NON – RENEWABLE ENERGY RESOURCES (FOSSIL FUELS)

1. Resources

A resource is anything; we get from the environment to meet our needs and desires. It may be any useful information, material or services. Thus any part of our natural environment such as land, water, air, minerals, forest, range land, wildlife, fish or even human population that man can utilize to promote his welfare are regarded as natural resources. The five basic ecological variables- energy, matter, space, time and diversity are sometimes called natural resources. Resources are dynamic which not only improves new knowledge, expanding science and new technologies but also to changing culture and social objectives. For example, some resources, such as solar energy, fresh air, fresh surface water, fertile soil, and wild edible plants are directly available for use by us and other organisms, while other resources such as petroleum, iron, groundwater, and modern crops are not directly available and their supplies are limited.

Types of Resources

Some resources are likely to get exhausted soon, whereas other would be lasting for a long period of time. Thus, depending upon the availability of resources, these are divided into two categories:

1. Renewable resources
2. Non-renewable resources

1. Renewable resources

There are the sources that are replenished through rapid natural cycles.Common examples of such resources are:

i. Oxygen in the air, which is replenished through photosynthesis.

ii. Fresh water, which is replenished through the water cycle.

iii. All biological products (food, fishes, timber, etc.,) which are replenished through natural cycles of growth and reproduction.

iv. Solar energy is also considered as renewable as on a human time scale and it is inexhaustible. It is expected that sun will last at least 6.5 billion years.

v. Some other renewable resources that can be renewed (hours to several decades) through natural processes include forests, grassland grasses, wild animals, fresh air and fertile soil. However, potentially renewable resources can be depleted when resources utilization rate exceeds the natural replacement rate.

2. Non-Renewable Resources

These are the resources, which once gone, have very little chance of recovery in nature. These are further classified as,

I. Non-renewable resources that can be recycled: These include all non-energy mineral resources which occur in the Earth's crust. For example,

a.Ores of copper, aluminum, mercury and other metals.

b. Deposits of fertilizer nutrients such as phosphate rock and potassium.

c. Minerals that are used in their natural states such as asbestos, clay, mica, etc.

As these deposits are mined, they are not replaced, and hence such materials are considered non-renewable. However, it is possible, at least in theory, to collect these materials and recycle them.

ii. Non-renewable resources that cannot be recycled: These resources exist in a fixed quantity in Earth's crust and thus theoretically can be completely used up. Now. We will know about the non-recyclable - non-renewable resources.

2.Non-Recyclable – Non-renewable Resources:

Resources that exist in a fixed quantity in Earth's crust and thus theoretically can be completely used up are called non-renewable (or exhaustible) resources. On a time scale of millions to billions of years, such resources can be renewed by geological processes. However, on the much shorter human time scale of hundreds to thousands of years, these resources can be depleted much faster than they are formed. Fossil fuels are derived from organic matter that accumulated during hundreds of millions of years of early bio-geological history. There is no way of recycling the energy in fossil fuels. Resources that cannot be recycled are those "mineral" energy resources, namely, fossil fuels (coal, oil, and natural gas), that presently supply better than 90 percent of our energy, and uranium that is used for nuclear (atomic) power. Non-renewable energy resources, such as coal, oil, and natural gas, can't be recycled or reused. Once burned, the useful energy in these fossil fuels is gone, leaving behind waste "heat and polluting exhaust gases. Most of the per capita economic growth has been fueled by relatively cheap non-renewable oil, which is expected to be economically depleted within 40 to 80 years. So we got two types of examples of non-renewable resources that cannot be recycle

1. Fossil fuels
2. Uranium

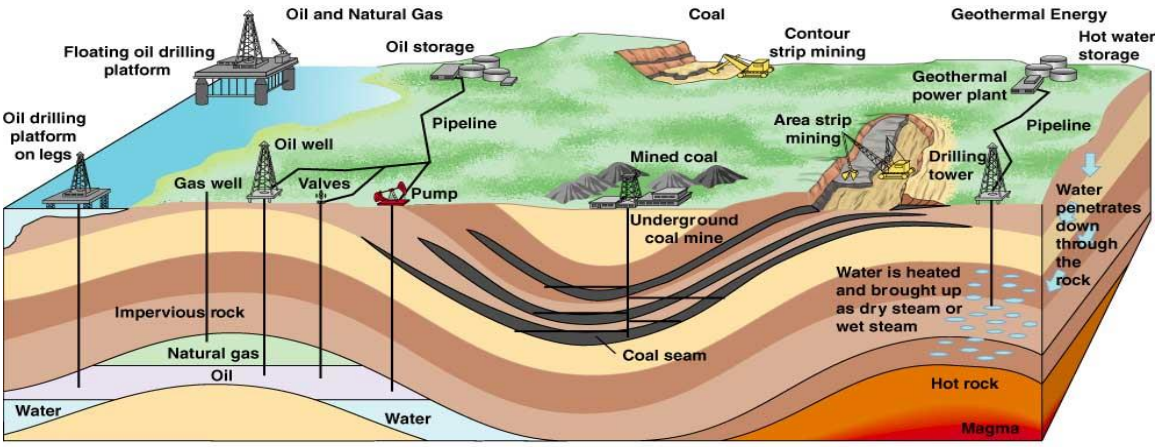


Fig: Nonrenewable energy resources removed from the earth's crust include: oil, natural gas, coal, and uranium(source: 2001Cole/brooks publishing)

FOSSIL FUELS

Ancient organic remains (fossils) in sediments which over eons become sedimentary rock giving rise to solid, liquid,and gaseous fuels. Essentially all fossil fuels are highly concentrated forms of far-ancient he industrial revolution (mid 19th to 20th early century).

Fossil fuel includes-

(A)Natural gas (B) Coal (C) Petroleum oil

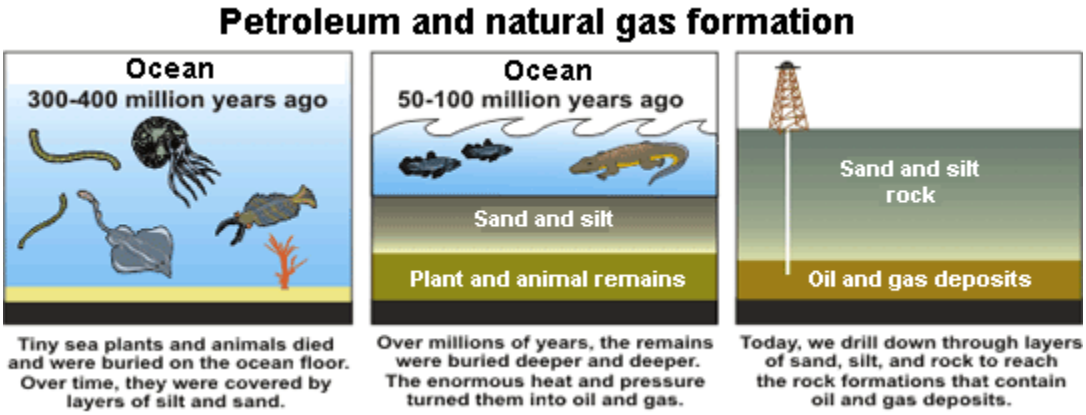
(A) Natural gas

Natural gas occurs deep beneath the earth's surface. Natural gas consists mainly of methane, a compound with one carbon atom and four hydrogen atoms. Natural gas also contains small amounts of hydrocarbon gas liquids and nonhydrocarbon gases. We use natural gas as a fuel and to make materials and chemicals.

Formation of natural gas

Millions of years ago, the remains of plants and animals (diatoms) decayed and built up in thick layers, sometimes mixed with sand and silt. Over time, these

layers were buried under sand, silt, and rock. Pressure and heat changed some of this organic material into coal, some into oil (petroleum), and some into natural gas. In some places, the natural gas moved into large cracks and spaces between layers of overlying rock. In other places, natural gas occurs in the tiny pores (spaces) within some formations of shale, sandstone, and other types of sedimentary rock where it is referred to as *shale gas* or *tight gas*. Natural gas also occurs in coal deposits and is called *coal bed methane*.



Source: U.S. Energy Information Administration (public domain)

Sources of natural gas

The search for natural gas begins with geologists, who study the structure and processes of the earth. They locate the types of rock that are likely to contain natural gas deposits. Some of these areas are on land and some are offshore and deep under the ocean floor.

Geologists often use seismic surveys on land and in the ocean to find the right places to drill wells. Seismic surveys on land use echoes from a vibration source at the surface of the earth, usually a vibrating pad under a special type of truck. Geologists can also use small amounts of explosives as a vibration source. Seismic surveys conducted in the ocean rely on blasts of sound that create sonic waves to explore the geology beneath the ocean floor.

If a site seems promising, an exploratory well is drilled and tested. Once a formation is proven to be economic for production, one or more production (or development) wells are drilled down into the formation, and natural gas flows

up through the wells to the surface. In the United States and a few other countries, natural gas is produced directly from shale and other types of rock formations that contain natural gas in pores within the rock. The rock formation is fractured by forcing water, chemicals, and sand down a well. This releases the natural gas from the rock, and the natural gas flows up the well to the surface. Wells drilled to produce oil may also produce associated natural gas.

The natural gas withdrawn from a well is called *wet natural gas*because it usually contains liquid hydrocarbons and nonhydrocarbon gases. Methane and other useful gases are separated from the wet natural gas near the site of the well or at a natural gas processing plant. The processed gas is called *dry* or *consumer-grade* natural gas. This natural gas is sent through pipelines to underground storage fields or to distribution companies and then to consumers.

Coal may contain *coalbed methane*, which can be captured when coal is mined. Coalbed methane can be added to natural gas pipelines without any special treatment. Another source of methane is biogas that forms in landfills and in vessels called *digesters.*

Most of the natural gas consumed in the United States is produced in the United States. Some natural gas is imported from Canada and Mexico in pipelines. A small amount of natural gas is also imported as liquefied natural gas.

(B) Coal: Coal is the most abundant form of fossil fuel available on earth. They were formed by the decay of old plants and animals several centuries ago. Coal is mostly found below the earth and is major source of fuel for electricity generation as of today. Most power stations on earth require huge reserves of coal to produce electricity continuously without break. When coal is burnt, it produces heat that is used to convert the water into stream.The steam is then used to move the turbines which in turns activate generators which produces electricity. Coal contains excessive amount of carbon. When it is burnt to produce power, it mixes up with oxygen to produce carbon dioxide. Carbon dioxide is one the gas responsible for global warming. The use of coal and other fossil fuels have only increased since they were discovered. Their excessive

extraction and use has resulted in degradation of environment and ecological imbalance. Though coal is still available in big quantity on this earth but it is predicted that it won't last for more than 40-50 years if switch is not made to green or clean energy.

Coal takes millions of years to form

Coal is a combustible black or brownish-black sedimentary rock with a high amount of carbon and hydrocarbons. Coal is classified as a nonrenewable energy source because it takes millions of years to form. Coal contains the energy stored by plants that lived hundreds of millions of years ago in swampy forests.

The plants were covered by layers of dirt and rock over millions of years. The resulting pressure and heat turned the plants into a substance now known as coal.

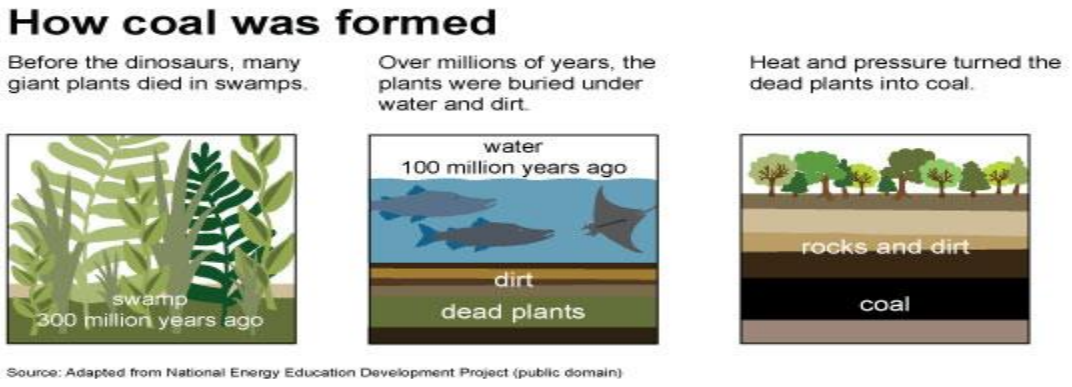


Fig: Coalformation (source: adaption from national energy education development project)

Types of coal

Coal is classified into four main types, or ranks: anthracite, bituminous, subbituminous, and lignite. The ranking depends on the types and amounts of carbon the coal contains and on the amount of heat energy the coal can produce.

The rank of a coal deposit is determined by the amount of pressure and heat that acted on the plants over time.

Anthracite contains 86%–97% carbon, and generally has the highest heating value of all ranks of coal. Anthracite accounted for less than 1% of the coal mined in the United States in 2014. All of the anthracite mines in the United States are located in northeastern Pennsylvania. Anthracite is mainly used by the metals industry.

Bituminous coal contains 45%–86% carbon. Bituminous coal in the United States is between 100 and 300 million years old. Bituminous coal is the most abundant rank of coal found in the United States, and it accounted for 48% of total U.S. coal production in 2014. Bituminous coal is used to generate electricity, and it is an important fuel and raw material for making iron and steel. West Virginia, Kentucky, Pennsylvania, Illinois, and Indiana were the five main bituminous coal-producing states in 2014, accounting for 70% of total bituminous production.

Subbituminous coal typically contains 35%–45% carbon, and it has a lower heating value than bituminous coal. Most subbituminous coal in the United States is at least 100 million years old. About 44% of total U.S. coal production in 2014 was subbituminous, and nearly 90% was produced in Wyoming.

Lignite contains 25%–35% carbon and has the lowest energy content of all coal ranks. Lignite coal deposits tend to be relatively young and were not subjected to extreme heat or pressure. Lignite is crumbly and has high moisture content, which contributes to its low heating value. Lignite accounted for 8% of total U.S. coal production in 2014. About 92% of total lignite production is mined in Texas and North Dakota, where it is burned at power plants to generate electricity. A facility in North Dakota also converts lignite to *synthetic natural gas* and pipes it to natural gas consumers in the eastern United States.

(C) Oil/Petroleum: Oil is available in abundance in most of the Middle East countries including Saudi Arabia, Kuwait, Iran, Iraq and UAE while some limited oil wells are present in North America and Canada. Most of the countries still have their huge dependency on these countries for their oil requirements. Like coal, it was also made out of dead plants and animals that had lived millions of years ago. When plants and animals died they were covered with thick layer of mud and sand which created huge pressure and temperature. These fossil fuels coal, oil and natural gas are result of those conditions only.

Wide usage of oil and oil related products has resulted in massive air pollution. It is a major source of fuel that is used in vehicles. Due to the process of combustion, harmful gases like carbon dioxide are released when oil is burnt. Everyday around 19.7 million barrels of oil is consumed in United States alone. Oil is transported to other nations using pipelines or ships. Leakage in ships leads to oil spill which affects animals and plants that live inside or around the sea. Just couple of years back, a ship containing oil of British Petroleum (BP) caused oil leakage which resulted in killing of many whales, fishes and small animals that live inside the sea.

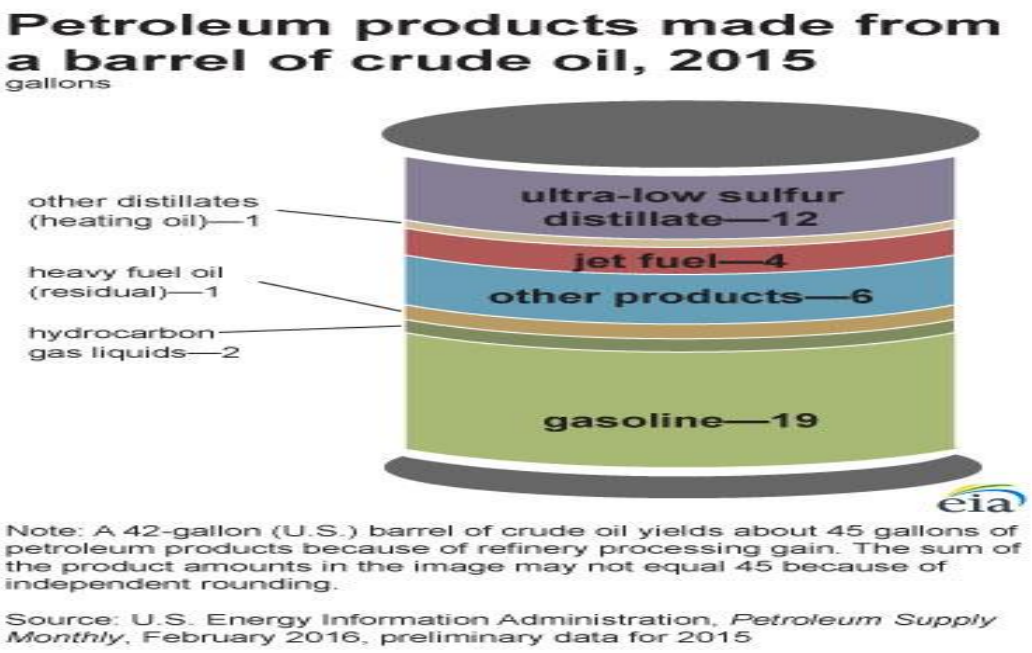


Fig: Petroleum products made from crude oil, 2015 (source: U.S. energy information administration, petroleum supply monthly, February 2015)

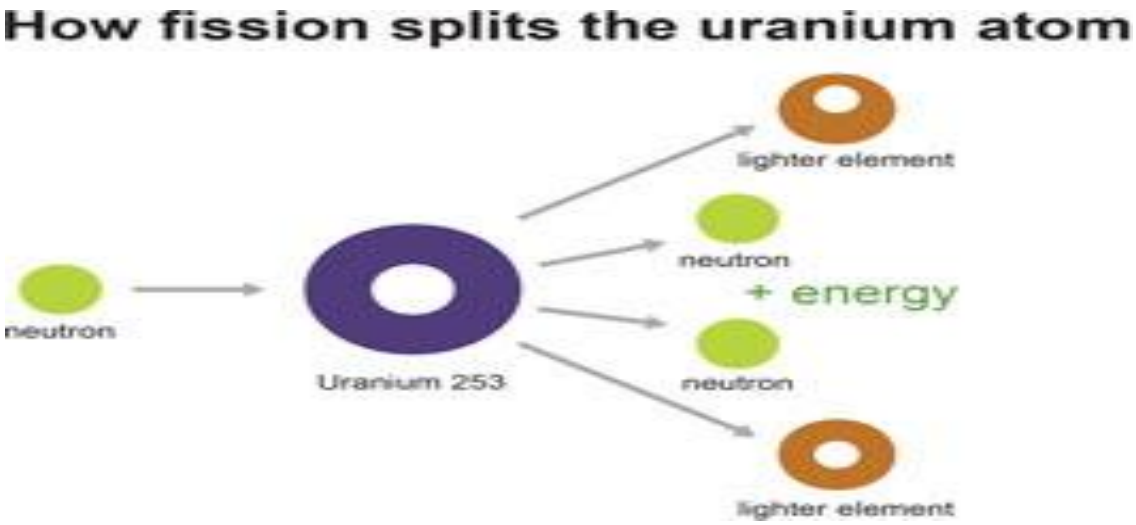
Nuclear Energy: Uranium

Nuclear energy is has become a hot technology today. More and more countries are switching to nuclear energy to fulfill their future energy demands. Around 16% of world's electricity production comes through nuclear energy. Nuclear power plants use Uranium as a fuel to extract energy from it.

The energy can be released through either of the two processes: Nuclear Fission or Nuclear Fusion. Nuclear fission is the most common technique to harness nuclear energy. U-235 element is bombarded with slow moving neutrons which break the atom and releases energy. The atoms that got split are then again hit by neutrons to produce mass amount of energy. Like fossil fuels, nuclear does not produces any greenhouse emissions. Nuclear power plants produce some sort of nuclear waste called radioactive elements.

These elements emit strong radiations and must be buried deep underground so that they don't affect human life. Couple of nuclear disasters has already

occurred in past including Chernobyl and Island Three Miles. In the recent past, there is the case of the disaster, which happened in Japan back in 2010. These disasters have again raised several questions on safety of nuclear power plants and people who work in these plants. Despite this, several power stations are coming up in different parts of the world. Another downside of nuclear energy is that it can be used to make nuclear bomb. Therefore, these remain targets for various terrorist organizations.



Source: Adapted from National Energy Education Development Project (public domain)

Future of Non-Renewable Energy Sources

Non-renewable energy sources have fueled the world's industrial complex for far too long. It has reached a point where the word is facing rapid starvation in this sector. There are also other associated effects too which also need to be carefully looked at just to make sure things are running as intended. However, this is not the case. With increased exploitation of these fossil fuels, there are many associated environmental effects like land pollution and air pollution which in turn affect both animal and plant life. The far-reaching consequences of non-

renewable sources are inexplicable and the trend has to be reversed soon before it is too late to do anything.

Carbon is a major source of fuel in non-renewable energy sources. When combustion takes place, carbon is mixed with oxygen and form carbon dioxide. It pollutes the environment and is responsible for global warming. In last few years, the concentration of carbon dioxide has only increased in the atmosphere. Not to mention, climate change, acid rain and change in seasons are some other effects that has been observed by many people. With so many problems, scarce resources and rising prices, these resources cannot be used for lifetime. The need of the hour is to look for some alternative sources of energy and protect our environment from such harmful gases.

Alternative of Non-Renewable Energy Sources

There are many active groups that are finding other alternative sources of energy. For instance, there has been increased exploitation and tapping of renewable energy sources. Worldwide there are several renewable energy projects that are undergoing to harness this energy as it is clean, replenished, sustainable and widely available.

Most people argue that even these projects consume fossil fuel in some indirect way to produce electricity. Manufacturing of turbines, generators, blades, solar panels, transformers and several other small components are done in factories which use fossil fuels to produce them. But, renewable energy experts say that energy produced by these plants is much higher than the energy consumed during making of these components.

Although, these energy sources have been in use since last few decades but it is only in the last few years that renewable energy has speed up the pace. Huge investments have been going in these projects and several companies across the world are setting up wind farms, solar farms and hydropower plants across several countries. Nuclear energy has also gain momentum.

Though it is not considered as renewable source due to the fact that it releases some toxic substances in the form of radioactive waste but it is sustainable form of energy. Even after several years, share of renewable energy in world power production is less than 20%. It is however believed that by 2020, renewable energy will have a major share in world's electricity production.

Coal mining as predominant as it is, should be limited to save the environment from many other associated effects aside from pollution. This was the major energy source in the early 19th century before plans were made to tap into renewable energy sources. Oil exploration was once the best trade and investment to make.

Nowadays, any discovery is just an environmental disaster in waiting. Geothermal power is another one that gives out lots of energy. The one bad thing is it is a non-renewable source of energy that has vast environmental effects. When carbon monoxide is released in the air, it bonds with oxygen resulting in reduction of percentage of oxygen in that specific area. This is a gas that has the capability to suffocate as it deprives oxygen from its surrounding to form carbon dioxide.

Conclusion

People use non-renewable sources of energy almost every day. When lights, appliances and electric heating and cooling devices are powered using electricity that comes from coal-fired power plants, the resulting emissions harm the surrounding air quality. Gasoline burned by vehicles sends pollutants into the air. Conserving energy by using less electricity and minimizing the use of gas-burning transportation leads to fewer toxins entering the environment. It also reduces demand for the use of non-renewable energy.

It is impossible to reduce energy consumption to zero because of the lifestyle needs that people have in modern society. However, converting from non-renewable energy sources to renewable ones reduces the negative impact of energy consumption on the environment. Electricity that comes from solar panels

or wind turbines does not release toxic emissions into the atmosphere. Changing from gas-powered to electric-powered vehicles or gas-electric hybrids also reduces harmful emissions and contributes to higher air quality. These conservation measures can help to slow the trend of global warming.