

UNIT 3- ENERGY SOURCES

Energy

Energy is essential to life and all living organisms. The sun, directly or indirectly, is the source of all the energy available on Earth. In Physics, energy is a quantitative property that must be transferred to an object in order for it to perform work. Hence, we can define energy as the strength to do any kind of physical activity. Thus, they say, Energy is the ability to do work

Energy is a conserved quantity and the law of conservation of energy states that energy can neither be created nor destroyed but can only be converted from one form to another. The SI unit of energy is Joule.

Energy Conversion: Transfer and Transform

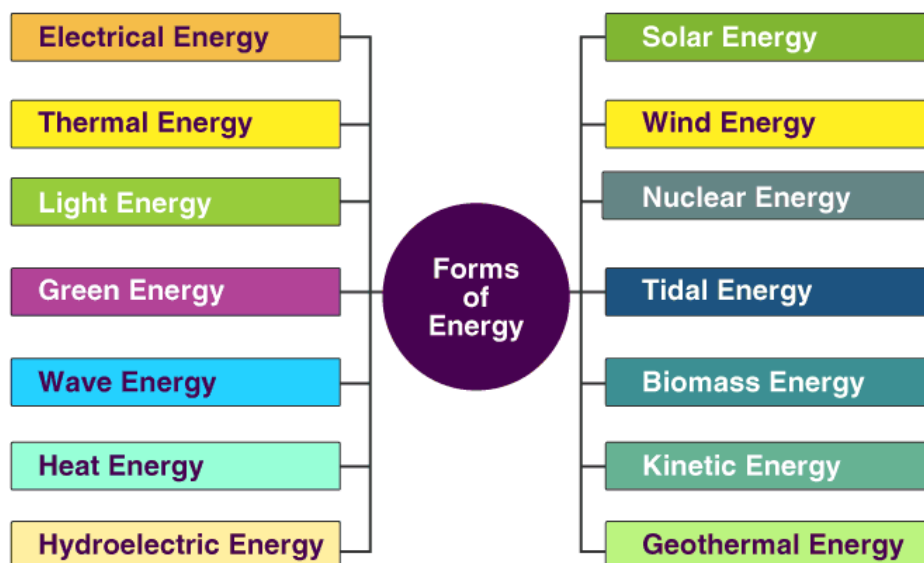
The movement of energy from one location to another is known as energy transfer. There are energy transfers going on all the time – whenever a system changes there is a change in the way some or all of the energy is stored.

Following are the four ways through which energy can be transferred:

- Mechanically – By the action of force
- Electrically – Electrically
- By Radiation – By Light waves or Sound waves
- By Heating – By conduction, convection, or radiation

The process which results in the energy changing from one form to another is known as energy transformation. While energy can be transformed or transferred, the total amount of energy does not change – this is called energy conservation.

Different Types of Energy



Renewable sources are ones which can be recycled or reused. Non-renewable sources cannot be reused and so there is a limited amount available and when that runs out there will be none left.

Renewable energy includes solar, hydro and wind energy. Wind energy is made when the wind moves the blades on a wind turbine. This movement creates wind energy which is converted into electrical energy.

Non-renewable energy includes coal, gas and oil. Most cars, trains and planes use non-renewable energy. They are made by burning fossil fuels to create energy.

Kinetic Energy

Kinetic energy is the energy associated with the object's motion. Objects in motion are capable of causing a change or are capable of doing work. To better understand, let us think of a wrecking ball. A wrecking ball in motion is used to do work such as demolition of buildings, stones, etc. Even a slow-moving wrecking ball is capable of causing a lot of damage to another object such as an empty house. However, a wrecking ball that is not in motion, does not do any work.

Kinetic energy is determined by the given formula $K.E = \frac{1}{2}mv^2$

Different types of Kinetic Energy include:

Radiant energy

- Radiant energy refers to the type of energy that travels by waves or particles. This energy is created through electromagnetic waves and is most commonly experienced by humans in the form of heat. Following are a few examples of radiant energy:
- When you turn on an incandescent light bulb, it gives off two forms of energy. There is visible light and heat that is generated. Both these generated energies are a form of radiant energy.
- Sunlight is an example of radiant energy.

Thermal Energy

Thermal energy is similar to radiant energy and is experienced in the form of heat or warmth. While radiant energy refers to waves or particles, thermal energy describes the level of activity among the atoms and molecules in an object. This is the only difference between radiant energy and thermal energy. Some examples of thermal energy include:

- The geothermal energy that comes from the decay of natural minerals and the volcanic action of the earth is an example of thermal energy.
- When you heat up the pizza in the oven, you are raising the temperature of the pizza. The molecules that make up the pizza are moving more quickly when the pizza is piping hot.
- The warmth that you feel emanating from the engine is an example of thermal energy.

Sound Energy

The vibrations that reach the human ear are experienced by humans as sound. The disturbance moves in the form of waves through a medium like air and reaches our eardrum. On reaching the eardrum, these vibrations are converted into electrical signals and sent to the brain which we interpret as the sensation of sound.

Electrical Energy

The flow of negatively charged electrons around a circuit results in electricity which we more commonly referred to as electrical energy.

Mechanical Energy

Mechanical energy is the energy associated with the mechanical movement of objects.

Potential Energy

Potential energy is the energy stored in an object or system of objects. Potential energy has the ability to transform into a more obvious form of kinetic energy.

Potential energy is determined by the given formula

$$\text{Potential Energy} = m \times g \times h$$

Both potential energy and kinetic energy form mechanical energy.

Mechanical energy is determined by the following formula

$$\text{Mechanical Energy} = \frac{1}{2}mv^2 + mgh$$

Different types of potential energy include

Gravitational Potential Energy

Gravitational potential energy is the energy stored in an object as the result of its vertical position or height. A book on a high bookshelf has a higher gravitational potential energy than the book at the bottom bookshelf.

Elastic Potential Energy

Elastic potential energy is energy stored as a result of applying a force to deform an elastic object. The energy is stored until the force is removed and the object springs back to its original shape, doing work in the process. The deformation could involve compressing, stretching or twisting the object.

Chemical Potential Energy

Chemical potential energy is the energy stored in the chemical bonds of the substance. It is the energy that can be absorbed and released due to a change in the particle number of the given species.

Electric Potential Energy

Electric potential energy is the energy that is needed to move a charge against an electric field. Some of the examples of electric potential energy include:

- An incandescent light bulb that is turned off
- A radio tower that is not working
- A black-light turned off
- A television before it is turned on

Fossil fuels

The substances which act as energy sources are known as fuels. The buried organic matters which can be converted to crude oil, coal, natural gas or any heavy oils by applying pressure and heat on earth's crust over hundreds of years are known as fossil fuels. This topic educates about the effect of burning fossil fuels on the environment.

Fossil fuels are hydrocarbons, primarily coal, fuel oil or natural gas, formed from the remains of dead plants and animals.

A fossil fuel is a fuel formed by natural processes, such as anaerobic decomposition of buried dead organisms, containing organic molecules originating in ancient photosynthesis that release energy in combustion. Such organisms and their resulting fossil fuels typically have an age of millions of years, and sometimes more than 650 million years.

Fossil fuels contain high percentages of carbon and include petroleum, coal, and natural gas. Peat is also sometimes considered a fossil fuel.

Commonly used derivatives of fossil fuels include kerosene and propane.

Fossil fuels range from volatile materials with low carbon-to-hydrogen ratios (like methane), to liquids (like petroleum), to nonvolatile materials composed of almost pure carbon, like anthracite coal. Methane can be found in hydrocarbon fields alone, associated with oil, or in the form of methane clathrates.

What are Fossil Fuels?

Fossil fuels are buried flammable geologic deposits of organic substances such as dead plants and animals that got deposited under several thousand feet of silt. These deposits decayed with the passage of time and got converted to natural gas, coal and petroleum due to the extreme heat and pressure inside the

earth's crust. They are also known as non-renewable sources of energy as it takes a very long time for it to replenish.

Types, Formation and Uses of Fossil Fuels

Fossil fuels are of the following types:

- Coal
- Petroleum
- Natural gas

Coal

- It is a hard, black coloured substance made up of carbon, hydrogen, nitrogen, oxygen and sulphur.
- The major types of coal are- anthracite, bituminous and lignite.
- Anthracite has a higher carbon concentration and is the hardest type of coal.
- Lignite has a high concentration of oxygen and hydrogen but a low concentration of carbon.
- Bituminous is a moderate form of coal.
- Coal is processed industrially to obtain derivatives like coke, coal tar and coal gas.

Formation of Coal

- The process of formation of coal is known as coalification.
- The dense forest present in the low-lying wetland got buried in the earth, millions of years ago.
- Soil kept depositing over them and they got compressed.
- As they went deeper and deeper, they faced high temperature and pressure.
- As a result, the substances slowly got converted into coal.

Uses of Coal

- Coal was used to produce steam in the railway engines initially.
- It is used to cook food.
- It is used to generate electricity in thermal plants.
- It is used in industries as fuel.

Petroleum

- It is a clear, oily liquid, usually green or black in colour.
- It has a very strange smell and is a mixture of petroleum gas, diesel, paraffin wax, petrol, lubricating oil, etc.

- It is also termed as “Black Gold” because of its wide range of uses in many industries.

Formation of Petroleum

- The sea animals and plants died and their bodies settled at the bottom of the sea.
- They got compressed by the layers of sand and clay.
- Their encounter with high temperature and pressure converts them into petroleum.
- The petroleum is separated from the crude oil by a series of processes in a refinery. This is known as petroleum refining.

Uses of Petroleum

- It is used to power internal combustion engines in the form of petrol.
- It is used in roofing, road pavements and as a water repellent.
- It is used in manufacturing detergents, plastics, fibres, polyethene, etc.

Natural gas

- It is a clean and non-toxic fossil fuel.
- It is colourless and odourless and can be easily transferred through pipelines.
- It is stored as compressed natural gas (CNG) under high pressure.
- It is a less polluting and less expensive fossil fuel.
- Methane is the most important natural gas.

Formation of Natural Gas

- The phytoplankton and zooplankton sink to the bottom of the ocean and mix with organic materials to form an organic-rich mud.
- The mud buried under more sediments and lithifies to form an organic shale. This prevents its exposure to oxygen. This is done to protect the organic materials from being decomposed by bacteria.
- The increasing pressure and temperature transform the shale into a waxy material known as the kerogen.
- At temperatures between 90-160°C kerogen is transformed into natural gas.

Uses of Natural gas

- Compressed Natural Gas is used for generating power.
- It is used as fuels in automobiles.

- It can be used at homes for cooking.
- It is used as a starting material in chemicals and fertilizers.

Advantages and Disadvantages of Fossil Fuels

Advantages:

- Fossil fuels can generate a large amount of electricity at a single location.
- They can be found very easily.
- They are cost-effective.
- Transportation of oil and gas can be done easily through pipelines.
- They have become safer over time.
- Despite being a finite resource, it is available in plenty.

Disadvantages

- Fossil fuels emit carbon dioxide when burnt which is a major greenhouse gas and the primary source of pollution. This has contributed to global warming.
- They are a non-renewable resource, i.e., once used they cannot be replaced.
- Combustion of fossil fuels makes the environment more acidic. This has led to unpredictable and negative changes in the environment.
- Harvesting of fossil fuels also causes fatal diseases among the people. For eg., the coal miners often suffer from Black Lung Disease. The natural gas drillers are constantly exposed to chemicals and silica which is dangerous for their health.

Effects of fossil fuels on the environment:

The burning of fossil fuels leads to the release of harmful products into the environment. An increase in the consumption of fuel leads to harmful effects on the environment. Following points will clearly depict these effects:

1. Carbon fuels such as wood, coal, petroleum release unburnt carbon particles in the environment. These particles are very dangerous pollutants and cause respiratory diseases for example asthma.
2. When fuels are incompletely burnt, they release carbon monoxide gas into the atmosphere. This gas is very dangerous as it is poisonous in nature. If we burn coal in a closed room, then the person sleeping in that room will be killed by the action of carbon monoxide.
3. The combustion of fossil fuels also releases a large amount of carbon dioxide into the atmosphere. Carbon dioxide is a greenhouse gas which is responsible for global warming. Global warming is a rise in the overall temperature of the earth's surface. This leads to the melting of polar caps and rise in the sea level and further results in flooding of coastal regions.

4. Burning of coal and diesel releases sulphur dioxide gas. This gas is extremely corrosive and suffocating in nature. Petrol gives off oxides of nitrogen. The oxides of sulphur and nitrogen get dissolved in rainwater and form acids. This is known as acid rain. This water is very harmful to plants, animals, and various monuments.

Alternatives to fossil fuels

Alternative fuels, known as non-conventional and advanced fuels, are any materials or substances that can be used as fuels, other than conventional fuels like; fossil fuels (petroleum (oil), coal, and natural gas), as well as nuclear materials such as uranium and thorium, as well as artificial radioisotope fuels that are made in nuclear reactors.

Some well-known alternative fuels include bio-diesel, bio-alcohol (methanol, ethanol, butane), refuse-derived fuel, chemically stored electricity (batteries and fuel cells), hydrogen, non-fossil methane, non-fossil natural gas, vegetable oil, propane and other biomass sources.

Nowadays these fuels are being replaced by CNG (compressed natural gas) because it is a cleaner fuel and produces less harmful products.

Bio Fuel

Bio-fuels are also considered a renewable source. Although renewable energy is used mostly to generate electricity, it is often assumed that some form of renewable energy or a percentage is used to create alternative fuels. Research is ongoing into finding more suitable bio-fuel crops and improving the oil yields of these crops. Using the current yields, vast amounts of land and fresh water would be needed to produce enough oil to completely replace fossil fuel usage.

Biomass

Biomass in the energy production industry is living and recently dead biological material which can be used as fuel or for industrial production. It has become popular among coal power stations, which switch from coal to biomass in order to convert to renewable energy generation without wasting existing generating plant and infrastructure. Biomass most often refers to plants or plant-based materials that are not used for food or feed, and are specifically called nitrocellulose biomass. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of bio-fuel.

Algae-based fuels

Algae-based bio-fuels have been promoted in the media as a potential panacea to crude oil-based transportation problems. Algae could yield more than 2000 gallons of fuel per acre per year of production. Algae based fuels are being successfully tested by the U.S. Navy Algae-based plastics show potential to reduce waste and the cost per pound of algae plastic is expected to be cheaper than traditional plastic prices.

Bio-diesel

Vegetable oil fuelled bus at South by South West festival, Austin, Texas (March 2008).

Bio-diesel is made from animal fats or vegetable oils, renewable resources that come from plants such as atrophy, soybean, sunflowers, corn, olive, peanut, palm, coconut, safflower, canola, sesame, cottonseed, etc. Once these fats or oils are filtered from their hydrocarbons and then combined with alcohol like methanol, diesel is brought to life from this chemical reaction. These raw materials can either be mixed with pure diesel to make various proportions or used alone. Despite one's mixture preference, bio-diesel will release a smaller number of pollutants (carbon monoxide particulates and hydrocarbons) than conventional diesel, because bio-diesel burns both cleanly and more efficiently. Even with regular diesel's reduced quantity of sulfur from the LSD (ultra-low sulfur diesel) invention, bio-diesel exceeds those levels because it is sulfur-free.

Alcohol Fuels

Methanol and ethanol fuel are primary sources of energy; they are convenient fuels for storing and transporting energy. These alcohols can be used in internal combustion engines as alternative fuels. Butane has another advantage: it is the only alcohol-based motor fuel that can be transported readily by existing petroleum-product pipeline networks, instead of only by tanker trucks and railroad cars

Hydrogen Gas

Unlike other forms of natural gas, hydrogen is a completely clean burning fuel. Once produced, hydrogen gas cells emit only water vapor and warm air when in use. The major issue with this form of alternative energy is that it is mostly derived from the use of natural gas and fossil fuels. As such, it could be argued that the emissions created to extract it counteract the benefits of its use.

Natural Gas

Natural gas sources have been in use for a number of decades, but it is through the progression of compression techniques that it is becoming a more viable alternative energy source. In particular, it is being used in cars to reduce carbon emissions. Demand for this energy source has been increasing. In 2016, the lower 48 states of the United States reached record levels of demand and consumption.

Despite this, natural gas does come with some issues. The potential for contamination is larger than with other alternative fuel sources and natural gas still emits greenhouse gases, even if the amount is lower than with fossil fuels.

Advantages of Alternative Energy

- **Environmental benefits.** Low or zero carbon emission is without a doubt the main advantage of alternative energy over fossil fuels. Solar and wind power virtually produce zero carbon emissions, while wood is providing a sustainable, environmentally friendly and inexpensive energy for heating, of course under condition that the firewood is sourced in sustainably managed forests and burned in efficient wood burning stoves.
- **Increased energy security.** Fossil fuels are unequally distributed and make the global economy dependent on a few exporting countries. Utilisation of alternative energy thus significantly

reduces dependence from the international energy supplies which in turn increases energy security by providing a stable and cost-effective energy supply.

- **Sustainability.** Unlike the traditional types of energy which are non-renewable, alternative forms of energy are renewable which means that they offer sustainable and stable energy supply in the long term. The Sun will not stop shining, the wind will not stop blowing, trees that are cut down for wood can easily be replaced, etc..

Disadvantages of Alternative Energy

- **High cost.** Unfortunately, the technologies that utilise alternative sources of energy remain relatively expensive. This of course has a major influence on the prices of energy which in turn causes concerns about adverse economic effects. A large segment of industry depends heavily on cheap energy in order to be able to keep up with the fierce global competition.
- **Low efficiency.** Alternative energy technologies are relatively new in offices and are not particularly efficient. This poses a problem with feasibility because the investment may not return, even in the long term. As a result, the interest of private investors for green technologies remains relatively low, while the Government can finance only a certain amount investments at a time.
- **Issues with the stability of the system.** The energy sector is not only seeking for alternative solutions to lower carbon dioxide emissions but to meet the rising demand for energy as well. In order for the energy supply system to remain stable, it is crucial for the supply to meet the demand. And with current technologies available, alternative types of energy – especially the most desirable ones such as solar energy – are unable to produce enough energy to meet the demand.

Hydrogen Fuel Cells

A **fuel cell** is an electrochemical cell that converts the chemical energy of a fuel (often hydrogen) and an oxidizing agent (often oxygen) into electricity through a pair of redox reactions. Fuel cells are different from most batteries in requiring a continuous source of fuel and oxygen (usually from air) to sustain the chemical reaction, whereas in a battery the chemical energy usually comes from metals and their ions or oxides that are commonly already present in the battery, except in flow batteries. Fuel cells can produce electricity continuously for as long as fuel and oxygen are supplied.

A fuel cell combines hydrogen and oxygen to produce electricity, heat, and water. Fuel cells are often compared to batteries. Both convert the energy produced by a chemical reaction into usable electric power. However, the fuel cell will produce electricity as long as fuel (hydrogen) is supplied, never losing its charge.

Fuel cells are a promising technology for use as a source of heat and electricity for buildings, and as an electrical power source for electric motors propelling vehicles. Fuel cells operate best on pure hydrogen. But fuels like natural gas, methanol, or even gasoline can be reformed to produce the hydrogen required for fuel cells. Some fuel cells even can be fueled directly with methanol, without using a reformer.

In the future, hydrogen could also join electricity as an important energy carrier. An energy carrier moves and delivers energy in a usable form to consumers. Renewable energy sources, like the sun and wind, can't produce energy all the time. But they could, for example, produce electric energy and hydrogen, which can be stored until it's needed. Hydrogen can also be transported (like electricity) to locations where it is needed.

There are many types of fuel cells, but they all consist of an anode, a cathode, and an electrolyte that allows ions, often positively charged hydrogen ions (protons), to move between the two sides of the fuel cell. At the anode a catalyst causes the fuel to undergo oxidation reactions that generate ions (often positively charged hydrogen ions) and electrons. The ions move from the anode to the cathode through the electrolyte. At the same time, electrons flow from the anode to the cathode through an external circuit, producing direct current electricity. At the cathode, another catalyst causes ions, electrons, and oxygen to react, forming water and possibly other products.

Benefits of Hydrogen Fuel Cell

Zero-Emission Power

Hydrogen fuel cells (HFCs) produce no harmful emissions, eliminating the costs associated with handling and storing toxic materials like battery acid or diesel fuel. In fact, when fueled with pure hydrogen, the only by-products are heat and water, making our products a zero-emission, sustainable power source. Hydrogen fuel cells are part of many well-planned corporate sustainability programs.

Robust Reliability

Hydrogen fuel cell technology has proven itself against tough conditions, including cold environments as low as -40 degrees F/C, weather environments like hurricanes, deserts, and winter storms, and even the hard-working business environments of material handling warehouses.

Improved Efficiency

According to the U.S. Department of Energy, hydrogen fuel cells are generally between 40-60% energy efficient. This range compares to the typical internal combustion engine of a car which is about 25% energy efficient. Hydrogen fuel cell efficiency is put to work to improve warehouse productivity by up to 15% using fuel cell forklifts to extend the mileage range for electric vehicles.

Scalable

The advantages of using a modular product are profound: greater reliability and easier serviceability. But most important of the fuel cell benefits may be scalability – and the savings provided when purchasing and using fuel cells. These products may be engineered precisely to meet a variety of customer power

needs – whether for on-road electric vehicles, material handling fleets, or stationary power. Paying only for what you need just makes sense.

Lower Operational Costs

Compared to batteries and internal combustion generators, fuel cells save money. They eliminate the need to change, charge, and manage batteries, subsequently reducing labor, time, space, and peak power demands. The units run longer than lead-acid batteries and can be fueled in as little as two minutes, substantially reducing vehicle and personnel downtime.

Advantages:

More detailed information is available in the applications section, which offers information specific to each industry.

- High Efficiency- when utilizing co-generation, fuel cells can attain over 80% energy efficiency
- Good reliability- quality of power provided does not degrade over time.
- Noise- offers a much more silent and smooth alternative to conventional energy production.
- Environmentally beneficial- greatly reduces CO₂ and harmful pollutant emissions.
- Size reduction- fuel cells are significantly lighter and more compact

Disadvantages:

- Expensive to manufacture due the high cost of catalysts (platinum)
- Lack of infrastructure to support the distribution of hydrogen
- A lot of the currently available fuel cell technology is in the prototype stage and not yet validated.
- Hydrogen is expensive to produce and not widely available

Nuclear Energy

Nuclear Energy is the energy in the core of an atom. Where an atom is a tiny particle that constitutes every matter in the universe. Normally, the mass of an atom is concentrated at the centre of the nucleus. Neutrons and Protons are the two subatomic particles that comprehend the nucleus. There ex a st massive amount of energy in bonds that binds atoms together.

Nuclear Energy is discharged by nuclear reactions either by fission or fusion. In nuclear fusion, atoms combine to form a larger atom. In nuclear fission, the division of atoms takes place to form smaller atoms by releasing energy. Nuclear power plants produce energy using nuclear fission. The Sun produces energy using the mechanism of nuclear fusion.

Applications of Nuclear Energy

- Nuclear technology
- Nuclear medicine
- Nuclear Technology is used in Industries

- Agricultural uses of nuclear technology
- Environmental uses of nuclear technology
- Biological Experimentations
- Medical diagnosis and treatments
- Scientific Investigations
- Engineering Projects
- Neutron Activation Analysis

Advantages	Disadvantages
Produces no polluting gases.	Waste is radioactive and safe disposal is very difficult and expensive.
Does not contribute to global warming.	Local thermal pollution from wastewater affects marine life.
Very low fuel costs.	Large-scale accidents can be catastrophic.
Low fuel quantity reduces mining and transportation effects on environment.	Public perception of nuclear power is negative.
High technology research required benefits other industries.	Costs of building and safely decommissioning are very high.
Power station has very long lifetime.	Cannot react quickly to changes in electricity demand.

Environmental Impact Assessment

Environmental Impact Assessment is defined as an activity designed to identify the impact on the bio geophysical environment, on man and well-being of legislative proposals, projects, policies, operational procedures and to interpret and communicate information.

It is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural, and human-health impacts, both beneficial and adverse.

EIA is a tool used to assess the positive and negative environmental, economic, and social impacts of a project. This is used to predict the environmental impacts of a project in the pre-planning stage itself so that decisions can be taken to reduce the adverse impacts.

EIA is a systematic process of identifying future consequences of a current or proposed action.

Objective of EIA:

The objective of EIA is

1. To identify, predict and evaluate the economic, environmental and social impact of development activities
2. To provide information on the environmental consequences for decision making and
3. To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

OR

1. Identifying, predicting, and evaluating economic, environmental, and social impacts of development activities.
2. Providing information on the environmental consequences for decision making.
3. Promoting environmentally sound and suitable development by identifying appropriate alternatives and mitigation measures.

The EIA process

The stages of an EIA process will depend upon the requirements of the country or donor. However, most EIA processes have a common structure and the application of the main stages is a basic standard of good practice.

The environment impact assessment consists of eight steps with each step equally important in determining the overall performance of the project. Typically, the EIA process begins with screening to ensure time and resources are directed at the proposals that matter environmentally and end with some form of follow up on the implementation of the decisions and actions taken as a result of an EIA report.

The eight steps of the EIA process are presented in brief below:

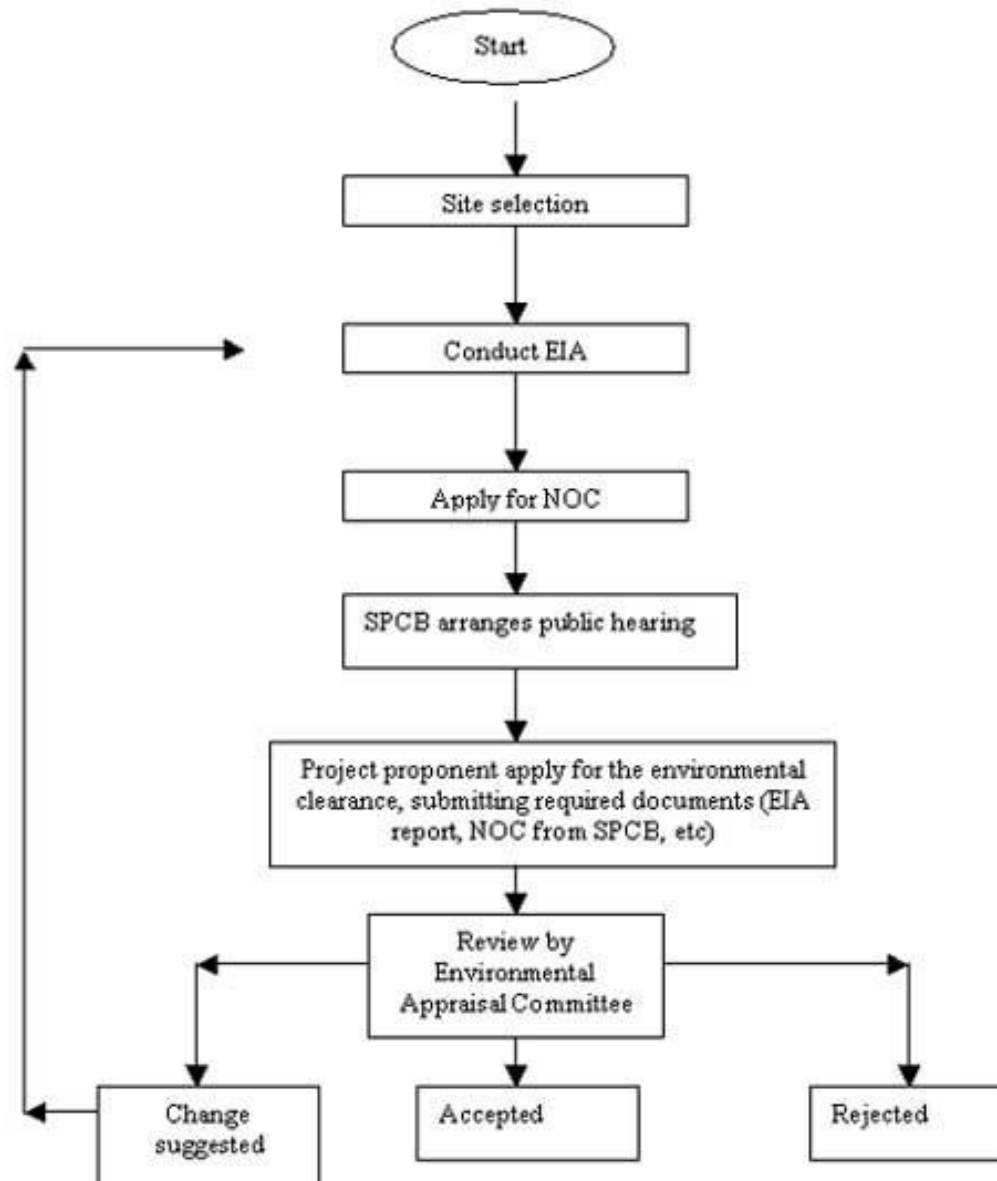
- Screening: First stage of EIA, which determines whether the proposed project, requires an EIA and if it does, then the level of assessment required.
- Scoping: This stage identifies the key issues and impacts that should be further investigated. This stage also defines the boundary and time limit of the study.
- Impact analysis: This stage of EIA identifies and predicts the likely environmental and social impact of the proposed project and evaluates the significance.
- Mitigation: This step in EIA recommends the actions to reduce and avoid the potential adverse environmental consequences of development activities.
- Reporting: This stage presents the result of EIA in a form of a report to the decision-making body and other interested parties.

- Review of EIA: It examines the adequacy and effectiveness of the EIA report and provides the information necessary for decision-making.
- Decision-making: It decides whether the project is rejected, approved or needs further change.
- Post monitoring: This stage comes into play once the project is commissioned. It checks to ensure that the impacts of the project do not exceed the legal standards and implementation of the mitigation measures are in the manner as described in the EIA report.

Environmental Impact Assessment (EIA) Process	
Process	Details in Brief
Screening	Which projects need a full or partial assessment study is decided in this stage
Scoping	<ul style="list-style-type: none"> • Which impacts are necessary to be assessed is decided in this stage. While doing so, legal requirements, international conventions, expert knowledge, and public engagement are also considered. • Alternative solutions that avoid or at least reduce the adverse impacts of the project are also studied in this stage • Investigation of alternate designs or sites that avoid or mitigate impact takes place
Assessment & Evaluation of Impacts and Development of Alternatives	Environmental impacts of the proposed project are analyzed and light is thrown upon the alternatives present to such projects
EIA Report also called Environmental Impact Statement (EIS)	An environmental management plan (EMP) and also a non-technical summary of the project's impact is prepared for the general public in this stage
Decision Making	The fate of the project is decided. Whether the project is to be given approval or not and if it is to be given, under what conditions
Monitoring, compliance, enforcement and environmental auditing	Monitoring whether the predicted impacts and the mitigation efforts happen as per the EMP

The overview of the EIA process is represented in figure given below

Figure 1: Generalized process flow sheet of the EIA process



Importance of Environmental Impact Assessment

1. EIA is a good tool for prudent environment management.
2. It is government-policy that any industrial project in India has to secure EIA clearance from the Environment Ministry before approval for the project itself.

Advantages of EIA

- EIA is a mechanism, which helps in planning the efficient use of human and natural resources (mass and material), which has proved valuable to both those promoting development and those responsible for their authority.
- It may reduce costs and time taken to reach a decision by ensuring that subjectivity and duplication of efforts are minimized
- It identifies the primary and secondary consequences, which might necessitate the introduction of expensive pollution control measures.
- The incorporation of EIA into decision making creates a number of benefits. If a forecast of likely impacts is available, allowances can be made to minimize the negative impacts.
- EIA can identify those areas most susceptible to adverse impacts and so guide site selection.
- EIA can aid the most suitable site in terms of benefit maximization and reduction of harmful effects.
- The results of EIA studies of a selected site aid the determination of broad environmental, social or health critical to be used, when a large number of sites are screened for their suitability.

Problems and Limitations in EIA

Implementation of EIA faces problems due to,

- Poor availability and reliability of data
- Insufficient training/education in EIA methodologies and in the establishment of appropriate legal and regulatory frameworks and institutional arrangement
- Negligence of beneficial impacts in EIA reports
- Lack of consideration of alternative sites, technologies, designs and strategies
- Insufficient involvement and participation of all interested and affected parties
- Insufficient emphasis on required cost effectiveness of EIA
- Lack of follow up monitoring and evaluation
- Inappropriate recommendations – mitigation/adaptation measures which are not affordable or feasible in terms of maintenance.
- Poor presentation of EIA results.

With appropriate planning and integration of environmental concerns into development projects, environmental impacts can be minimized and social impacts can be completely mitigated. Thus we assure at the notion of sustainable development “improving the quality of human life, while living within the carrying capacity of supporting ecosystem”.