THE MAGIC OF ENERGY
Study Guide

Energy: The ability to do work

Energy makes everything happen and can be divided into two types:

- Stored energy is called potential energy.
- Moving energy is called kinetic energy.

Fossil Fuels: What are they?

Non-renewable energy sources (fossil fuels) were formed millions of years ago, when dinosaurs walked the Earth. Oceans covered most of the Earth. They were filled with tiny sea plants and animals. When the plants and animals died, they sank to the bottom and were covered by sand and mud. Layers of dead plants, animals, sand and mud built up over time. Heat and pressure turned these layers into fossil fuels such as: • coal • oil • natural gas.

Why did we start using these? Up until now, fossil fuels have been used to generate electricity because they're widely available, inexpensive, easy to transport, easy to use, and the power plants can be located almost anywhere.

Why do we HAVE to change NOW? When coal, natural gas or oil are burned, they release gases into the atmosphere:

- Carbon dioxide (CO2) is a "greenhouse gas," trapping heat in the lowest part of the earth's atmosphere.
- Sulfur dioxide (SO2) is a key contributor to acid rain, primarily in the northeast U.S.
- Nitrogen oxide (NOx) contributes to acid rain and smog, as well as health issues such as lung inflammation, immune system changes and eye irritation.

While fuels like coal, natural gas and petroleum are still plentiful, pollution caused by using these energy sources will become a serious problem. But even before that our supply will run out - once we use them, they're gone forever.

Global Warming

We all hear about Global Warming now. Global warming is a blanket of air that traps heat from the sun in a blanket of air which covers our Earth. Without this blanket, the Earth would be so cold people could not live here. But too much trapped heat would make it too hot to live here as well. This is called global warming. It can change the fragile balance for life on Earth.

What Can We Do??

We can and are harnessing the 4 basic elements of the earth, which are free and unlimited.

- Earth, Wind Fire and Water. Each offers us energy and life.
- Earth: Bio Mass and Geo thermal energy
- Wind: Wind mills and wind Turbines
- Fire: The sun, solar energy
- Water: hydro-electric, wave and ocean energy.

Earth: We can get two types of energy from the earth.

1. Geothermal Energy

The word geothermal comes from the Greek words geo (earth) and therme (heat). So, geothermal energy is heat from within the earth. We can use the steam and hot water produced inside the earth to heat buildings or generate electricity. Geothermal energy is a renewable energy source because the water is replenished by rainfall and the heat is continuously produced inside the earth. People around the world use geothermal energy to heat their homes and to produce electricity by digging deep wells and pumping the heated underground water or steam to the surface.

2. Bio Mass Energy

The word biomass means organic matter - biomass energy (or "biofuels") comes from natural material, such as wood products, municipal solid waste, agricultural crops and even landfill gases. If you burn wood in a fireplace, you're producing biomass energy; if you put ethanol gasoline in your car, you're consuming biomass energy.

Biomass energy offers significant environmental advantages:

- It contains no sulfur, so it doesn't contribute to acid rain
- It saves space in landfills by re-using waste products
- It contributes no new carbon dioxide to the atmosphere - any CO2 emitted during electricity generation is reabsorbed by new plant material.

WIND: Wind Energy

Wind can be used to do work. The kinetic energy of the wind can be changed into other forms of energy, either mechanical energy or electrical energy. Farmers have been using wind energy for many years to pump water from wells using windmills. Blowing wind spins the blades on a wind turbine -- just like a large toy pinwheel. This device is called a wind turbine and not a windmill. A windmill grinds or mills grain, or is used to pump water. Today, the wind is also used to make electricity. The blades of the turbine are attached to a hub that is mounted on a turning shaft. The shaft goes through a gear transmission box where the turning speed is increased. The transmission is attached to a high speed shaft which turns a generator that makes electricity.

The advantages of wind power: Wind energy is free and completely renewable, there are no hazardous emissions, and there are no adverse environmental impacts. Wind power is also becoming more economical to produce and technological innovations have brought the cost of wind power down.

FIRE: The Sun

The sun has produced energy for billions of years. Solar energy is the sun's rays (solar radiation) that reach the earth. We have always used the energy of the sun as far back as humans have existed on this planet. As far back as 5,000 years ago, people "worshipped" the sun. Ra, the Sun God, who was considered the first king of Egypt. We know today, that the sun is simply our nearest star. Without it, life would not exist on

Photo credit: NASA - SOHO Project
Extreme Ultraviolet Imaging Telescope

our planet. We use the sun's energy every day in many different ways. When we hang laundry outside to dry in the sun, we are using the sun's heat to do work -- drying our clothes.

We can also change the sunlight directly to electricity using solar cells. Solar cells are also called photovoltaic cells - or PV cells for short - and can be found on many small appliances, like calculators, and even on spacecraft. They were first developed in the 1950s for use on U.S. space satellites. These individual solar cells are arranged together in a PV module and the modules are grouped together in an array. Some of the arrays are set on special tracking devices to follow sunlight all day long.

Solar energy can be converted to electricity in two ways:

- **Photovoltaic** (PV devices) or "solar cells" – change sunlight directly into electricity. PV systems are often used in remote locations that are not connected to the electric grid. They are also used to power watches, calculators, and lighted road signs.
- **Solar Power Plants** - indirectly generate electricity when the heat from solar thermal collectors is used to heat a fluid which produces steam that is used to power generator.

Solar Panel Costs

In the recent past, solar panels have been very expensive. However, due to the implementation of energy policies and the reforms the cost of electricity has been drastically reduced, forcing the cost of panels down as well.

WATER: We can use the energy of the water in several ways:

Wave Energy: Kinetic energy (movement) exists in the moving waves of the ocean. That energy can be used to power a turbine. The rising water forces the air out of the chamber. The moving air spins a turbine which can turn a generator. When the wave goes down, air flows through the turbine and back into the chamber through doors that are normally closed.

Tidal Energy: Another form of ocean energy is called tidal energy. When tides come into the shore, they can be trapped in reservoirs behind dams. Then when the tide drops, the water behind the dam can be let out just like in a regular hydroelectric power plant.
Tidal energy has been used since about the 11th Century, when small dams were built along ocean estuaries and small streams. The tidal water behind these dams was used to turn water wheels to mill grains. In order for tidal energy to work well, you need large increases in tides. An increase of at least 16 feet from low tide to high tide is needed. There are only a few places where this tide change occurs around the earth.

Photo credit: *Popular Mechanics*, December 1997.
Top picture shows water flowing from left to right.
Bottom left shows project while under construction.
Right picture shows turbine assembly and baldes.

Hydro electric plants:
There are 2 types of hydro electric plants:

- A **high-head plant** takes advantage of the force of falling water. Large-scale facilities like the Hoover Dam and Grand Coulee Dam are examples of high-head hydro plants. Dams are built along major rivers to create reservoirs; the utility controls the flow of water through the dam in response to the demand

- A **run of the river plant**, like those found in the Midwest, relies on the flow of the river to spin the turbines. These plants produce a much smaller amount of electricity.

The Challenges to Renewable Energy

Coal and oil have always been the most cost-effective way to make the large amount of electricity needed for modern life. Producing electricity from renewable resources is simply more expensive. Green technology doesn't have the entrenched infrastructure that fossil fuels have developed over the years, making the initial cost of building green power facilities more expensive.

The Economics of Change:

Renewable energy resource development will result in new jobs for people and less oil we have to buy from foreign countries. According to the federal government, America spent $109 billion to import oil in 2000. If we fully develop self-renewing resources, we will keep the money at home to help the economy.

Conclusion

To make sure we have plenty of energy in the future, it's up to all of us to use energy wisely. It's also up to those who will create the new energy technologies of the future.
All energy sources have an impact on the environment. Concerns about the greenhouse effect and global warming, air pollution, and energy security have led to increasing interest and more development in renewable energy sources such as solar, wind, geothermal, wave power and hydrogen.
Unlike fossil fuels, which dirty the atmosphere, renewable energy has less impact on the environment and renewable energy development will result in jobs and less oil imported from foreign countries.

But we'll need to continue to use fossil fuels and nuclear energy until new, cleaner technologies can replace them. One of you who watched our show today might be another brilliant scientist like Albert Einstein or Marie Curie and find a new source of energy. Until then, it's up to all of us. The future is ours, but we need energy to get there.

Magic of Energy - Vocabulary List

Energy**: The ability to do work. There are two kinds of energy.**

Kinetic Energy: Objects in motion
Potential Energy: The possibility of motion
Fossil Fuels: Formed under the earth millions of years ago by the decomposition of plants and animal matter.
Coal: Today it is in the form of a hard black mineral substance.
Oil: Also took millions of years to create. It is today in the form of a thick black very flammable liquid
Natural Gas: A combustible mixture of gaseous hydrocarbons the accumulates in porous sedimentary rocks, usually those yielding petroleum
Toxic: Poisonous
Algae: Stuff that contains the chlorophyll needed for photosynthesis. It is distinguished from plants by the absence of true roots, stems, and leaves and by a lack of non-reproductive cells in the reproductive structures. There are many different kinds of algae.

Decomposition: Break down or decay
Dinosaurs: Various extinct, often gigantic, carnivorous or herbivorous reptiles.
Environment: The world around us.
Elements: Parts
Renewable: Can make more
Solar Energy: Energy from the sun.
Radiation: The process in which energy is emitted in particles or waves
Solar Cells: Devices, that converts sunlight directly into electric current.
Photovoltaic Cells: A kind of solar cell

Solar panel**: A bank of solar cells**

Panel: A group of people working together to discuss a particular topic.
Convert: Change
Electricity: The science of dealing with electric charges and current
Hydro: Water
Turbine: Motor
Windmill: A device, which collects the movement of the air.
Pollution: The introduction of harmful substances or products to the environment
Emission: A substance discharged into the air, especially by an internal combustion engine.
Biomass: Organic matter, especially plant matter that can be converted to fuel and is thought of as an energy source.
Organic Matter Things that occur naturally. Usually carbon-based substances derived from living things.
Conserve: Save
Reduce: Make smaller or use less
Reuse: To use again

Recycle**: To treat or process to make it suitable for reuse.**

Renew: To make, say, or do again.