23 Clean Energy

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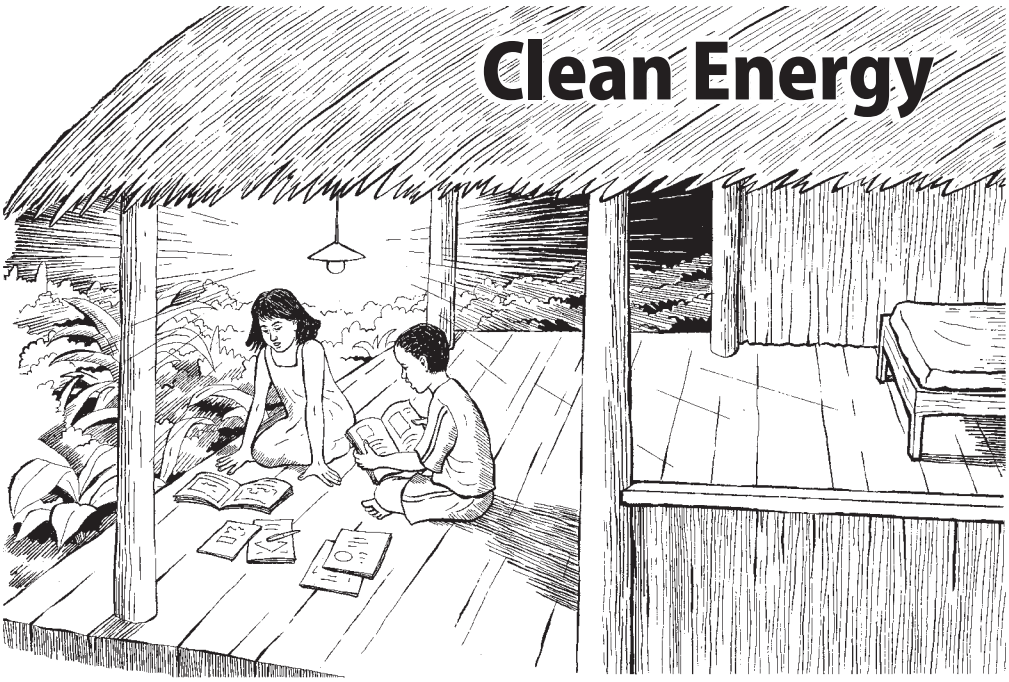
Clean Energy



It takes energy to light a home, to cook a meal, to lift and carry water, and to do all of the things we do every day. Sometimes this energy is human energy, such as the strength to walk, chop wood, or lift a bucket. Often this energy comes in the form of electricity to power lights, water pumps, fans, and other machines.

Electricity makes our lives and our work easier. It allows us to have light to work and study by, refrigeration to keep food and medicines cool so they do not spoil, washing machines, drills, and so on to make work easier, and radio and television to keep us informed and entertained. All these things can make our lives healthier and more comfortable.

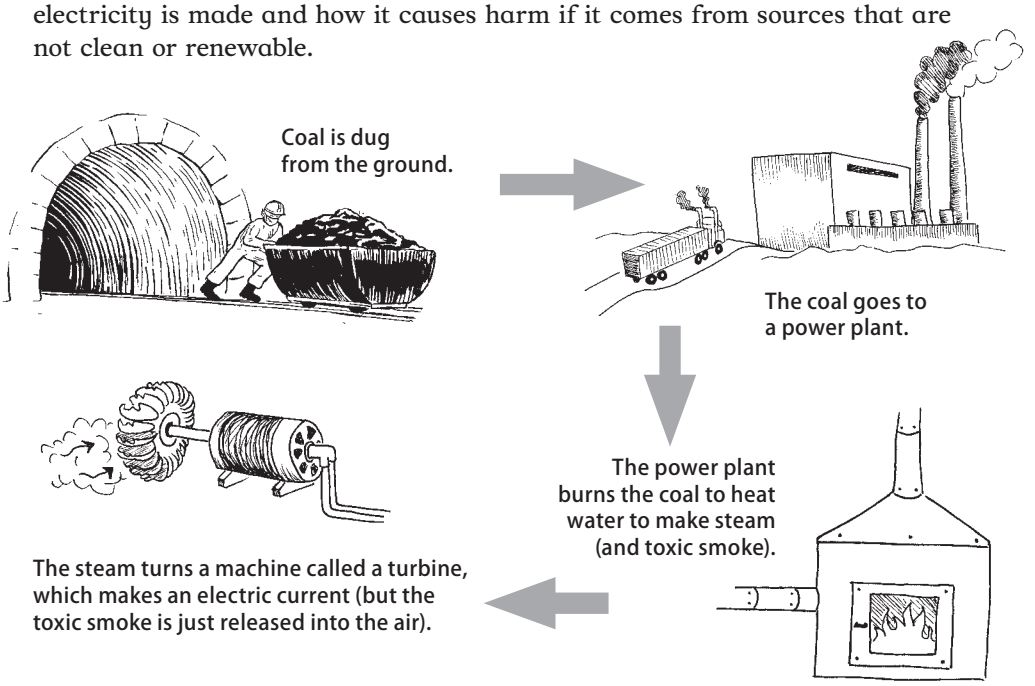
Unfortunately, access to electricity is a far-off dream for many people. Most of the electricity used in the world is in cities and the wealthy countries of the North. Of the world's 6 billion people, 2 billion have no electricity.

We also use energy for transportation, usually from **fossil fuels** such as gasoline (petrol) or diesel to power automobiles, buses, trucks, railroads, and airplanes. As with electricity, the wealthy countries of the North use more than their fair share of transportation fuel.

To prevent pollution and to reduce global warming (see page 33), the world must burn less less oil, coal, and natural gas. Especially people in rich countries, who use too much, must use less. For everyone to have enough electricity and transportation without increasing global warming, we must change to non-polluting power sources (**clean energy,** also called renewable energy). These include wind power, solar power, water power, and biogas.

How Electricity Is Produced

Most electricity today is made by burning fossil fuels (oil, coal, and natural gas). Some energy also comes from nuclear power, and from large dams (see page 170). To understand why we need clean energy to replace fossil fuels, nuclear power, and energy from large dams, it helps to understand how electricity is made and how it causes harm if it comes from sources that are not clean or renewable.



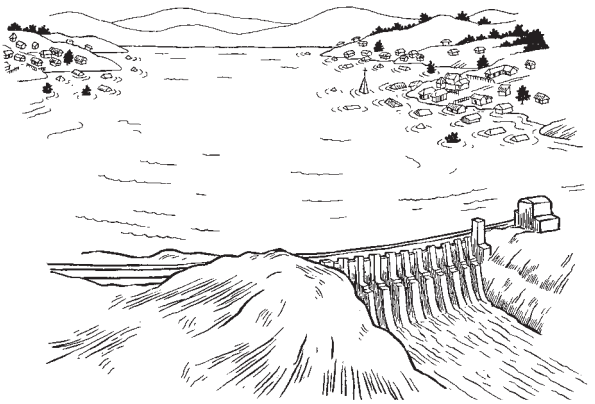
Whether from coal, oil, or natural gas and nuclear power, making electricity is all done the same way. First the power source makes heat, which is used to make steam, which turns large turbines to make electricity. Large hydroelectric dams use falling water, rather than steam heat, to turn a turbine to make electricity. But all of these kinds of energy lead to toxic pollution, destruction of communities and watersheds, and many serious health problems. None are healthy or sustainable, especially when they are used on a very large scale.

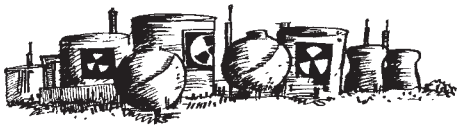
Fossil fuels are growing scarce and becoming more expensive to find. Fossil fuels are **nonrenewable**, meaning that once they are used up, systems based on them will literally run out of fuel. At the same time, the danger of global warming (see page 33) and pollution from burning fossil fuels has grown to become a serious environmental health problem for every single person and place in the world.

Health problems from nonrenewable energy

Burning fossil fuels in large power plants is the way most electricity is made. Digging up and burning fossil fuels pollutes air, soil, and water, leading to respiratory and skin problems. It also produces toxic chemicals that cause cancer and birth defects (see Chapter 16, and page 506). Our use of fossil fuels leads to global warming, and to wars for control of oil resources.

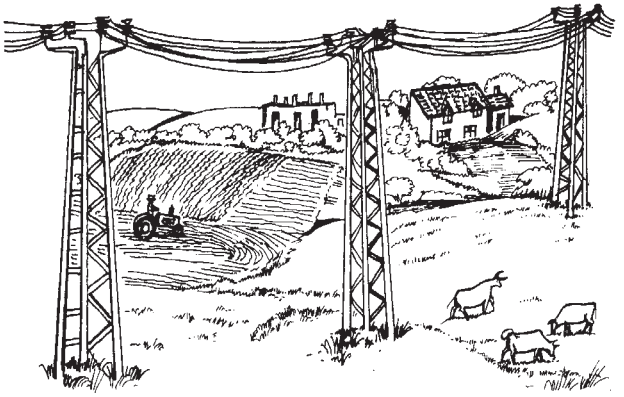
Big hydroelectric energy (using water from large dams to make electricity) leads to people being forced to leave their homes, go hungry, and lose valuable land, and causes an increase in diseases such as malaria and schistosomiasis (see Chapter 9). Small dams have many fewer problems.





Nuclear energy is very dangerous because of the toxic materials it uses (see page 491), the threat of accidents, and the harmful waste it leaves behind, causing health problems for many generations. Nuclear energy is not clean energy.

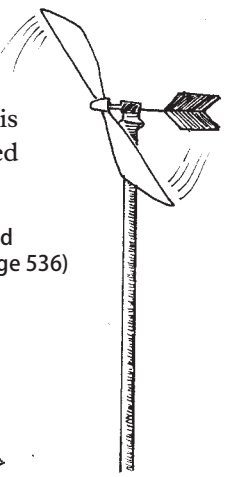
High voltage wires (the cables that carry electricity from where it is made to where it is used) can cause health problems such as cancer of the blood **(leukemia)** and other cancers. It is best not to build homes very close to high voltage wires, especially directly beneath them.



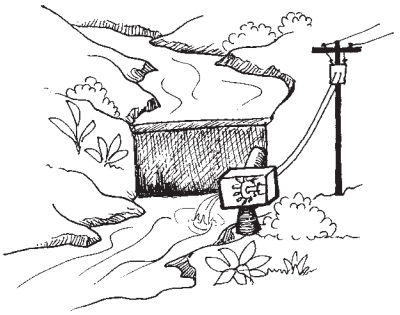
High voltage wires are just as dangerous when used with clean energy as with fossil fuels. Making energy locally, which is an important part of clean energy, reduces the need for high-voltage wires.

Benefits and Costs of Clean Energy

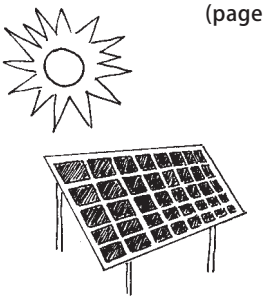
Clean energy is energy that can be made with few negative social, cultural, health, and environmental effects. Clean energy is also called **renewable** or sustainable energy, because it is produced from sources that do not run out, such as:



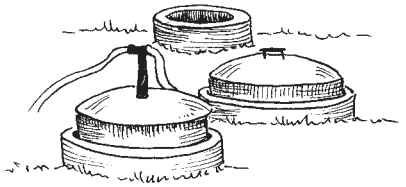
wind (page 536)



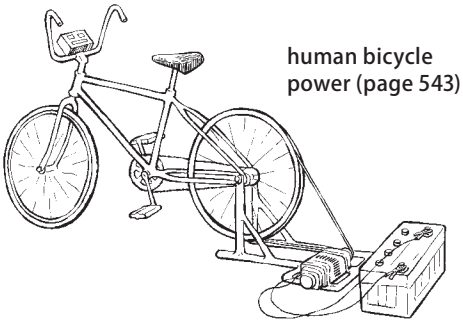
falling water from small dams (page 534)



sunlight (page 537)



biogas and other biomass (page 540)



human bicycle power (page 543)

By using clean energy, we reduce harm to both human health and the environment caused by finding and using fossil fuels and other forms of polluting, nonrenewable energy. Clean energy can provide power in rural villages, in big cities, and in factories without causing harm.

Each way of making clean electricity has advantages and disadvantages. And each depends on local conditions such as how much wind, sunshine, or falling water there is in each place. Electricity, even clean electricity, may be too costly for many people to afford. But as more and more people use clean energy, and as the ways to make clean energy are improved, it will likely become easier and less costly to make and use.

Paying for clean energy

Home energy systems that run on solar, wind, or water power cost money to install. But once they are in place they cost little to run and maintain. The income generated by labor-saving electric machines such as grain grinders and water pumps, and the ability to work after nightfall, can often pay for the initial costs.

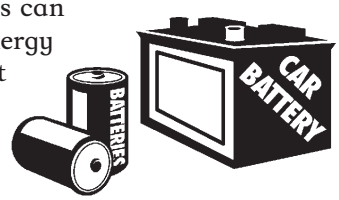
People in many countries are developing ways to make it possible for everyone to have access to clean energy. Forming village cooperatives to pay for energy collectively is one solution. Another solution is microcredit programs (see page 539). Microcredit programs allow families to pay small amounts over time, rather than a large amount all at once. By paying into a "revolving credit fund," money is made available to help more people install home energy over time.

There are no longer any technical reasons why people in poor countries or rural areas should not have electricity. The reasons they do not have electricity have to do with a scarcity of social justice.

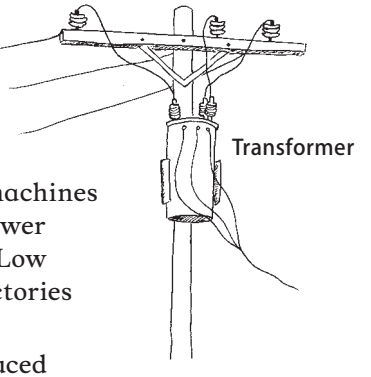
Storing energy

Any form of energy, in order to be useful when and where it is needed, must be stored. For gas or oil-powered transportation, this means storing fuel in the tank of a car or bus so it can be burned along the journey. For electricity, it means using batteries.

Even if energy is made using clean sources such as wind, water, or sunshine, it must be captured in batteries. Batteries can often be among the most costly parts of a clean energy system. They also contain toxic materials and must be replaced after several years. So far, there is no good replacement for batteries as a way to store electrical energy.

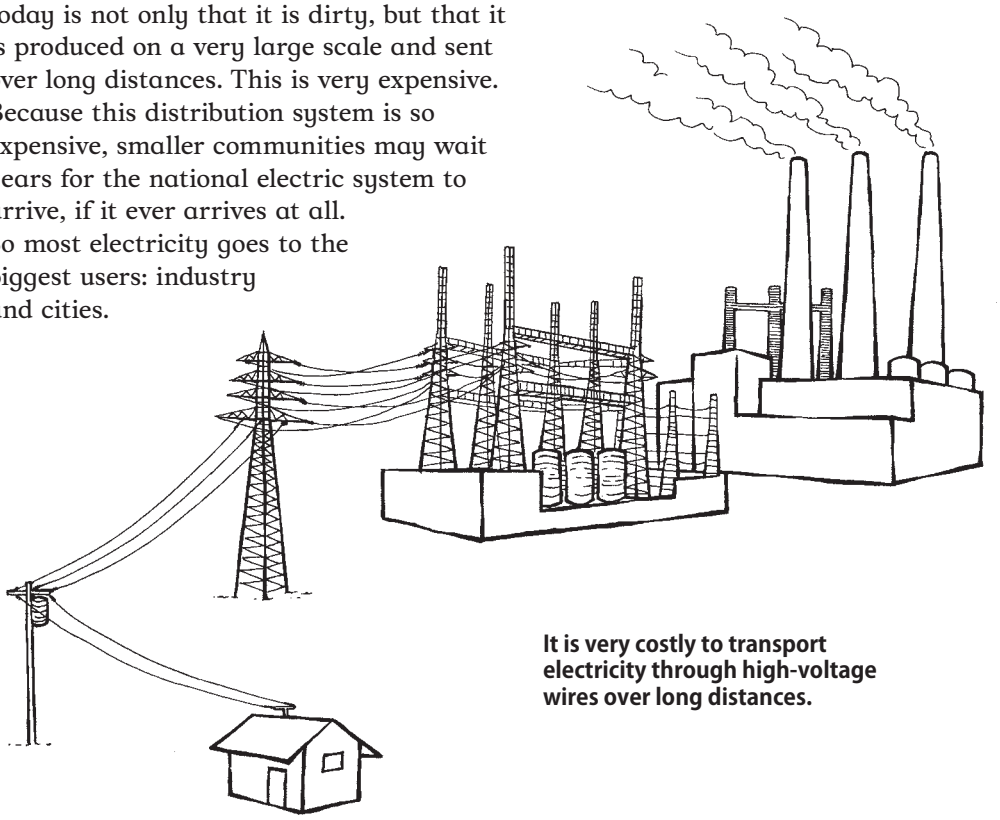


Energy Distribution



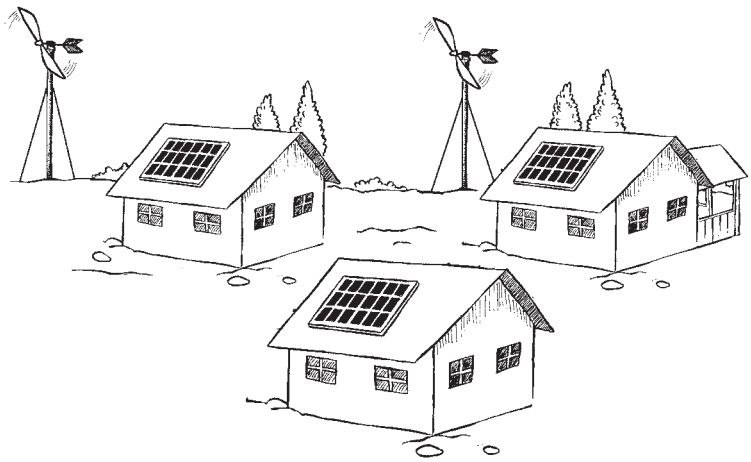
Large power plants run by private industry and governments generate electricity and distribute it through high-voltage wires to different areas. Then the electricity passes through transformers (machines that change the electricity from high voltage to a lower voltage that can be used in homes and businesses). Low voltage wires bring the electricity into houses or factories to run lights and machines.

The problem with the way most electricity is produced today is not only that it is dirty, but that it is produced on a very large scale and sent over long distances. This is very expensive. Because this distribution system is so expensive, smaller communities may wait years for the national electric system to arrive, if it ever arrives at all. So most electricity goes to the biggest users: industry and cities.



It is very costly to transport electricity through high-voltage wires over long distances.

Clean energy from wind, sun, and water can be made in smaller quantities at a lower cost, so clean energy is easier to use close to where it is produced. Communities that use clean energy can have control over their own energy resources. When electricity is made locally from sunlight, water, or biogas, it reduces dependence on fossil fuels, and on expensive, high-voltage distribution systems. It also avoids having faraway government agencies or large corporations setting prices and controlling where the energy can go.



Clean energy works best if a mix of different sources is used. If one source becomes unavailable, such as sunshine on cloudy days, or falling water in the dry season, the other sources are still able to make power.

Fossil fuel energy distributes electricity, dependence, and pollution. Clean energy distributes electricity, independence, self-reliance, and sustainability.

Solar-powered rural clinics

In a remote part of Burma near the border of Thailand, people of the Karen ethnic community live in constant struggle with the Burmese military. Due to this oppression, no governmental or non-governmental organization (NGO) is able to provide health care in this area. But Karen groups on the Thailand side of the border have built a network of medics supporting over 28 clinics that care for almost 100,000 people in the region. The medics treat land mine victims and other people wounded in the conflict, as well as other health problems.

Three NGOs, Green Empowerment, Sun Power Energy International, and a local group called Border Green Energy Team, brought solar panels and batteries to the border and trained Karen villagers, refugees, and medics to assemble and use them. The medics carried the equipment through the jungle. Now all 28 clinics in the war zone have electricity to run lights, laptop computers, and life-saving medical equipment, and villagers know how to repair and maintain their own solar energy systems.

Making the Best Use of Electricity

Aside from using clean energy, an important way to reduce pollution from electricity is to use it more carefully. If we waste less electricity, our power plants will not have to produce so much — or produce so much pollution. There are many ways governments can promote better energy use, including regulating industry to use cleaner production methods (see page 458), and improving existing power plants and power lines.

Reduce waste, reduce demand

Compact fluorescent light bulbs last much longer than regular (incandescent) light bulbs, saving electricity and money.

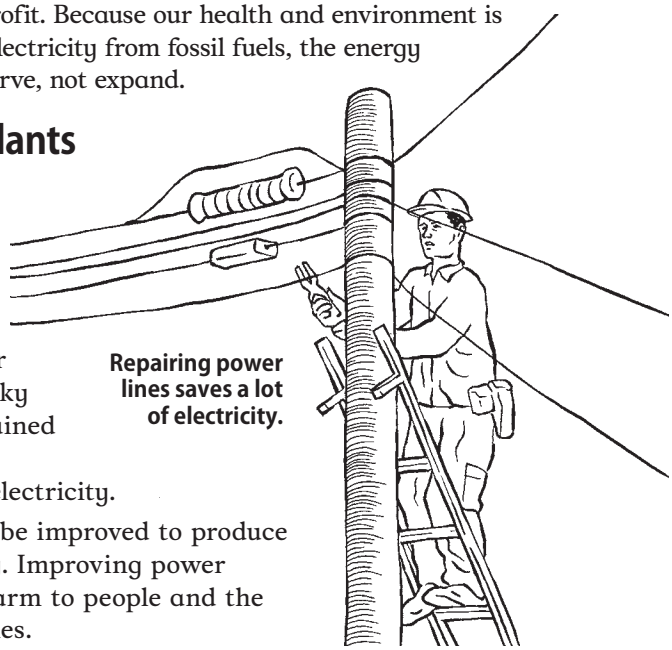
Reducing the demand for more electricity by people and industries that use too much is the best way to reduce the use of fossil fuels. Governments can reduce the demand for energy by encouraging factories, businesses, and people who live in cities to use energy more efficiently. When less energy is used, it reduces both the cost of making energy and the harm to peoples' health and the environment.

Governments can charge more or ask for higher taxes from industries that use the most electricity. Governments can also encourage electricity use at different times of the day, so that it is not in demand all at one time.

The corporations that make electricity are like other businesses. The more they make and sell, the more they profit. Because our health and environment is harmed by too much production of electricity from fossil fuels, the energy corporations must be forced to conserve, not expand.

Improve existing power plants and power lines

Power lines carry electricity from power plants to wherever the electricity is used. The way electricity moves through a power line can be compared to how water moves through a pipe. Just as a leaky pipe wastes water, a poorly maintained power line wastes electricity. Poor quality power lines waste a lot of electricity.



Repairing power lines saves a lot of electricity.

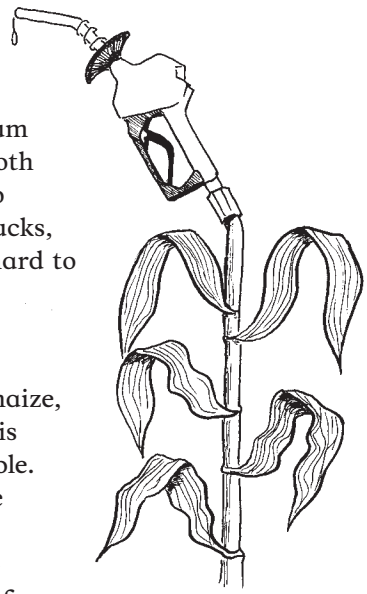
Existing power plants can also be improved to produce more, cleaner, and safer electricity. Improving power plants costs less and causes less harm to people and the environment than building new ones.

Transportation

Along with electricity, the biggest use of energy worldwide is as fuel for transportation in trains, airplanes, trucks, buses, and automobiles. Just as with electricity, people in wealthy countries use more fuel for transportation than people in poor countries. Pollution from burning fuel for transportation is a major cause of illnesses such as asthma, bronchitis, and cancers, and also causes global warming.

In order to burn less fuel and have more fairness in transportation, people in wealthy countries, especially the United States, must use more public transportation (trains and buses) and fewer private automobiles. Cities and transportation systems must encourage bicycles instead of cars.

The problem with plant-based fuels



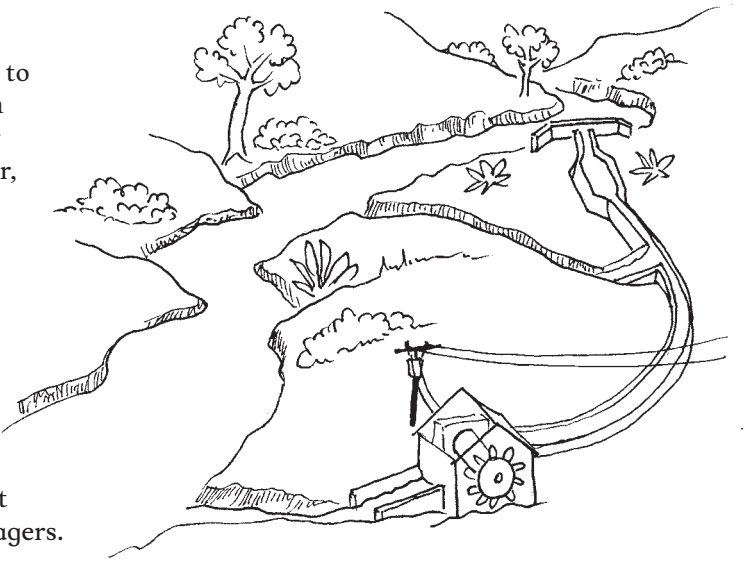
When the automobile engine was invented, it was made to run on fuels made from plants, such as vegetable oil or alcohol. But soon after, when petroleum became cheap to produce, gasoline and diesel fuel (both made from petroleum) became the main fuels used to power automobile engines, as well as motorcycles, trucks, and airplanes. The petroleum industry worked very hard to prevent plant-based fuels from being used.

Now that oil has again become expensive, many countries are turning to plant-based fuels to replace petroleum. Fuel made from palm, soybeans, canola, maize, or other plant oils is called "biofuel" or "agrofuel." This seems like a good solution because plants are renewable. But there are many reasons why agro-fuels will cause more problems than they solve.

- Producing oil from plants that could be used for food leads to competition between growing fuel for cars and growing food for people. With so many people suffering from lack of food, we cannot afford to turn food into fuel.
- One reason to reduce dependence on fossil fuels is to decrease global warming. But to produce the amounts of crops needed to make biofuel requires the use of petroleum fertilizer, farm machinery, and transportation of the fuel crop from where it is grown to where it is processed and distributed, and finally to where it is used. In the end, producing biofuels uses more energy than it produces, and causes more global warming than petroleum!
- When forested land is cleared to grow biofuel crops, the trees that absorb global warming gases are destroyed. For example, biofuel made from palm oil causes 10 times as much global warming as diesel oil.

Small Dams

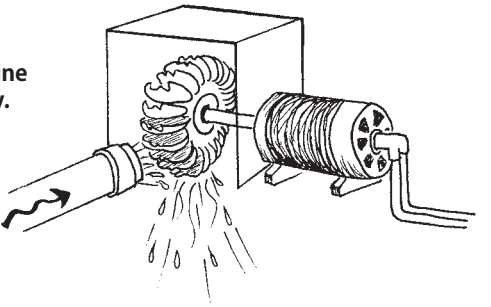
Small dams can be used to generate electricity from running or falling water (called small hydropower, and micro-hydropower when it is very small). Where there is enough water from rivers or streams, micro-hydropower is the least costly way to provide electricity to rural communities. These projects can be set up and managed by villagers. In China, India, and Nepal, thousands of small hydropower projects supply power to villages and towns.



Water is taken from the river, run downhill to a turbine, and then flows back into the river.

In small hydropower projects, water is channeled from a river or stream and runs downhill through a pipe. The falling water in the pipe turns a turbine, and then returns to the river or stream. Small dams do not displace people or change the flow of the river the way large dams do. Micro-hydropower projects use dams only a few meters tall to direct water toward the turbine.

Water turns the turbine to produce electricity.



(To learn more about micro-hydropower and to contact organizations that install micro-hydropower systems, see Resources.)

Micro-hydropower unites communities

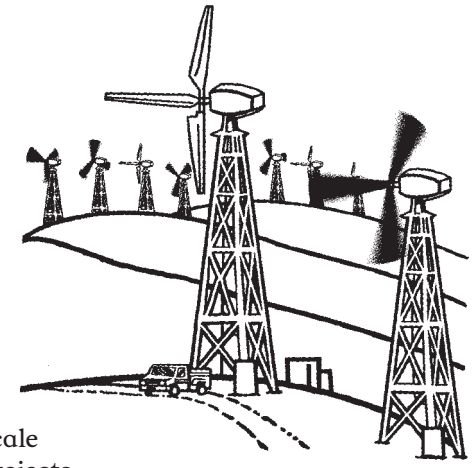
As the country of Nicaragua recovered from many years of war, people throughout the country devoted themselves to rebuilding farms, water systems, schools, and health clinics. But the country was left in deep poverty, and the government was unable to provide electricity to many rural communities.

The village of La Pita had no electricity, and the nearest power lines were 70 kilometers away. People in La Pita had fought on opposing sides in the war, and this made it difficult to carry out community projects. But after they worked together to build a school and a clinic, they decided to bring electricity to the village as well.

The villagers asked a local group called the Association of Rural Development Workers-Benjamin Linder to help them electrify La Pita. Because the village lies close to a river that runs year-round, La Pita was a good site for a micro-hydropower project. The development workers helped the villagers organize the project and get support from a small international agency called Green Empowerment, which provided funds and technical skills.

Community members worked together for many hours to build the small dam and turbine that now send electricity to 400 villagers. The electricity is used in people's homes, the community school, 2 carpentry shops, and local farms. When the electric plant was installed and running, the community formed an association to run and maintain the system, making sure everyone in La Pita benefits. Despite differences people had in the past, electricity and the responsibility for generating it is now shared by everyone. The small village of La Pita, far from the national power lines, has its own power.

Wind Power

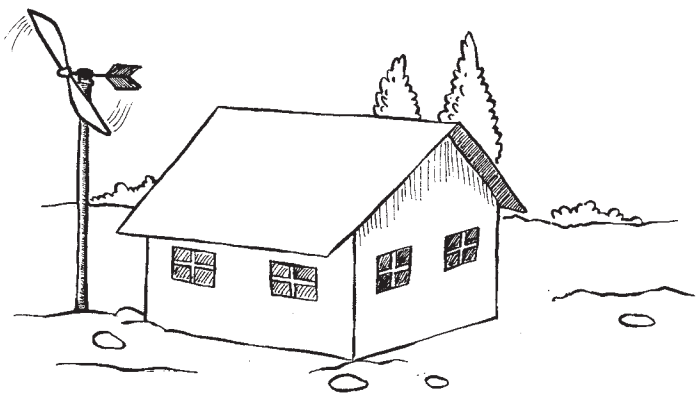


Energy from the wind has been used for hundreds of years to pump water and grind grain. In recent years, wind is being used to generate electricity in Europe and North America, India, China, South Africa, and Brazil. Large and small windmills generate electricity as the force of the wind turns the blades.

Wind power may be the cheapest and best way to replace fossil fuels for large-scale electricity generation. Large-scale wind projects are often connected to national electric lines. For wind energy to work well, constant strong winds are necessary. Coastal areas, open plains, and mountain passes are best for wind power. Because wind in most places is not constant, wind turbines require batteries to store the electricity or a back-up power system (solar panels or a gas-powered generator).

Small-scale wind energy

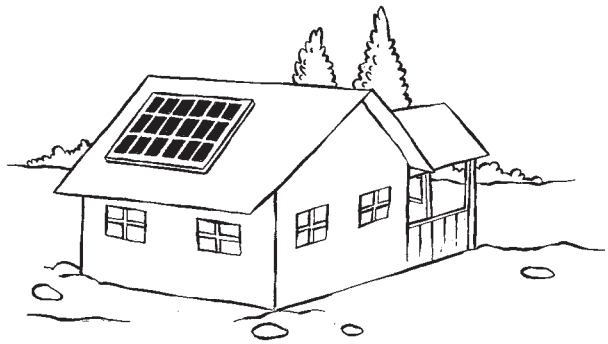
Wind turbines are used to charge batteries for homes in some parts of the world. But because wind energy relies on constant wind, requires careful measurements to set up and maintain the turbines, and wind turbines may be costly, this may not be the best choice for home or village electricity. Wind may seem better at first glance than solar, because a wind turbine may cost less than solar panels, but in the long term it needs more repairs and maintenance.



(To learn more about wind power and to contact organizations that install wind power systems, see Resources.)

Solar Power

When you feel the sun heating your body or the air in your house, this is solar energy. There are many ways to make efficient use of the sun's energy to heat water (see page 538), to make water safe (see page 98), and to cook food or heat a house (see page 378). The sun's energy can also be used to make electricity.

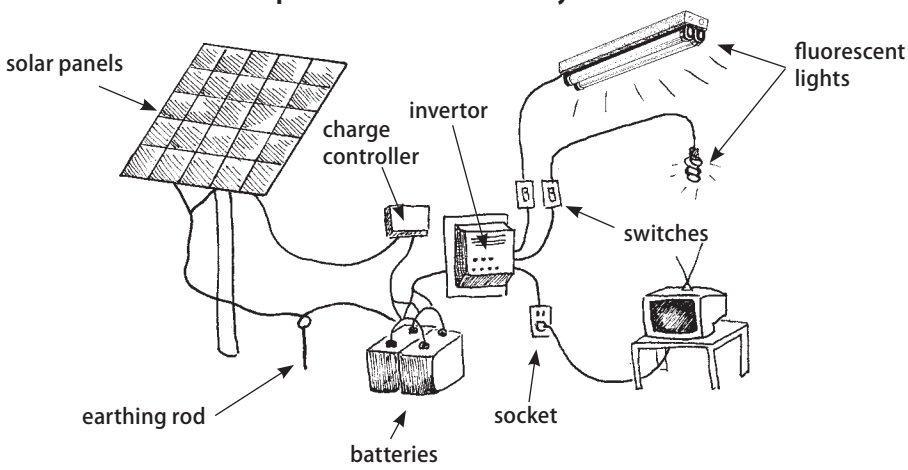


Solar panels on the roof of a house collect energy from the sun.

Solar energy requires the use of **solar panels** or solar cells to capture the sunlight and change it into electricity. Because the sun is not always shining, the electricity made must be stored in batteries before being used to run lights, motors, and other machines.

A solar energy system can be costly to install because it requires solar panels, batteries, and other parts. But sunlight is free (and endlessly renewable). Once a solar system is in place, it costs little to run and maintain. The biggest costs of maintaining a solar system are replacing the batteries every 3 to 5 years and replacing solar panels if they break.

The parts of a solar electric system



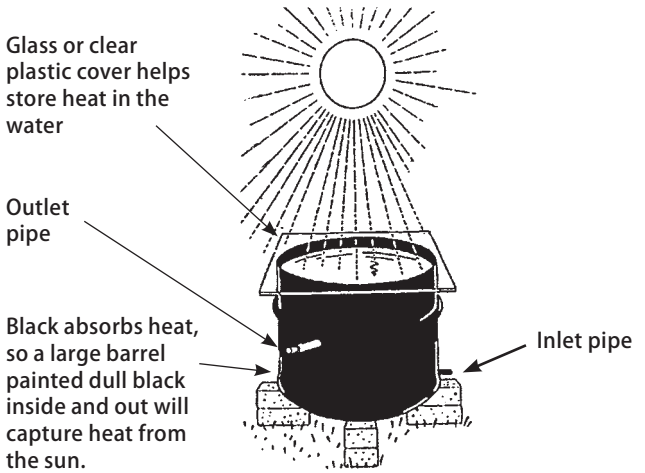
(To learn more about solar energy and to contact organizations that install solar electric systems, see Resources.)

Solar hot water

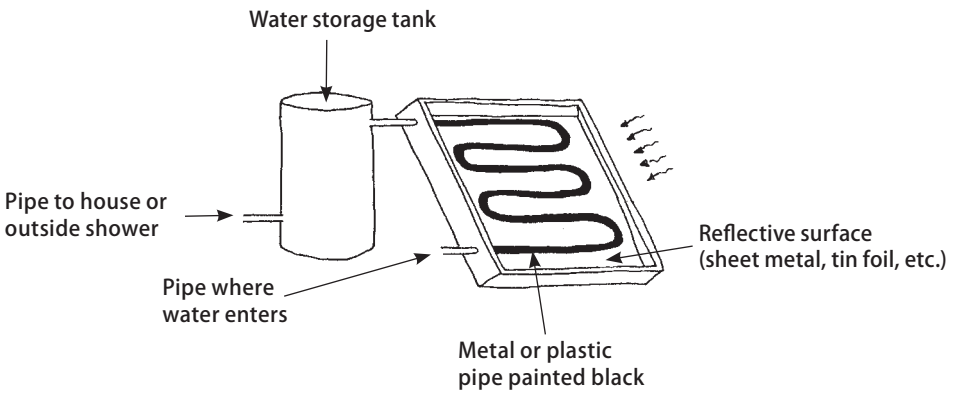
In areas with a lot of sunlight, one of the most direct uses for solar energy is to heat water for drinking or bathing. Solar hot water does not require solar panels or costly equipment. All that is needed is a water storage tank, and pipe painted black to absorb the sun's rays.

In mild climates, solar collectors are needed to heat water. They are more costly than simple solar water heaters, but less costly than the solar panels needed for electricity, and less costly than heating water with nonrenewable resources.

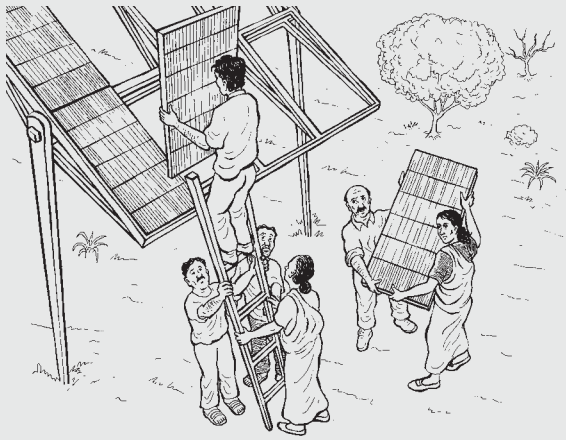
A simple water heater



Solar water heater placed in the sun on a roof or at ground level



Microcredit helps fund solar power



Most homes in rural Sri Lanka are not connected to the national electric power system. But as in many tropical countries, the island of Sri Lanka has a lot of sunshine. In 1991, an organization called SELF (Solar Electric Light Fund) came to Sri Lanka to help people use their sunshine to make electricity.

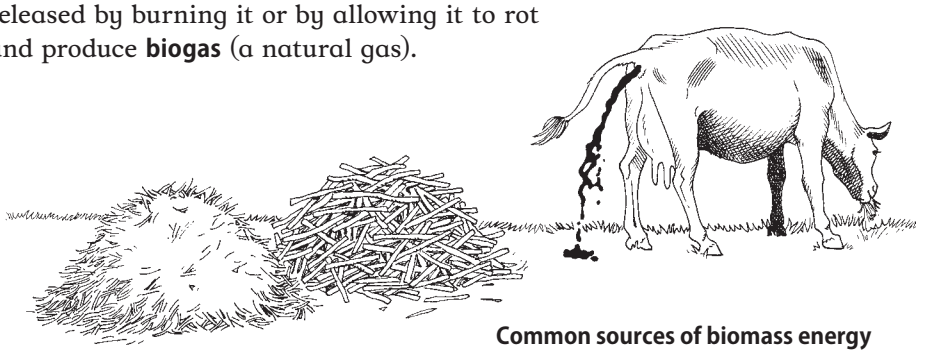
Because they could not give away solar power systems for free, SELF came up with a way to help people pay for their own systems. Together with a Sri Lankan non-profit organization, they formed a "solar cooperative." The cooperative set up a microcredit fund. Cooperative members paid a small down payment to have a solar system set up, and made small payments to the fund every month for up to 8 years. As the fund grew, more families were able to use it to pay for their own solar systems. After 5 years, the first 48 families had repaid enough into the microcredit fund to allow 25 more families to buy solar systems.

Building on this success, SELF began working with Sarvodaya, the largest NGO in Sri Lanka, with over 3 million members. SELF and Sarvodaya developed a "Solar Seed" program, which introduced solar electricity to over 100 villages. The program installed demonstration solar systems in community centers, schools, and Buddhist temples. SELF then organized a microcredit fund to help Sarvodaya members buy home solar systems. The program started with 300 households. A few years later, it was so successful that Sarvodaya began planning for a "million-home" solar program.

Thousands of homes in rural Sri Lanka now have solar electricity. Using the microcredit system, thousands more will soon have solar electricity. If they continue working this way, Sri Lanka may one day be the world's first nation to run entirely on sunlight.

Biomass Energy

In many countries, **biomass** (waste material from plants and animals) is a common household energy resource. The energy in biomass materials can be released by burning it or by allowing it to rot and produce **biogas** (a natural gas).



Common sources of biomass energy

Biomass from plants is renewable, but when it is burned as fuel it contributes to global warming and health problems. When you make a fire with wood or cow dung, you are using biomass energy on a small scale.

On a larger scale, crop wastes (residues) can be used to generate electricity. In Cuba, for example, a large amount of electricity is generated by burning sugarcane stalks after they have been harvested and milled for sugar. Rice husks, wood waste, and other kinds of biomass can also be used in this way. While it may be renewable, pollution from burning crop wastes is bad for the health of the community and the environment.

Biogas

Biogas is produced when organic matter rots. When biogas is captured in a closed container, it can produce a small flame for cooking, or electricity for heating, lighting, pumping water, and operating motors and farm equipment. By converting the organic matter in human, animal, and plant waste into energy, biogas turns waste products into a resource that is good for the environment and for community health. Biogas can be made from many kinds of organic matter:

- animal manure and urine
- human feces and urine
- food waste such as meat, blood, bones, and vegetable scraps
- plant matter such as crop residues, straw, leaves, bark, branches, and grass cuttings

Biogas is invisible and does not smell. When it is burned, it produces a clean blue flame. Using biogas for cooking instead of solid fuels like wood reduces illnesses from indoor cooking smoke (see Chapter 17), and reduces the pressure to cut down trees for fuel. The material left behind after producing biogas can be used as a high quality fertilizer. Burning biogas does not lead to climate change and global warming.

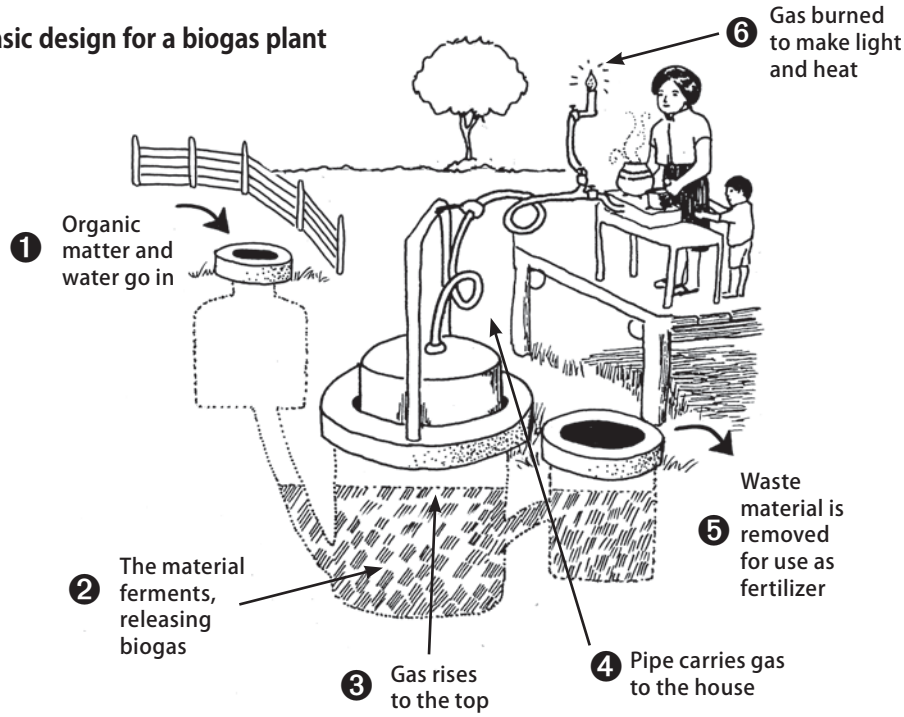
Make a small biogas plant

The design of the biogas plant depends on the quantity and kind of wastes you have, the climate, and the construction materials available. You can collect biopgas in a tank or a 5 to 10 meter long sausage-shaped plastic bag. Different kinds of animal and plant waste create different amounts of gas, so it is difficult to say how many animals are needed to produce biogas.

Manure from cows, pigs, chickens, and even human waste can be used to produce biogas. Cows produce the most, by far, and are the best source of biogas fuel. To have enough fuel to cook every day (5 hours per day on a 2-burner stove), 4 or 5 cows are needed.

Before building a biogas plant, you must be sure you have enough waste material available to generate the amount of energy for your needs.

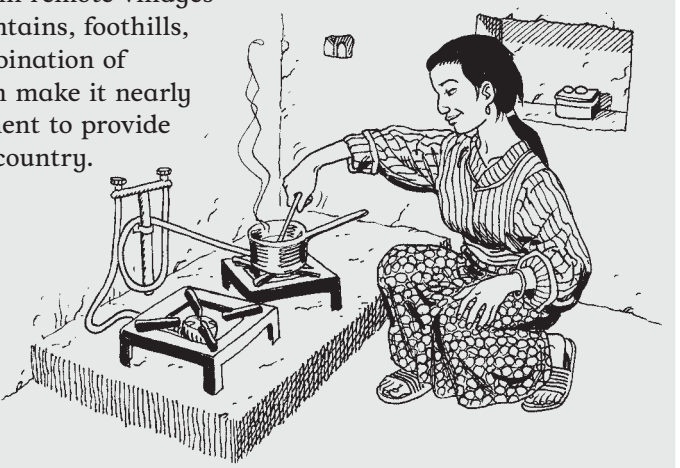
A basic design for a biogas plant



(To learn more about biogas and to contact organizations that build biogas systems, see Resources.)

Biogas powers rural life

In Nepal, most people live in remote villages scattered across high mountains, foothills, and deep valleys. The combination of poverty and rugged terrain make it nearly impossible for the government to provide electricity throughout the country.

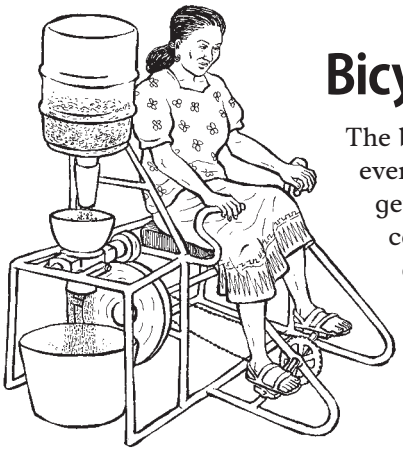


Because it is an agricultural nation, most households in Nepal have cattle. In the early 1990s the government of Nepal discovered that they could use cattle dung mixed with water to make biogas, providing energy for people in rural areas to have heat, light, and cooking fuel for very little money. With support from the governments of Germany and Holland, they established the Biogas Support Program (BSP).

The goal of this program is to provide a biogas system to as many homes in Nepal as possible. BSP designed a biogas system that was low-cost, efficient, and easy to use and maintain. BSP workers did outreach and education to teach rural people about the uses and benefits of biogas. They also started a microcredit program to help families pay the costs of the biogas systems.

In the first 2 years, 6000 biogas systems were installed. The program was so effective that over the next 10 years, 100,000 more systems were installed. By the year 2010, the government hopes to have installed 200,000 biogas systems.

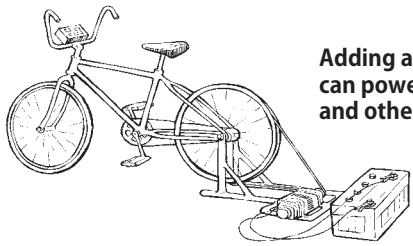
Families all over rural Nepal now use biogas for cooking, heating, and light. By using biogas, each house saves 4 tons of firewood and 32 liters of kerosene per year. Each biogas plant also produces 5 tons of fertilizer per year, which farmers use to improve their crop yield. Thanks to biogas, many families in Nepal are now healthier, warmer, and less dependent on fuels that pollute and damage the environment.



Some machines run on human bicycle power.

Bicycle Power

The bicycle may be one of the greatest machines ever invented. Bicycles provide an easy way to get around using only human energy, and have countless benefits for people's health and the environment. But more than this, human power can be harnessed by bicycles and used as energy for running many different kinds of machines.



Adding a battery, bicycles can power lights, televisions and other machines.

Maya Pedal bicycle power

In 1997, a group came together in Chimaltenango, Guatemala, to promote sustainable development. Called Maya Pedal, this NGO promotes health, environmental protection, and a sustainable rural economy through bicycle power.

They began by collecting used bicycle parts to build bicycle-powered machines to meet the needs of rural people. Maya Pedal sold bicycle-powered machines to anyone who wanted to buy one, but groups that wanted to start sustainable development projects were offered especially low prices.

A women's collective asked for a bicycle-powered blender to produce shampoo made from aloe vera grown in their own gardens. With the money they make from the shampoo, the women support their families and fund their town's reforestation project. Another group asked for a bicycle-powered grain mill. They use the mill to grind corn for animal feed which they sell at low cost to local communities. People everywhere have found creative ways to use bicycle power. (See *Where There Is No Dentist,* page 151, for a photo of people using a bicycle-powered dental drill!)