GEOLOGY REVISION

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Geology Lo.8

Ores

What are Ores?

A naturally occurring mineral containing a valuable constituent (such as metal) for which it is mined and worked

Gold-Copper ore

- **Note:** All ores are minerals but not all minerals are ores
- Compare between ORE and MINERAL

MINERAL	VS	ORE
The natural materials in which the metals or their compounds are found in earth are called **minerals.**		Those minerals from which metals can be extracted profitably, conveniently and quickly are called **ores.**
		
All minerals are not ores.		All ores are minerals.
Clay and Bauxite are minerals of Aluminium		Bauxite is ore of Aluminium but not clay as Al can be extracted economically , easily from Bauxite but not clay

ZT Classes

Properties of ores:

- Made of different minerals
- Differ in distribution throughout the world
- Can be found in rocks on land or in seas
- Ores are usually found in igneous rocks
- Ores are non-renewable
- Ores are denser than common rocks
- Ores are metals
- Ores of iron and aluminum are the two most-used metals.

Places to find ores:

- Old continental rocks : in continents that are older

- Orogenic belts : they happen due to collision of plates and deposition of ores in the rocks

- Hydrothermal activity : deposition of minerals that are not solidified with igneous rocks move up the surface and solidifies , they are called hydrothermal deposits.

List of some metals and their common ores with their chemical composition:

Metal	Ore	Composition	Metal	Ore	Composition
Aluminum	Bauxite	$Al_2O_3.nH_2O$	Zinc	Zinc blende or Sphalerite	ZnS
	Diaspore	$Al_2O_3.H_2O$		Calamine	$ZnCO_3$
	Kaolinite	$Al_2Si_2O_5(OH)_4$		Zincite	ZnO
Iron	Haematite	Fe_2O_3	Lead	Galena	PbS
	Magnetite	Fe_3O_4		Anglesite	$PbSO_4$
	Siderite	$FeCO_3$		Cerrusite	$PbCO_3$
	Iron pyrite	FeS_2	Tin	Cassiterite (Tin stone)	SnO_2
	Limonite	$Fe_2O_3.3H_2O$	Silver	Silver glance (Argentite)	Ag_2S
Copper	Copper pyrite	$CuFeS_2$		Pyrargyrite (Ruby silver)	Ag_3SbS_3
	Copper glance	Cu_2S		Chlorargyrite (Horn Silver)	AgCl
	Cuprite	Cu_2O		Stefinite	Ag_2SbS_4
	Malachite	$CuCO_3.Cu(OH)_2$		Prousitite	Ag_2AsS_3
	Azurite	$2CuCO_3.Cu(OH)_2$			

Factors responsible for finding ores:

- Surface mapping (from geologic maps)
- Observation
- Sampling and Analysis
- Geosciences
- Geostatistical models

(copper geologic map)

Scientists use geosciences (geophysics and geochemistry)

a. Geochemistry : study the chemistry of rocks and minerals to identify if they have ores but they cannot determine how deep they are
b. Geophysics: study the properties of rocks by using tools

Note:

There is no exploration technique that can give a complete picture of what is below the surface. The geologist must be able to assess the data collected. It is important to look at all the clues to find minerals. Millions of dollars are spent on exploration. However, only a very small number of explored areas become profitable mines.

Ways to find ores:

- Seismic waves reflection: when these waves hit the ores are bounce back, they depth can be recorded on geophone
- Gravimeter: they measure the difference in gravity of rocks and the denser rocks would have more ores
- Electric current: When passing electric current through rocks the two conductors that can conduct the current are either water or ores
- Magnetometer: they are used to detect the change in earth magnetic field caused by the existence of iron ore in rocks

Extraction of ores:

1. MINIG

Mining site

- **SURFACE MINING**

Surface mining is a cost-effective method for extracting minerals near Earth's surface, including coal, iron, and bauxite, and is particularly suitable for extracting minerals near the earth's surface.

- UNDERGROUND MINING (SUBSURFACE MINING)

Underground mining is ideal for extracting minerals deep under the earth's surface, such as gold, lead, and silver. The depth and economic value of the deposit determine the mining method, with the Mponeng Gold Mine in South Africa being the deepest.

- PLACER MINING

Placer mining is a process of separating valuable metals from sediments through sifting, often found in natural sediment accumulation environments like riverbeds, sands, and sands.

- IN-SITU MINING

In-situ mining involves extracting minerals from earth without extracting rocks and ore, primarily uranium, by injecting a solution that dissolves the mineral and pumps it back to the surface.

2. Hand-picking: The ore is broken into little pieces, and the sand and mud that adheres to it are washed away by a stream of water.

3. Hydraulic washing: This procedure is also known as levigation or gravity separation. It is based on the specific gravities of the ore and gangue particles being different.

4. Electromagnetic separation: Magnetic ore is separated from impurities by placing powdered ore on a leather belt over magnetic rollers, attracting ore particles and removing impurities, enabling extraction of chromite, rutile, and wolframite.

5. The froth floatation process is a widely used method for sulphide ores, involving a large tank filled with ore, water, pine oil, metal sulphide, and ethyl xanthate or potassium ethyl xanthate. It removes oil-soaked ore particles, stabilizes the mixture with cresol and anisole, and uses ethyl xanthate as collectors.

6. Liquation: This technique is appropriate for ore with readily fusible mineral particles and a high melting gangue.

7. Chemical separation (leaching): The process involves using a chemical reagent to dissolve powdered ore, separating bauxite from Fe2O3, SiO2, and TiO2, with Al2O3 being soluble and the rest insoluble.

$$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$$

$$NaAlO_2 + 2H_2O \rightarrow Al(OH)_3 +$$

$$NaOH\ 2Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O$$

$$Ag_2S + 4NaCN \rightarrow 2Na[Ag(CN)_2] + Na_2S$$

Side effects of mining

- Mining is unsafe for human and the environment
- It causes soil erosion
- Pollutes soil, water and air
- Affect biodiversity
- Affect human health

Important terminology (geo words)

- Ore: A type of rock that contains minerals with important elements including metals that can be extracted from the rock at a profit.
- Gangue: commercially worthless material that surrounds, or is closely mixed with, a wanted mineral in an ore deposit.
- Ore deposits: Ore accumulation. Parts of the crust, where ores are concentrated
- Mining: Extraction of ores, or other valuable minerals from the ore deposits

Summary of Digging deeper in EARTH COMM

Almost all of Earth's mineral resources are on the continents. The water of the oceans contains huge amounts of chemical elements, for he most part, the concentrations are extremely small. For most of these chemical elements, the cost of extraction makes it impractical to use them as mineral resources.

Gold is a good example. Its concentration in ocean water is only 0.011 µg (millionths of a gram) per liter. That adds up to more than 10 billion total kilograms of gold in the oceans. It is far greater than the known reserves of gold in continental ore deposits. The technology used to extract gold from seawater is difficult and expensive. It is not at all economical.

Great areas of the deep ocean floor are covered with dark-colored, rounded masses.

Many of these areas are found in the Pacific Ocean. The masses are called iron– manganese nodules.

They range in size from golf balls to large fists. They consist of very fine-grained minerals of iron and manganese, with many other chemical elements in smaller concentrations. Techniques for mining them from the ocean floor have been developed.

There are two problems : The sediment stirred up and suspended in the water during mining would have a harmful effect on the deep ocean environment. Also, the open oceans do not belong to any one country. They belong to humankind.

Earth's continents are geologically old. The oldest continental bedrock is 4 billion years old. This is only half a billion years younger than Earth itself.

Also, large areas of Earth have bedrock that is older than a billion years. However, the geologic processes that form the bedrock record work on short geologic time scales. This means that there has been plenty of time for the geologic record of the continents to become very varied. It shows a jumble of irregularly shaped areas. The areas are colored in with a variety of colors and patterns. These are rocks of different types and different ages. You can see that a large part of the United States has complex geology.

They have not been subjected to ore-forming processes. In contrast, most areas of the western United States and some areas of the eastern United States show a complex pattern of rock types. These areas are called orogenic belts.
The word “orogenic” means “mountain-building.” These are areas where collisions between Earth’s lithospheric plates have resulted in a great uplift of the land surface. Mountains have been formed. In many places, these mountains have been worn down from their original heights. In some of those areas, igneous activity has led to deposition of various ores.

One of the most important processes that forms ore is called hydrothermal activity.
Magmas contain many valuable chemical elements. These elements are in very small amounts. They become concentrated in water-rich “juices.” These juices are left over after most of the magma has crystallized to form ordinary igneous rocks. These elements tend not to be included in the main minerals that crystallize from the magma. These juices work their way upward toward the surface. As they move upward, they cool. This causes a great variety of unusual minerals to crystallize. Many deposits are valuable ores. One example of this is a hydrothermal deposit. Much of the copper, zinc, tin, lead, mercury, gold, silver, platinum, and so on, come from hydrothermal ore deposits.

Ores of iron and aluminum are the two most-used metals. Almost all iron ore comes from special sedimentary rocks. These rocks are very rich in iron minerals. These minerals were deposited in the oceans far back in geologic time.
In the United States, these rocks are mined for iron ore. The mining takes place in northern Minnesota and northern Michigan. Aluminum ore consists of aluminum oxides. These are formed when rocks that contain aluminum are weathered at Earth’s surface in warm and humid climates. Aluminum ore is also called bauxite Some bauxite is mined in the United States. However, most comes from other countries.

Some countries are richer in mineral deposits than others. Countries that have large areas of very old continental rocks are especially rich in mineral resources. Canada, Russia, Congo, South Africa, Brazil, and Australia are some examples. The United States has lots of energy reserves. (These include coal, oil, and natural gas.) However, it is not as rich in most mineral deposits as other large countries. The United States has abundant iron, copper, and tin deposits. Yet almost all of the aluminum must be imported. This is also the case for ores of several special metals that are important in making steel. These include nickel, cobalt, and chromium.
The United States government stockpiles important metals. This is done in case supplies from other countries become reduced or cut off in the future.

Looking for mineral resources relies on many factors. Observation, data, and analysis is crucial. A good understanding of the geosciences is important. Experience is also valuable. However, there is still quite a lot of uncertainty. Minerals may not be in the places prospectors expect them to be. Also, even if a mineral deposit is found, problems can arise. There is no guarantee that it is concentrated. It may not be profitable to extract a mineral deposit if it is not highly concentrated. Exploration is very expensive. Drilling is the most expensive way to explore. However, it is the only sure way to confirm the type and amount of minerals present.

In mineral exploration, drill holes are often at least 300 m deep. They may cost $150 per meter. In oil exploration, a single drill hole may cost millions of dollars. Geologists try to avoid spending money on “dry holes.” They use other ways to find out more about what is below the surface. This helps them to eliminate areas with low exploration potential.

Geologists map the surface by examining rock types in the field. They know that all mineral deposits are associated with specific kinds of rocks. Therefore, they can look for those specific rocks as “guides to ore.” They do this before any other kind of work. Then they look for folds, faults, and fractures in the rocks. They also look for any unusual colors and rock formations that do not seem consistent with the surroundings. They also may take rock samples to analyze in the laboratory. Then they record all the information on a map. Geologic maps help geologists infer what lies below the surface.

An instrument called a magnetometer is used to detect changes in Earth’s magnetic field. Rocks that contain a lot of iron-bearing minerals affect the local magnetic field. Geologists can also measure how well rocks conduct electricity. Geologists put electrical current in the ground for exploration. Most of the current flows through water in the pore spaces of rock. If a rock conducts electricity very well, it is likely to contain one of two things. It may just contain a lot of water. It also may contain a lot of metallic minerals. The

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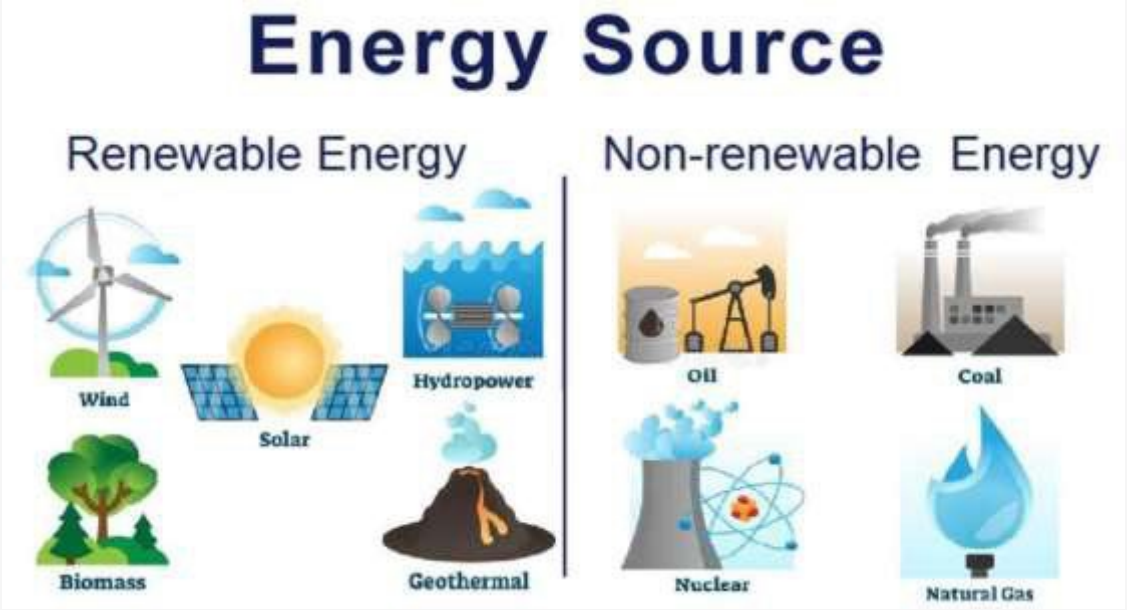
GEOLOGY Lo.9

Renewable and non-renewable energy source

- Both are type of energy sources found in nature
- Both have special costs and benefits that make one ore preferable than the other

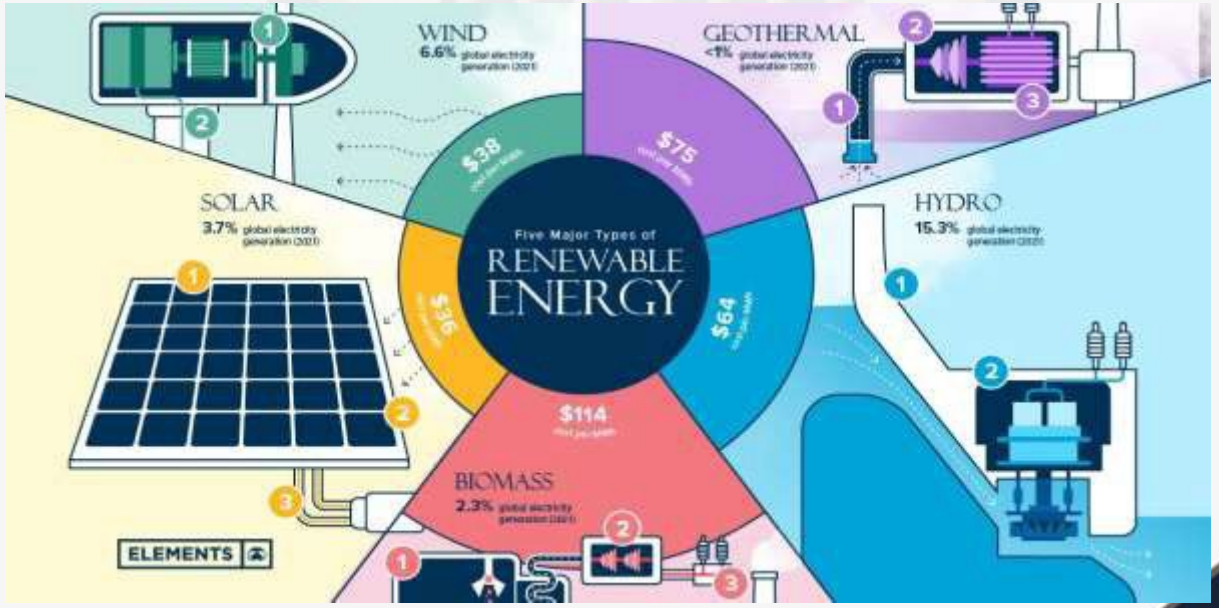


NON-RENEWABEL ENERGY RESOURCES

- Nonrenewable resources are natural resources that are limited in supply and cannot be replaced except over millions702of years.
- It can not be reduced or recycled
- Nonrenewable energy resources include fossil fuels ,natural oil, coal, radioactive elements such as uranium

RENEWABLE ENERGY RESOURCES

- Renewable resources will not run out because they are replaced as quickly as they are used
- Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished. Renewable energy sources are plentiful and all around us.
- It can be reduced or recycled and used many time
- It use sustainable particles, an action that reduce the environmental pollution and protect earth biodiversity



Fossil fuels

- Fossil fuels are mixtures of hydrocarbons that formed over millions of years from the remains of dead organisms.
- They include petroleum (commonly called oil), natural gas, and coal. Fossil fuels provide most of the energy used in the world today.
- They are burned in power plants to produce electrical energy, and they also fuel cars, heat homes, and supply energy for many other purposes

Fossil fuels contain stored chemical energy that came originally from the sun.

- Ancient plants changed energy in sun light to stored chemical energy in food, which was eaten by other organisms.
- After the plants and other organisms died, their remains gradually changed to fossil fuels as they were pressed beneath layers of sediments.
-

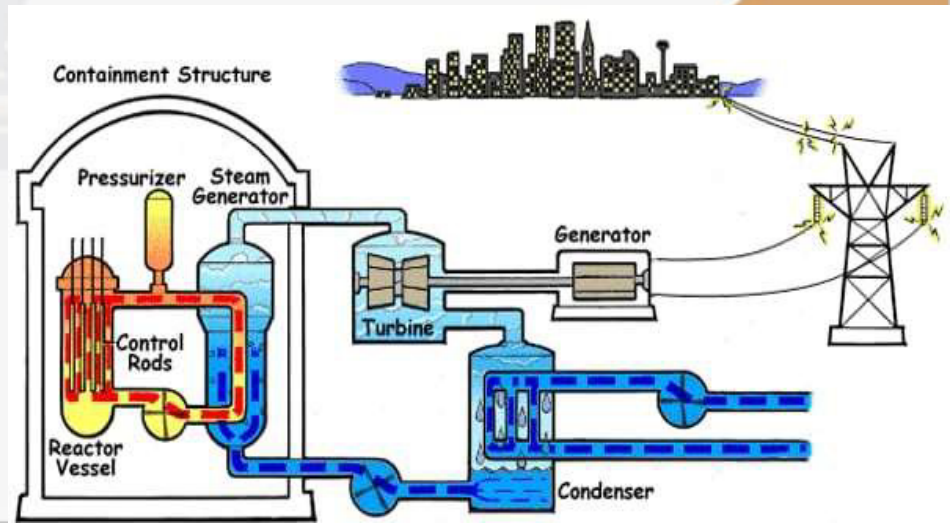
Petroleum and natural gas formed from marine organisms and are often found together. Coal formed
from giant tree ferns and other swamp plants.

- When fossil fuels burn, they release thermal energy, water vapor, and carbon dioxide.
- Carbon dioxide produced by fossil fuel use is a major cause of global warming.
- The burning of fossil fuels also releases many pollutants into the air.
- Pollutants such as sulfur dioxide form acid rain, which kills living things and damages metals, stonework, and other materials.
- Pollutants such as nitrogen oxides cause smog, which is harmful to human health.
- Tiny particles, or particulates, released when fossil fuels burn also harm human health.
- Natural gas releases the least pollution; coal releases the most
- Petroleum has the additional risk of oil spills, which may seriously damage ecosystems.

Nuclear Energy

Like fossil fuels, the radioactive element uranium can be used to generate electrical energy in power plants. In a nuclear power plant, the nuclei of uranium atoms are split in the process of nuclear fission.

- This process releases a tremendous amount of energy from just a small amount of uranium.
- The total supply of uranium in the world is quite limited, however, and cannot be replaced once it is used up.
- This makes nuclear energy a nonrenewable resource.
- Although using nuclear energy does not release carbon dioxide or cause air pollution, it does produce dangerous radioactive wastes.
- Accidents at nuclear power plants also have the potentialto release large amounts of radioactivematerial into the environment.



Nuclear fission

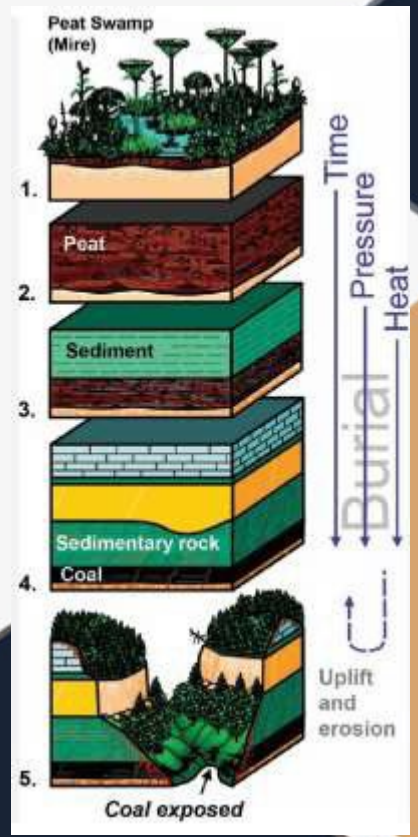
Radioactive uranium is concentrated and made fuel road that generate large amount of heat as a result of the radioactive decay.
The heat used to turn into the water steam.
Expansion of steam is used to drive a turbine any generator

- Advantages
- Does not emit CO_2 pollutants
- Continuously generates electricity.

- Disadvantages:
- Expensive to start and maintain power plants.
- Safety concerns.
- Waste that remains toxic for many years.
- Non-renewable

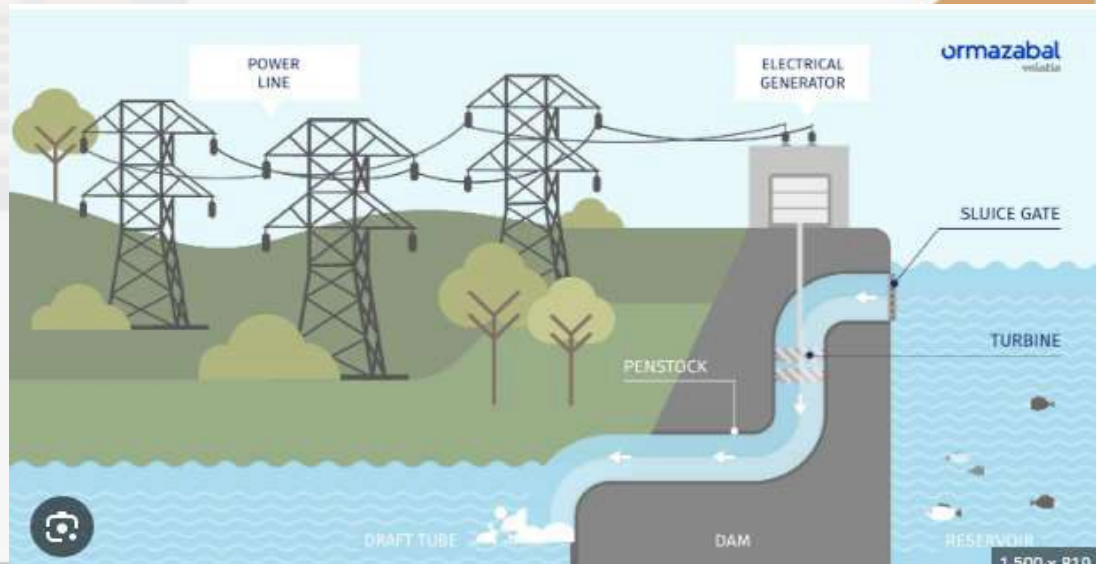
coal

- Energy in coal is form of solar radiation that is stored as a chemical energy in rock
- It is a sedimentary or metamorphic rock produced in swamps where is a large scale acumination to first become peat .
- Compaction of peat is due to burial drives off volatile components like water and methane, eventually producing a black result in more caron rich coal called lignite.
- Further compaction and heating the result in more carbon rich coal called bituminous coal .
- If the rock became metamorphed, a high grade coal called anthracite is produced .
- However if temperature and pressure become extremely High, all of the carbon is converted to graphite.
- Graphite will burn only at high temperature and is therefore not useful as an energy source
- Anthracite coal produce the most energy when it burned, with less energy produced by bituminous coal and lignite



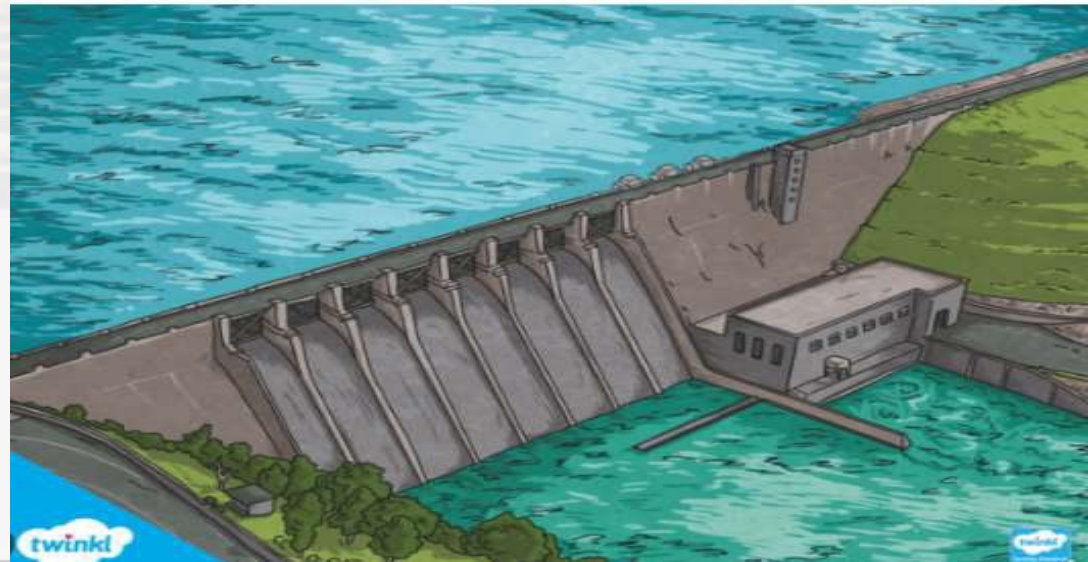
HYDROELECTRIC POWER

- Water is the top renewable resource used to generate electric power.
- Hydroelectric power is generated when flowing water spins a turbine.
- The turbine is connected to a generator. Hydroelectric plants are located where suitable waterways are available.
- Many of the best of these sites have already been developed. (Figure 3 shows the hydroelectric plants developed in the United States.)
- Seventy percent of the hydroelectric power in the United States is generated in the Pacific and Rocky Mountain states.
- There are two basic types of hydroelectric systems.
- One is based on falling water. The other is based on a natural river current.
- In a falling-water system, water builds up in reservoirs created by dams.
- This water then falls through large pipes.



The falling water applies pressure against the turbine blades.

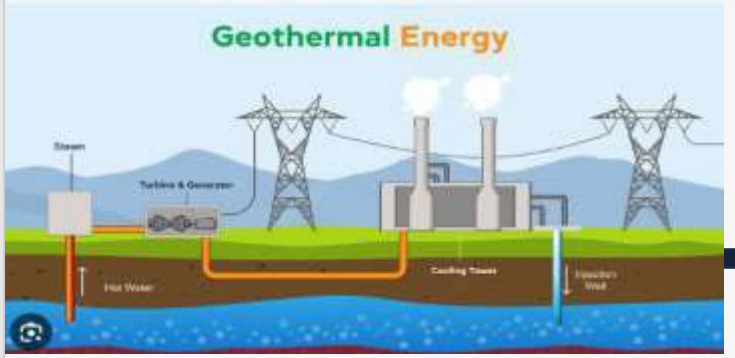
- The blades drive the generator to produce electricity.
- The second system is called a run-of-the-river system.
- In it, the force of the river current applies pressure to the turbine blades to produce electricity.
- Because they do not store water, these systems depend upon seasonal changes and stream flow.
- Using water to generate electricity has advantages.
- Water is a renewable resource and is a source of cheap power.
- Compared to fossil fuels, there is little air pollution.
- That is because there is no fuel combustion.
- Also, there is limited thermal pollution compared to nuclear plants.
- Hydroelectric power plants can start generating electricity quickly.
- They do not need to wait for water to be heated into steam
- Also, the flow of water can be adjusted to make quick changes in power output during
- peak demands for electricity.
- Like other energy sources, the use of water has drawbacks.
- These include impacts on the environment caused by damming rivers and streams.
- Dams affect the habitats of the local plants and animals.
- Another drawback to some hydroelectric power plants is that they depend upon the flow of water.
- This can vary with seasons and during droughts



WIND

THE WND IS A RENEWABLE SOURCE OF ENERGY
THERE ARE TWO TYPES OF WIND TURBINES : HORIZONTAL AXIS WIND TURBINS HAWT AND VERTICAL AXIS WIND TURBINES VAWT THE HAWT IS THE MOSTCOMMON TYPE OF WIND TURBINES. THEY USUALLY HAVE TWO OR THREE LONG THIN BLADES THAT LOOK LIKE AN AIRPLANE
THE VAWT HAVE SHORTER, WIDER CURVED BLADES THA RESEMBLE THE BEATERS USED IN AN ELECTRIC

Advantage	Disadvantage
The wind power industry creates employment opportunities.	Wind turbines can only be successfully installed in specific areas.
Wind energy has relatively low operating expenses.	Wind turbines are really quite difficult and expensive to install.
It is an everlasting and renewable energy source.	Wind blades include a safety concern to individuals working near them in windy conditions.
We are gradually reducing our reliance on fossil fuels by embracing wind energy to create electricity.	To be efficient and effective, a wind turbine necessitates a continuous supply of wind energy and is wholly unpredictable.



GEOTHERMAL ENERGY

IT COME FROM HEAT ENERGY BURIED BENEATH THE SURFACE OF THE EARTH. MOST OF THIS HEAT IS AT DEAPTH BRYOND CURRENT DRILLING METHODS. IN SOME AREAS OF THE COUNTRIES, MAGMA FLOWE CLOSE ENOUGH TO THE SURFACE OF EARTHTO PRODUSE STEAM.
THAT STEAM CAN THEN BE USRD IN THE STEAM TURBINES PLANTES

Advantages	Disadvantages
Geothermal energy sourcing is good for the environment.	The extraction of geothermal energy causes greenhouse emissions.
Geothermal energy is a reliable source of renewable energy.	There is a possibility of depletion in geothermal sources.
Geothermal systems have high efficiency.	There is a high-cost investment needed for geothermal systems.
There is no too little geothermal system maintenance needed.	It is hard to implement geothermal systems in big cities.
There is an unlimited supply of geothermal energy.	Geothermal reservoirs cannot easily be found.

DIGGING DEEPER

MEETING ELECTRICITY NEEDS

Energy Resources

The world's population continues to grow. This means that the need for energy will likely grow as well. Energy is needed for heating or cooling. It is needed to generate electricity. It is used in industrial processes. It is also used for transportation. Different energy resources can be used for many different purposes. Energy resources include coal, natural gas, and petroleum. Hydropower, **nuclear fission**, solar, wind, waste biomass, wood, and oceanic power are other sources. **Nuclear fusion** has been proposed as the long-term source. However, the progress made in research to make this possible has been very slow.

Generating Electric Energy

Energy resources are used to generate electricity. Electricity is an energy source with which you are very familiar. Electric power is the rate at which electricity does work. It is measured at a point in time. The unit of measure for electric power is a watt (W). The rate at which an appliance transforms electric energy is called its capacity. You can check the tags or labels on electrical appliances for this information. For example, you might see a "1200-W hair dryer" or "40-W stereo receiver." Electric energy is the amount of work that can be done by electricity. Its unit of measure is the watt-hour (Wh). A 1200-W hair dryer used for 15 min would require 300 Wh of electric energy

- Fossil fuels can be burned to generate electricity. Fossil fuels supply about
- 70 percent of the electricity in the United States. Coal, petroleum, and
- natural gas are examples of fossil fuels. They are the main ones used by the
- electrical power industry. When these fuels are burned, a variety of gases
- and particles are formed. Pollution-control equipment can be used to catch
- these. If they are not caught, they are let out into the atmosphere. Other
- sources of energy can also be used for electricity. These sources include
- water, geothermal energy, solar thermal energy, photovoltaic energy,
- and biomass. They have many advantages over fossil fuels.

- **Fossil Fuels and Nuclear Energy**
- Most of the electricity in the United States is produced in steam turbines.
- A turbine converts the kinetic energy of a moving fluid (liquid or gas) to
- mechanical energy. In a fossil-fueled steam turbine, the fuel is burned in
- a boiler to produce steam. The steam then turns the turbine blades. The
- blades turn the shaft of the generator to produce electricity. In a nuclear
- powered steam turbine, a reactor replaces the boiler. The reactor contains
- a core of nuclear fuel. (The fuel is mostly enriched uranium.) The fission of
- uranium produces the heat in the reactor. The heat is used to make steam.
- The steam is then passed through the turbine generator to produce
- electricity. This is the same as what occurs in the fossil-fueled steam
- turbine. *Figure 2* shows the nuclear power plant locations and uranium
- resources available in the United States

- nuclear fission: the process by which an atomic nucleus splits into two or more large fragments of comparable mass, simultaneously producing additional neutrons and vast amounts of energy.
- nuclear fusion: a nuclear process that releases energy when lightweight nuclei combine to form heavier nuclei.
- electric power: rate of power associated with the generation and transmission of electricity.
- electric energy: energy associated with the generation and transmission of electricity.
- fossil fuel: fuel derived from materials (mainly coal, petroleum, and natural gas)that were generated from fossil organic matter and stored deep in Earth for geologically long times.
- geothermal energy: energy derived from hot rocks and/or fluids beneath Earth's surface.
- photovoltaic energy: energy associated with the direct conversion of solar radiation to electricity.
- turbine: a rotating machine or device that converts the mechanical energy of fluid flow into mechanical energy of rotation of a shaft.
- renewable resource: a resource that can be replaced in nature at a rate close to its rate of use.
- hydroelectric power: electrical power derived from the flow of water on Earth's surface.
- nonrenewable resource: a resource that exists in a fixed amount or is used faster than it can be replaced in nature
- Appliance capacity: the rate at which an appliance transforms electric energy required , for example, you might see 1200 watt/hour. So, A dryer used for 15 min would require 300w/h of electric energy.

Geology Lo.10

Solar energy

- Solar energy is the light and heat that the sun provides to Earth. This kind of energy is a
resource that is renewable.

- Solar energy comes in various forms. These consist of wind, photovoltaic, biomass, and both direct
and indirect sun radiation.

- One source of tidal energy is the sun. Nonetheless, the Earth-moon system is primarily responsible for producing tidal energy. Furthermore, keep in mind that wind power comes from the sun's heat since wind energy is found in the temperature differential between air segments.

- Solar energy sources include: • Direct solar thermal and photovoltaic power, Indirect solar wind power.

- Solar energy is generated at the Sun's extremely hot core. This happens as a result of nuclear fusion.

Solar energy

- Surface emits electromagnetic radiation in every direction. primarily consists of light in the visible spectrum

- The electromagnetic spectrum is divided into two wavelength groups: ultraviolet (UV) at shorter wavelengths (10 nm to 380 nm) and infrared (IR) at longer wavelengths (750 nm to 1 mm).

- The radiation moves at the speed of light. It takes almost eight minutes to reach Earth

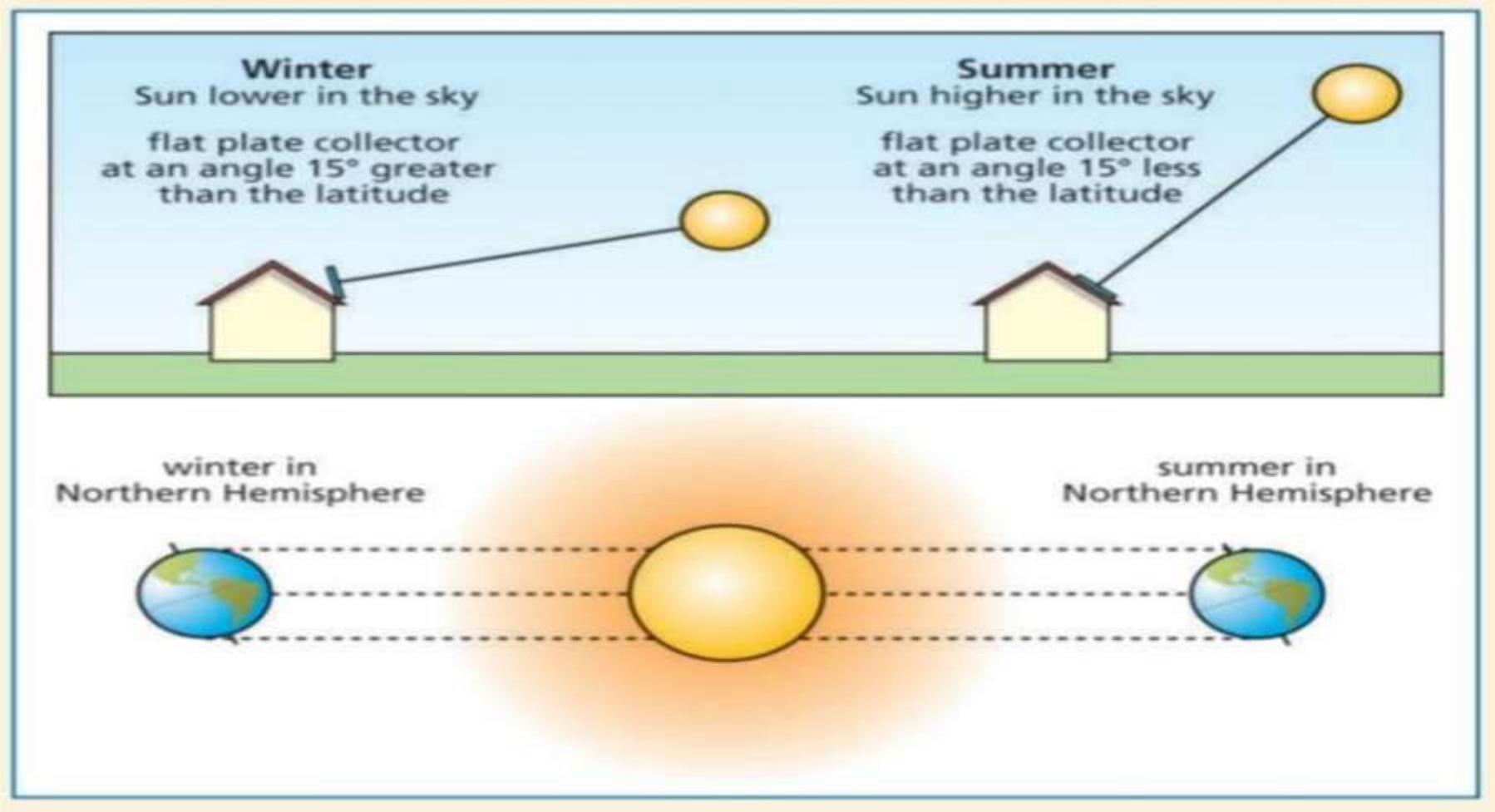
- Insolation: The rate at which sunlight reaches a particular piece of land.

- Latitude, season, time of day, air clarity, aridity of the sky, and land surface slope are all factors that affect insolation.

- summer and winter orientation of solar cells:-
  The sun is lower in the sky during winter, and the flat plate collector is angled 15 degrees greater than the altitude.

- The Sun is higher in the sky during the summer, with a flat plate at an angle of 15 less than the altitude

Solar energy



This figure shows how the Earth's axis tilts in the summer and winter.

Solar Heating

Home heating: is one of the main uses of solar energy.
There are two kinds of it
1 **Active:** needs special equipment in the form of solar collector
2 **Passive:** Don't rely on mechanical equipment, but they are not as effective as active systems
3 **Water heating:** another major use of solar energy, have two main parts.
-They include solar collectors and storage tanks.

Solar Heating can be also used for:

- Solar energy is produced in the externally hot core of the sun, This occurs through the nuclear fuse.
- Insolation: It's the rate at which a given area of land receives solar energy. It depends on latitude, season, time of day, cloudiness of the sky, clearness of the air, and the slope of the land surface. It decreases when a surface is not perpendicular to the sun's rays.
- If the Sun is directly overhead and the sky is clear, the rate of solar radiation on a horizontal surface at sea level is about 1000 W/m2 (watts per square meter). This is the highest value insolation can have on Earth's surface.
- When the rays from the Sun are not direct, there is more atmosphere between the Sun and Earth's surface, so more of the radiation is absorbed before it reaches Earth's surface.

Solar Heating

There’re two basic types of solar heating:

In active systems a solar collector is used to collect and distribute solar energy.

In passive systems, the building is Designed to let in large amounts of sunlight and the heat produced from the Sunlight is trapped inside.

Solar heating home heating is one of man’s uses of solar energy.

Active system: special equipment like a solar collector. Storage tank, solar energy is collected within the; flat; rectangular box with a transparent cover.

The water heating bottom of the collector box is plate-counted black on the upper surface and insulated on the lower surface

“Solar energy” trikes black surface is converted to heat, cool water circulated through pipes from hot collector box to storage tank, water is warmed, provide us in the pool or homes not expensive

- **air heating**
- **Many buildings use solar collectors to provide more than just hot water**
- **Buildings may use passive solar heating**

Solar Heating

- **In winter,** the sun, homes Directly through large windows heating building

- **In summer,** the sun is blocked by over hag from shining into buildings Materials absorb, store sun heat and can be built into sunlit floors, walls then they heat up during the day. Al right they slowly release the heat. Many designs for passive solar heating also provide delighting simply the use of natural sunlight to brighten up a building.

Star beating reduces the use of fossil fuels
- 90 percent efficient water heating
- 60 percent efficient water heating
- 30 to 40 percent efficiency of electricity produced from fossil fuels

▪ Photovoltaic PV cells (direct source)

To generate electricity from solar energy in power toys, calculators' roadside telephones, call boxes
They convert light into electric energy Some are simple calculations of wristwatches.

- PV is the cheapest form of electricity; efficiency is not high but increasing In crystalline silicon.

Photovoltaic Energy

It's used to generate electricity. Photovoltaic (PV) devices generate electricity directly from sunlight via an electronic process that occurs naturally in certain types of material, called semiconductors.

Electrons in these materials are freed by solar energy and can be induced to travel through an electrical circuit, powering electrical devices or sending electricity to the grid.

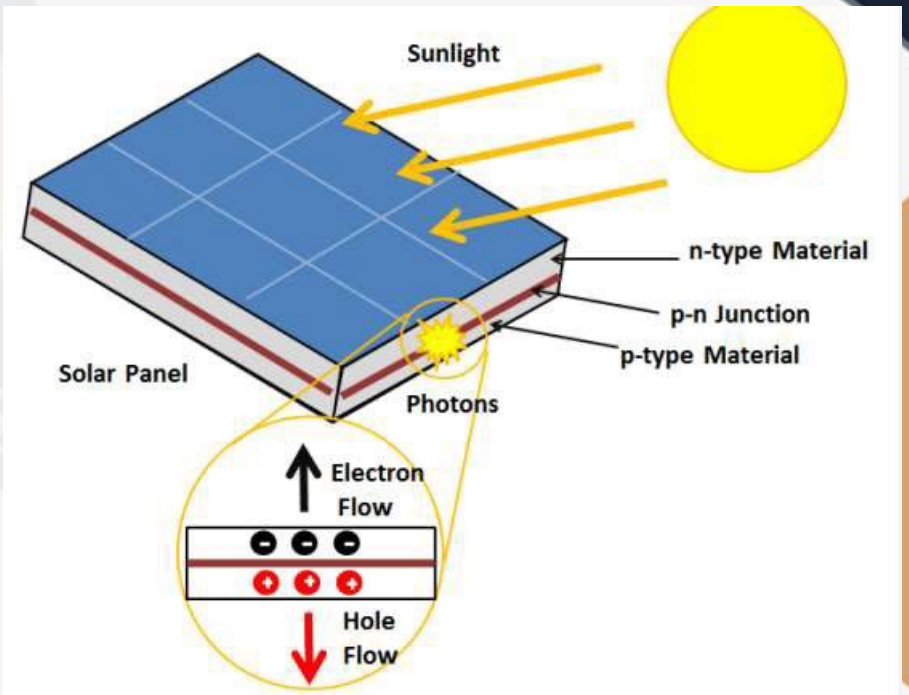
They're also known as "Solar cells".

Their efficiency isn't high, but it's increasing as technology is progressing.

How does PV work?

Photons strike and ionize semiconductor material on the solar panel, causing outer electrons to break free of their atomic bonds.

Due to the semiconductor structure, the electrons are forced in one direction creating a flow of electrical current. Solar cells are not 100% efficient in crystalline silicon solar cells, in part because only certain light within the spectrum can be absorbed. Some of the light spectra are reflected, some are too weak to create electricity (infrared) and some (ultraviolet) creates heat energy instead of electricity.



Wind Power

- People have been using wind power for hundreds of years to pump water from wells.

➢ Yet, it has only been in the past 35 years that communities have started to use wind power to produce electricity

This figure shows wind turbines from an electricity-generating wind farm near Palm Springs, California.

- Wind turbines. (In 2010, it had a wind-power capacity of 9727 MW [megawatts] with several tens of thousands of wind turbines.)
- Other areas in the country have a high potential for wind power as well.

- These areas include the Rocky Mountains, the flat Midwest states, Alaska, and many more.
- Commercial wind turbines can have blades with a diameter as large as 60 m

Wind Power

- Wind is moving air, so it has mechanical energy that can do work. People have been using wind for energy for thousands of years

- The old-fashioned windmill in that figure one way that wind energy can be used.
- The wind turbines in the opening photo above are a much newer way of using wind energy.
- They change the kinetic energy of the wind to electrical energy.
- However, only certain areas of the world get enough steady wind to produce much electricity.
- Many people also think that wind turbines are noisy, dangerous to birds, and unattractive in the landscape.

Wind Power Use

- Wind is the source of energy for wind power.
- Wind has been used for power for centuries.
- For example, windmills were used to grind grain and pump water.
- Sailing ships traveled by wind power long before ships were powered by fossil fuels.
- Wind can be used to generate electricity, as the moving air spins a turbine to creat

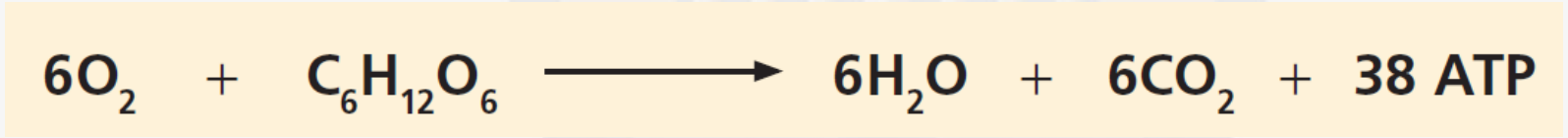
Consequences of Wind Power

- Wind power has many advantages. It does not burn, so it does not release pollution or carbon dioxide.
- Also, wind is plentiful in many places. Wind, however, does not blow all of the time, even though power is needed all of the time.
- Just as with solar power, engineers are working on technologies that can store wind power for later use.
- Windmills are expensive and wear out quickly. A lot of windmills are needed to power a region, so nearby residents may complain about the loss of a nice view if a wind farm is built.
- Coastlines typically receive a lot of wind, but wind farms built near beaches may cause unhappiness for local residents and tourists.
- The Cape Wind project off of Cape Cod, Massachusetts has been approved but is generating much controversy.
- Opponents are in favor of green power but not at that location.
- Proponents say that clean energy is needed and the project would supply 75% of the electricity needed for Cape Cod and nearby islands
- California was an early adopter of wind power. Windmills are found in mountain passes, where the cooler Pacific Ocean air is sucked through on its way to warmer inland valleys

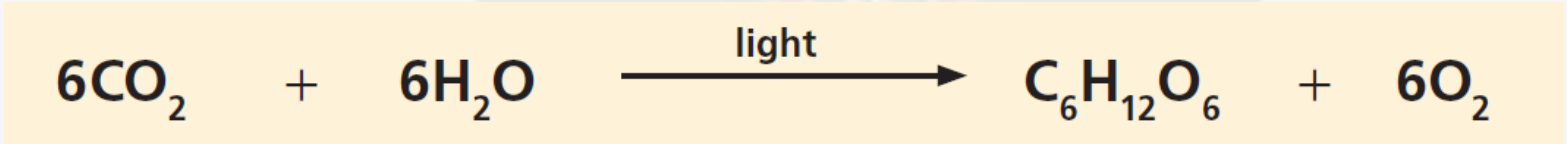
Earth science (ES.1.11) The Coal

Coal as a fossil fuel

- There are only four main sources of energy available.
- 1:solar radiation 2:Earth's interior heat 3:decay of radioactive material in Earth 4:the tides
- The energy in coal is from solar radiation that is stored as chemical energy in rock.
- Green plants convert solar energy into chemical energy(Photosynthesis process).
- The energy stored in glucose is released when bonds holding the molecule together are broken and then form new, stronger bonds(Oxidation). Oxidation occurs through respiration, also it takes place in decomposition.



Equation of photosynthesis.



Equation of respiration.

It's a small introduction. Ready to the next (:

Formation of Coal

- Most coal starts out as peat. It is an unconsolidated and porous deposit of plant remains from a swamp.
- Structures of the plant matter, such as stems, leaves, and bark can be seen in peat.
- Today, most peat comes from peat bogs(*Swamps*) that formed during the retreat of the last ice sheets. That was between 10,000 and 20,000 years ago.
- Coal, by definition, is a combustible rock. More than 50 percent of coal by weight is material made of carbon.
- The plant remains are altered physically and chemically. This takes place as result of bacterial decay, compaction, and heat.
- Most coal was formed from the lush growth of plants in coastal freshwater swamps. These are called coal swamps.
- They are found in low-lying areas that are separated from any sources of mud and sand.
- Plants here are rooted down into earlier deposits of plant remains. When these plants die, they serve as the roots of even later plants. In such an environment, the accumulation of plant debris exceeds the rate of bacterial decay of the debris.

Formation of Coal

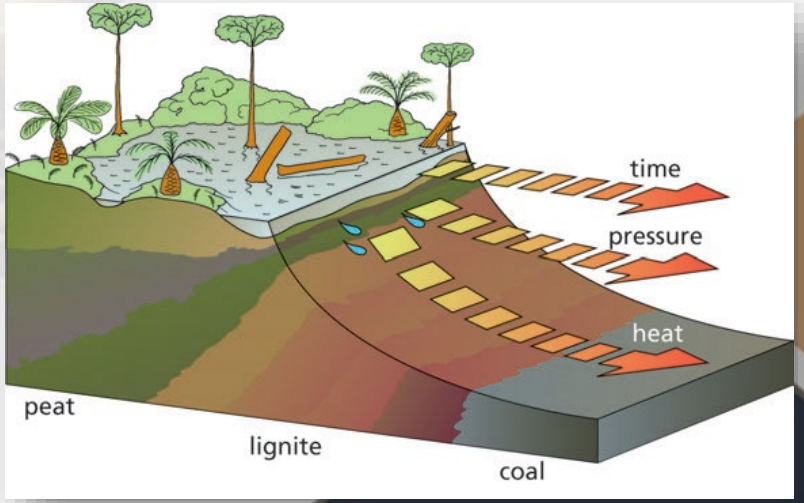
- Plant debris is basically the leftover parts of plants that have died or fallen off, like leaves, stems, or branches.
- There are direct relation ship between plant debris exceeds and rate of bacterial decay.
- During compaction, much of the water that was in the pore spaces of the plant material is squeezed out.
- As the coal becomes enriched carbon, it is said to increase in rank.

- There are some ranks of Coal: Peat →Lignite →sub-bituminous → bituminous → Anthracite

- It is estimated that it takes 35 meters of original peat material to produce a thickness of one foot of bituminous coal.
- Coal is always between layers of other sedimentary rocks. These are mainly sandstones and shales.

How coal are Formed?

Coal is formed in swamps, where when plants die, they fall on top of each other and are then filled with dirt by the air. Then, over time, layers of dirt accumulate over the dead plants, leading to increased pressure and increased heat. Over time, the rank of coal increases (due to pressure and temperature) from lowest to highest.



Types of coal

- Mainly, the type of coal depends on the depth and temperature of burial.

- Coal that is buried very deeply reaches high rank. This results from the high pressures and temperatures of deep burial.

Sulfur:

- One of the most important features of coal is sulfur content.
- Sulfur is important because it is released into the atmosphere as sulfur dioxide when the coal is burned. It then combines with water in the atmosphere to form sulfuric acid(acid rain result of that).
- The sulfur content of coal can range from just one percent to as much as five percent. The percentage depends mainly on the sulfur content of the original plant material.

Carbon and Heat content:

- The carbon content of coal increases with increasing rank of coal. The heat content is also an important feature of coal. The greater the heat content, the smaller the mass of coal that needs to be burned to produce the needed heat.
- The heat content of coal increases with the rank of the coal. It depends mainly on the carbon content.
- The amount of energy in coal is expressed in British thermal units (Btu) per pound. One Btu is the amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit.

Table 3: Percentage of Carbon and Heat Content of Coal

Coal Rank	Carbon Content (%)	Heat Content (Btu per lb)
Lignite	25–35	4000–8300
Sub-bituminous	35–45	8300–11,500
Bituminous	45–86	10,500–14,000
Anthracite	86–98	≥ 14,000

Types of coal

Usage of each type of coal:

- *Peat* can be used as a source of fuel. However, it has a very low heat content.
- *Lignite* (also called brown coal) is the least buried and usually the youngest type of coal. It is used mainly for electric power generation.
- *Sub-bituminous* coal is a desirable heat source because of its often low sulfur content.
- *Bituminous* coal is used mainly for generating electricity. It is also used for making coke for the steel industry.
- *Anthracite*, found in a very small supply in the eastern United States, has been used mainly for home heating.

ASH:

- The part of coal that does not burn is called ash. Most of the ash consists of sand, silt, and clay that were deposited in the coal swamp along with the plants.
- The purest coal has only a small fraction of one percent ash. The ash content of usable coal can be much higher. Some of the ash remains behind, and some goes up the flue.
- Ash in coal is not desirable because it reduces the heat content slightly. It also must be removed and discarded.

Coal exploration and Mining

Factors of extract coal:

- Three major factors determine which coals are economical for mining at this time.

1. Cost it would take to transport the coal to where it would be used.

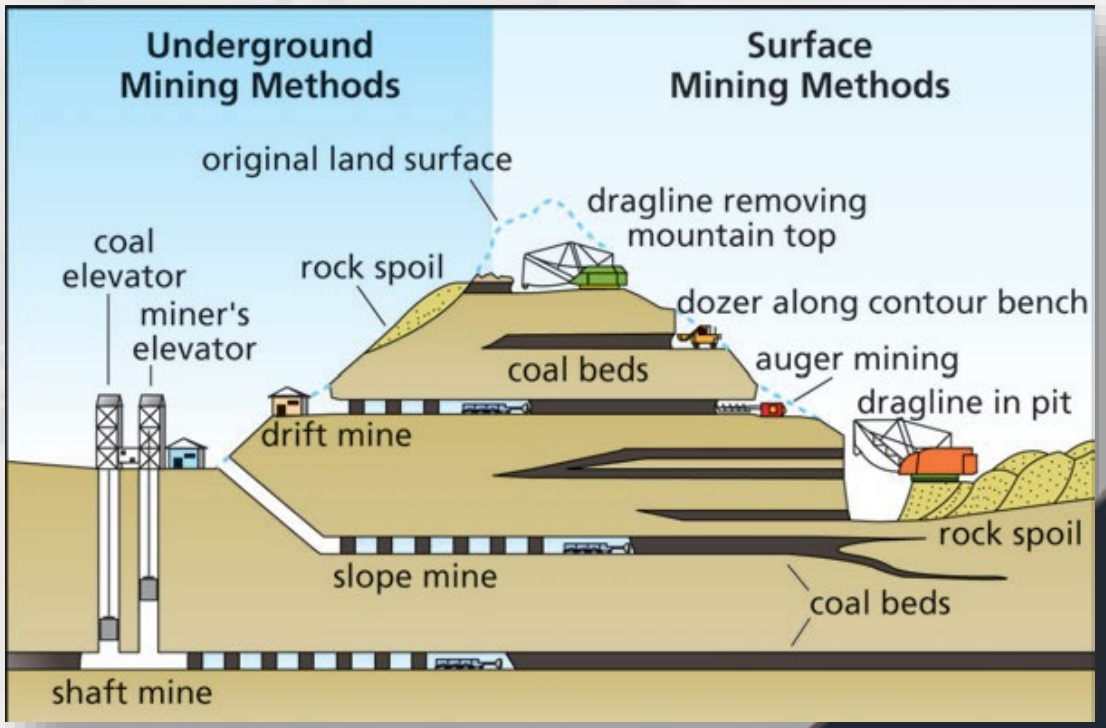
2. Concern for the environment that comes with the mining and use of coal.

3. The quality, thickness, volume, and depth of coal are important in assessing whether or not the coal is mined.

Types of mining of coal:

1. Surface mining
- Area mining
- Contour mining
- mountaintop removal mining
- auger mining

2. Under ground mining:
- Drift mining
- Slope mining
- shaft mining



Earth Science
(ES.1.12)
Petroleum and Natural gas

The Nature and Origin of Petroleum and Natural Gas

- Petroleum is also called crude oil. It is a liquid that consists mainly of organic compounds.
- Natural gas consists mainly of a single organic compound(Methane).

- They have a very high heat content per unit weight. They cost less than coal to transport and are fairly easy to transport.

- Both are used as the raw material (called feedstock) for making plastics and many other synthetic compounds. Also used in paints, medicines, insecticides, and fertilizers.

- Natural gas is also a raw material used in antifreeze, clothing dyes, photographic film, and explosives.

- Oil and natural gas are found in the pore spaces of some sedimentary rocks.

- Much of the organic matter is oxidized before it is buried.

- As the sediments get buried more and more deeply, the temperature and pressure increase. This causes some of the organic matter to be changed into oil and gas. Petroleum geologists use the term “maturation” for this process.

- They call the range in burial depth that is right for generation of oil and gas the “oil window” or “gas window”.

- They call the regions rich in organic matter subjected to these depths “the kitchen”.

The Nature and Origin of Petroleum and Natural Gas

- The mudstone and shale that form the source rocks for oil and gas are impermeable.

- source rocks: sedimentary rocks, containing significant concentrations of organic matter, in which petroleum and natural gas are generated during burial of the deposits.

- The oil and gas rise very slowly and percolate through the source rocks. The gas and oil are less dense than water. Water is the main filler of the pore spaces.
- When the gas and oil reach fractures and much more permeable rocks, such as some kinds of sandstone and limestone, they can move much more rapidly.

- They form oil and gas seeps and escape to the atmosphere or produce tar mats. If the rocks are capped deep in Earth by an impermeable layer called a seal, the oil and gas are prevented from moving up.
- A large volume of porous rock containing oil and gas with a seal above is called a reservoir. The oil and gas can be brought to the surface by drilling deep wells into the reservoir.
- Petroleum reservoirs around the world range in age from more than a billion years to just a few million years old. Geologically, this is very young.

- seal: an impermeable layer or mass of sedimentary rock that forms the convex upward top or roof of a petroleum reservoir.
- reservoir: a large body of porous and permeable sedimentary rock that contains economically valuable petroleum and/or natural gas.

The Nature and Origin of Petroleum and Natural Gas

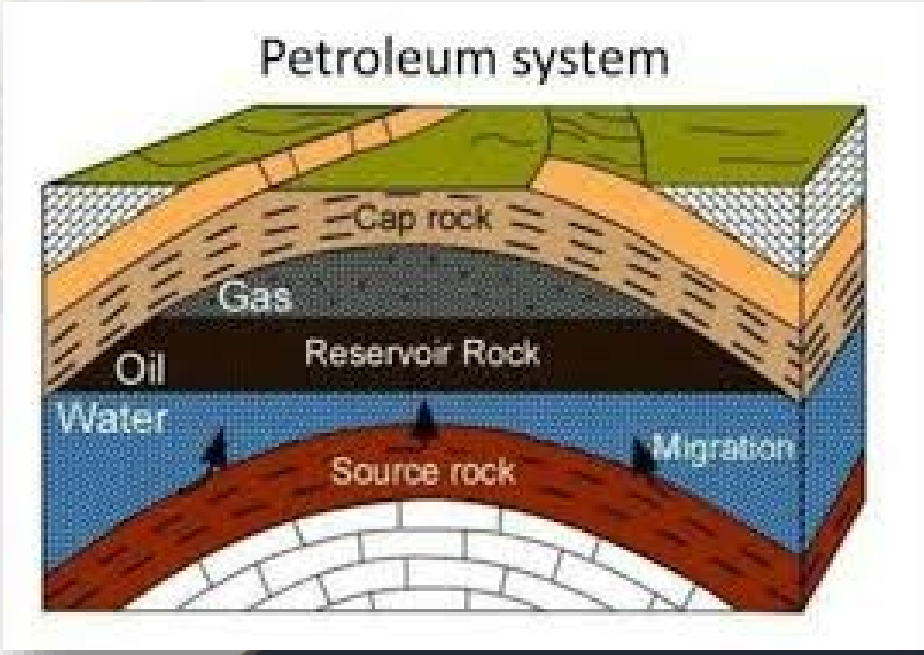
Summery of petroleum and natural gas formation:

- When living organisms and plants die and are buried underground, they decompose due to heat and pressure and turn into organic matter.

- Organic matter rises to the top due to density, and when it reaches the source rock, the speed of its rise decreases because it is a relatively impermeable rock.

- There are two ways then: the first is to not encounter impermeable rock and come out to the surface of the earth, or to encounter impermeable rock (seal or cap rock) and remain under the surface of the earth and be stored as in the picture, and then it is called reservoir rock.

- Then the evaporation comes and they extract it using a drilling rig.



Porosity and permeability

Porosity:

- Most sedimentary rocks have open spaces in addition to the solid materials.
- These open spaces are called pores. Sedimentary rocks are the most porous rocks.
- Porosity is a measure of the percentage of pores in a material. It is defined as the volume of pore spaces divided by the bulk volume of the material, multiplied by 100.

$$\text{porosity} = \frac{V_{water}}{V_{soil}} \times 100$$

- It is expressed as a percentage. The porosity of loose granular material such as sand can be as much as 30–40 percent.
- If the sand particles have a wide range of sizes, the porosity is less.
- The sand slowly becomes buried in sedimentary basins to depths of thousands of meters. There, temperatures and pressures are much higher, this called cement. The cement in sedimentary rocks is not the same as the cement that is used to make concrete. Porosity has directly relationship with size of material.

Permeability:

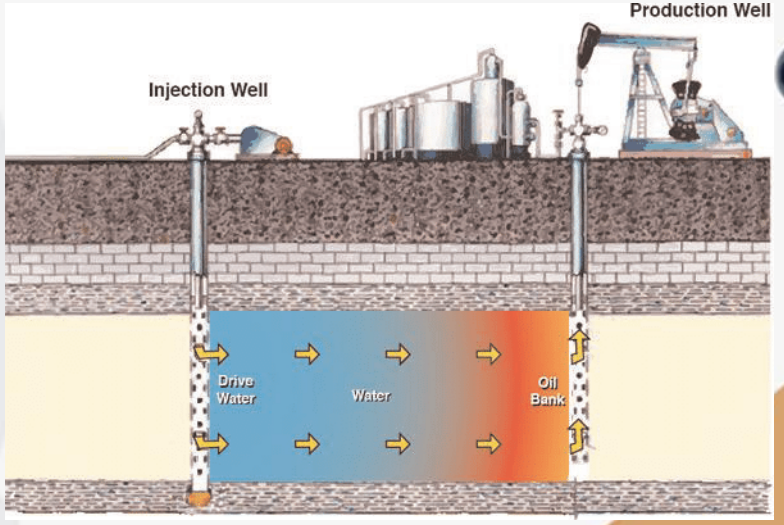
- When the pore spaces are all connected to one another, fluid can flow slowly through the rock. Fluid flows through a porous rock when the fluid pressure differs from one place to another.

$$\text{permeability} = \frac{V_{water}}{time}$$

- The rate of flow through the porous material in response to a pressure difference is called the permeability of the material. For a rock to have a high permeability, it generally has to have high porosity.
- Good petroleum reservoir rocks must have high porosity to hold the oil or gas. They must also have high permeability. Rocks that have high porosity, also have high permeability.

Recovery of petroleum

- Oil and gas are removed from reservoirs by drilling deep wells.
- Wells can be drilled vertically downward for some distance. Then they can be diverted off to the side at precise angles.
- Much of the oil in a reservoir remains trapped in place after years of production. The main reason is that oil adheres to the walls of the pores in the form of coatings.
- The coatings are especially thick around the points of contact of sediment particles. There, the pore spaces narrow down to small “throats.”



- Several techniques have been developed to recover some of the remaining petroleum.
- Use of such techniques is called secondary recovery. One of the most common methods of secondary recovery is to inject large quantities of very hot steam down into a well. This causes some of the remaining petroleum to flow more easily.

- Areas for oil exploration and production are called “plays” in the oil business. The major plays now lie in deep offshore areas of the oceans.
- Solid organic matter is found in certain sandstones, called tar sands.

Earth science (ES.1.13) Environment

Energy resources and their impact on the environment

Fossil fuels and carbon cycle:

- Fossil fuel supply 85 % of the primary energy consumed in United States.

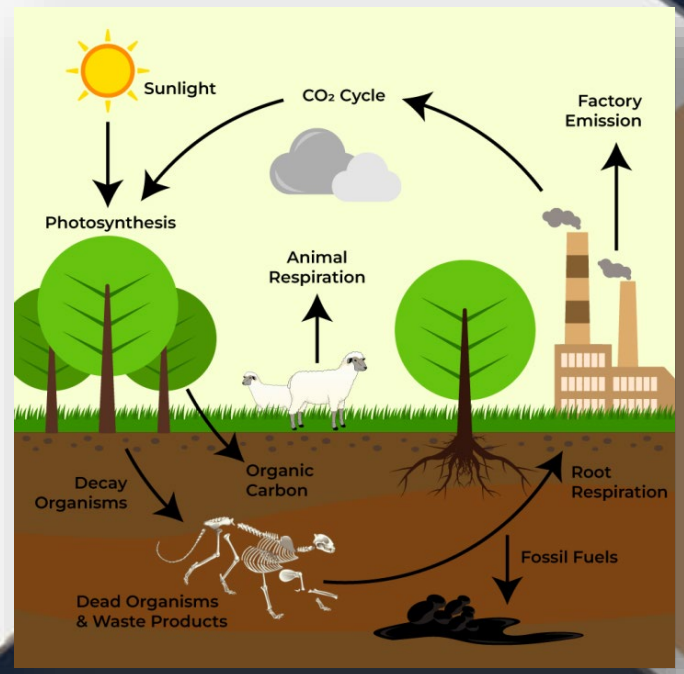
- The amount of carbon dioxide produced depends on the carbon content of the fuel.
- Natural gas emits about half of the carbon dioxide produced by coal. Petroleum fuels emit about three quarters.

- According to the first law of thermodynamics, the amount of energy always remains constant. The amount of chemical energy consumed when a fossil fuel is burned equals the amount of heat energy released.

- According to the law of conservation of energy, Matter cannot be created or destroyed. It helps you to understand what happens when one type of matter is changed into another type.

- carbon cycle: the continuous exchange and recycling of carbon through the Earth system. It is the idea that many processes work together in a global movement of carbon from one reservoir to another. The ocean is the largest reservoir of carbon found in the form of bicarbonate salts.
- Photosynthesis and respiration cause most of the movement (flux) of carbon dioxide between the atmosphere, land, and oceans.
- anthropogenic: generated or produced by human activities.

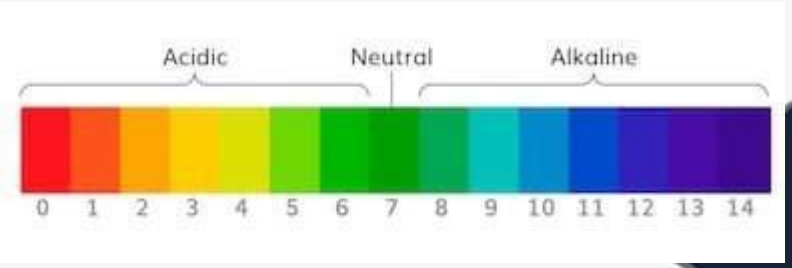
- concentrations of carbon dioxide in the atmosphere over time, scientists have learned that levels of carbon dioxide in the atmosphere have increased about 25 percent in the last 150 years.



Coal and acidic rain

Acidity and PH scale:

- Acidity: the measure of the concentration of hydrogen ions in an aqueous solution.
- High (H^+) is acidic, low (H^+) is basic.
- Mixing acids and bases can cancel out their effects. substance that is not acid and not base is neutral.
- The pH scale measures how acidic or basic a substance is. It ranges from 0 to 14.
- A pH of 7 is neutral, a pH less than 7 is acidic, and a pH greater than 7 is basic.
- Each whole pH value below 7 is 10 times more acidic than the next higher value.
- For example, a pH of 4 is 10 times more acidic than a pH of 5 and 100 times (10 times 10) more acidic than a pH of 6. The same holds true for pH values above 7, each of which is 10 times more alkaline (another way to say basic) than the next lower whole value.



Acid rain and how it form:

- Rain water is mildly acid. Its pH is about 5,7. The reason is that carbon dioxide in the atmosphere dissolves in rainwater. Some of this dissolved carbon dioxide reacts with the water to form a weak acid, called carbonic acid (H_2CO_3).
- Coal contains as much as 5% sulfur. When the coal is burned, the sulfur is emitted as sulfur dioxide gas (SO_2). The sulfur dioxide then reacts with oxygen and then with water in the atmosphere to form sulfuric acid. This is a strong acid.

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

- Some of the sulfuric acid then dissociates into hydrogen ions and sulfate ions in solution in the water.

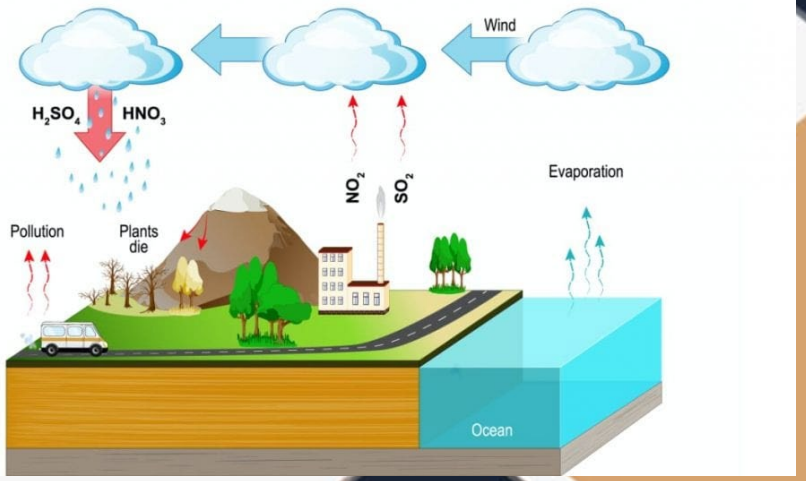
$$H_2SO_4 \longrightarrow H^+ + HSO_3^- \longrightarrow 2H^+ + SO_4^{2-}$$

Coal and acidic rain

Acid rain:

- The H+ ions reach Earth's surface dissolved in raindrops. Burning of fuels also produces nitrogen-oxide gases. These gases react with water to form nitric acid, another strong acid.
- Some of the nitric acid breaks down to release hydrogen ions, by a reaction similar to that of sulfuric acid. Burning of coal is not the only source of sulfuric acid and nitric acid.

- Acid rain is especially damaging to lakes. If the pH of lake water becomes too acidic from acid rain, it kills fish, insects, aquatic plants, and plankton.
- Environmental scientists describe lakes that have suffered heavily from acid rain as "dead." This is because the entire food web of the lake has been disrupted to the point where little is left alive in the lake.



- Because of this, various technologies have been developed. Their purpose is to reduce the emission of sulfur dioxide from coal-fueled electric power plants. The general term for these processes is flue-gas desulfurization. It is also called scrubbing.
- Several kinds of scrubbers are used. The most common is the wet scrubber. In wet scrubbing, the flue gas from the power plant is sprayed with a calcium carbonate solution in the form of a slurry.
- The SO_2 is oxidized to form calcium sulfate. Scrubbers of this kind can remove up to 95 % of the SO_2 that is emitted from the power plant.
- Scrubbers can have a useful by-product. Certain kinds of scrubbers are now in operation that produce pure calcium sulfate (gypsum) as a by-product. This gypsum can then be used industrially, to make plaster and wallboard, rather than having to be mined and processed.

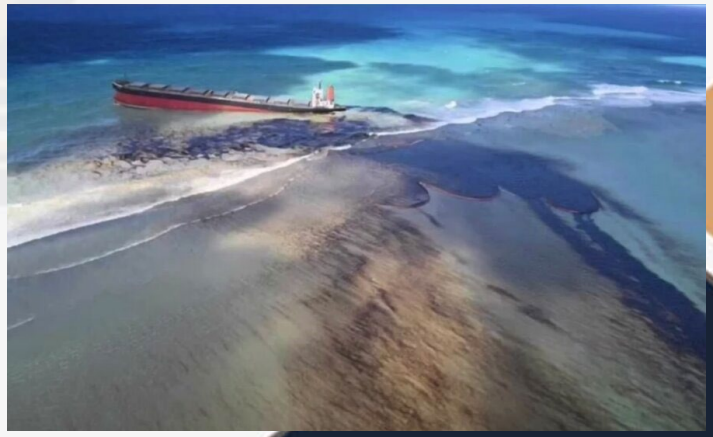
Oil Spills and the Environment

- Oil spills occur when oil is transferred to vessels, as it is transported across oceans, and when pipelines break. They can also occur during drilling operations.

- The impacts of oil spills include contamination of coastal and marine ecosystem s as well as human health problems. When oil spills occur in the ocean, waves, ocean currents, and wind often move the oil on shore.

- When oil reaches the coast, it interacts with sediments such as beach sand, rocks, and boulders. Beach sand and gravel saturated with oil may be unable to protect and support coastal vegetation.

- Rocks and boulders coated with oil can be toxic to coastal wildlife. Marine oil spills can also be harmful to deep ocean and coastal fisheries. Oil residue is not only toxic, but sticky. As a result, marine life can be poisoned and smothered.



- Oil spills can affect humans as well. There are potential health impacts that can result from oil spills. These include accidents suffered by those on damaged tankers and drilling platforms. Those who inhale toxic fumes or eat fish or shellfish contaminated by oil can become ill.

Oil Spills and the Environment

How can we avoid this problem:

- Efforts to clean up the spill and limit its damage included the use of fire booms. These are U-shaped devices that were towed behind boats and used to pull oil to controlled areas for safe burning.

- Dispersants were also sprayed on the oil. These chemicals changed the chemical and physical properties of the oil in order to reduce its potential effects.

- Sand berms were also constructed along the Gulf Coast to capture oil from the spill.

Advantages and Disadvantages of Energy Resources

1. Advantages:
- Energy resources allow you to maintain a very high quality of life
- Provide jobs for many people

2. Disadvantages:
- Deterioration of air quality
- Acid rain
- Global warming
- Groundwater contamination
- Financial burden on households