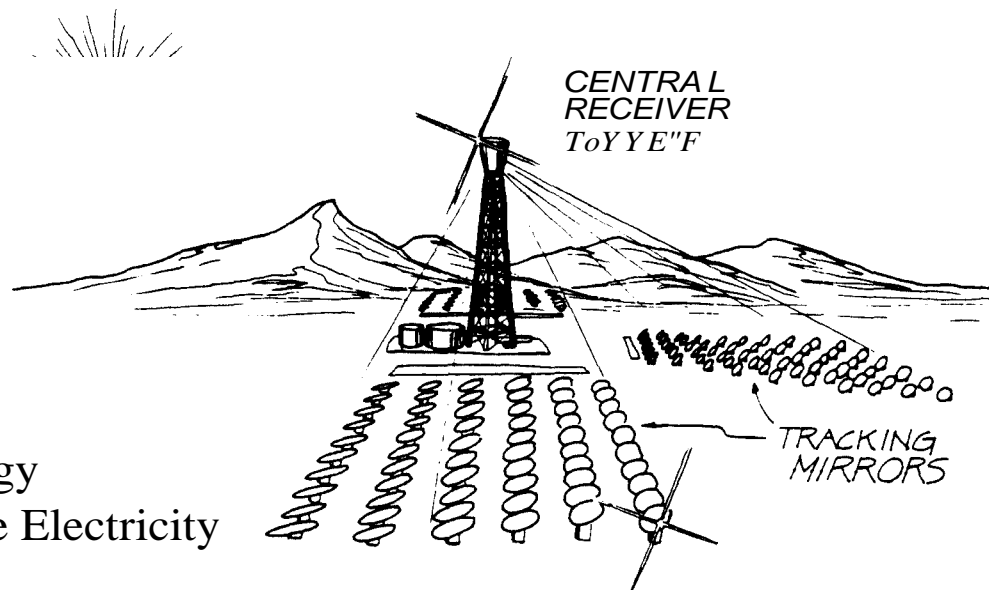
Solar Cells Used on Earth



Let the sun's reflection focus on the tower. Systems like these are called *tracking* because they follow the sun from sunrise to sundown.

Even if a solar energy system *isn't* designed to follow the sun, the sun's heat can still be captured. Solar heating systems which aren't of the tracking kind are called *flat-plate* systems. In comparison to tracking systems, they are not very sophisticated, but almost all of the solar energy systems in use today are of the flat-plate variety. Over a million flat-plate systems are

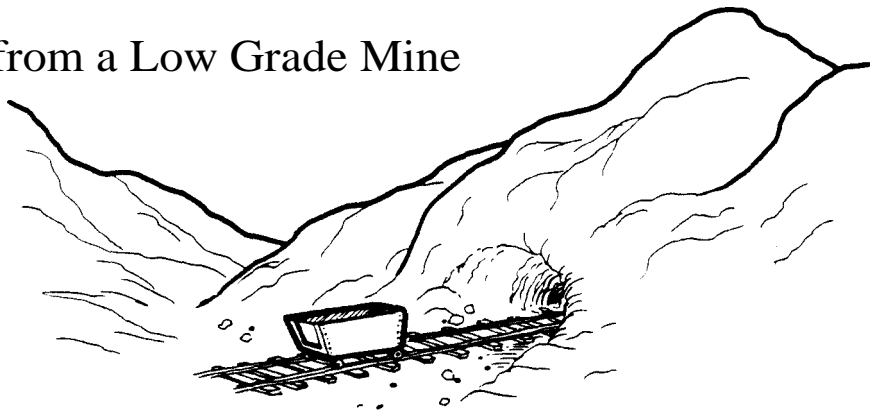
Solar Energy to Generate Electricity



now in operation, mostly in countries with hot, sunny climates such as Israel and Australia. The most common use for such systems is to heat water, but it is also practical to use them to warm a house in winter. Since flat-plate systems are the simplest and most widely used methods of using solar energy today, we will investigate them in detail. But first it is important to understand why solar energy has just recently begun to be a practical means of providing direct heating.

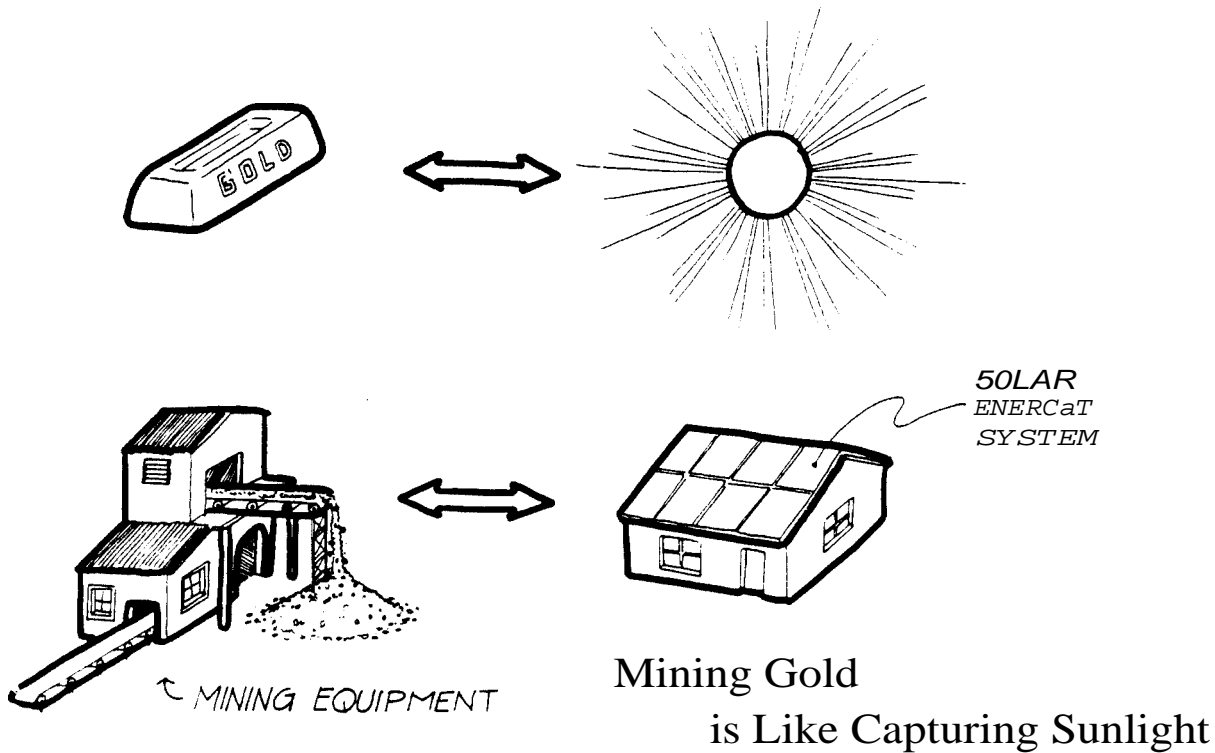
If sunlight is free, why hasn't solar energy been used before to heat houses and produce electricity? The following example will help you understand why. Let's suppose you owned a gold mine that contained only very low-grade gold ore. You would have to do a lot of digging before you got even a little gold. If you bought some expensive mining equipment, you could process much more of the low-grade ore and get more gold. Thus, even though the gold itself is free, it would be very costly to get very much of it out of the mine. You would have to balance the cost of the mining equipment against how much money you'd get when you sold your gold. If the gold were very valuable and the mining equipment relatively cheap, it might be worthwhile to dig up the gold. But if the equipment were expensive and the gold not very valuable, you'd be better off to leave it in the ground. Many gold mines in Utah that have only low-grade ore were closed down years ago; some have recently reopened because the price of gold has increased enough to make mining it worthwhile.

Gold from a Low Grade Mine



Solar energy is like the low-grade ore. The sun's rays must be "mined," or collected, and then transformed into useful heat or electricity before they are worth anything. A solar energy system helps you get "free" solar energy, just as the mining

equipment helps you get "free" gold. But, like mining equipment, a solar energy system can be very expensive-perhaps more than the sun's energy is worth.



If conventional energy is expensive-that is, if the cost of heating by using fossil fuels and electricity goes up-then it might be worth the expense to install a solar energy system. But if these forms of energy are cheap, then the cost of installing a solar energy system would probably be too expensive. Simply put, the cost of the solar energy would come to more than the value of the energy it could collect from the sun. Just as many gold mines in Utah were shut down when it became too costly to mine their gold, many solar hot-water heaters used in Florida and California during the 1950s were shut down when the cost of electricity was so cheap. Recently the cost of heating by gas, oil, and electricity has risen so much that solar energy systems are once again worthwhile, much as the Utah gold mines have once again become profitable because of the rise in the price of gold.

A solar energy system can be thought of as "mining" sunlight. If mining equipment is simple and rugged, it will give

many years of service before it must be replaced. But mining equipment can't be too expensive or it will make mining low-grade ore unprofitable. Like mining equipment, solar energy systems must be simple, rugged, and low in cost so that they will give many years of service without making the sunlight that they "mine" unprofitable. This is why the flat-plate collector solar system is being used so much today in countries such as Japan, Israel, and Australia: It is a very simple, rugged system whose cost is low enough to make the use of solar energy worthwhile.