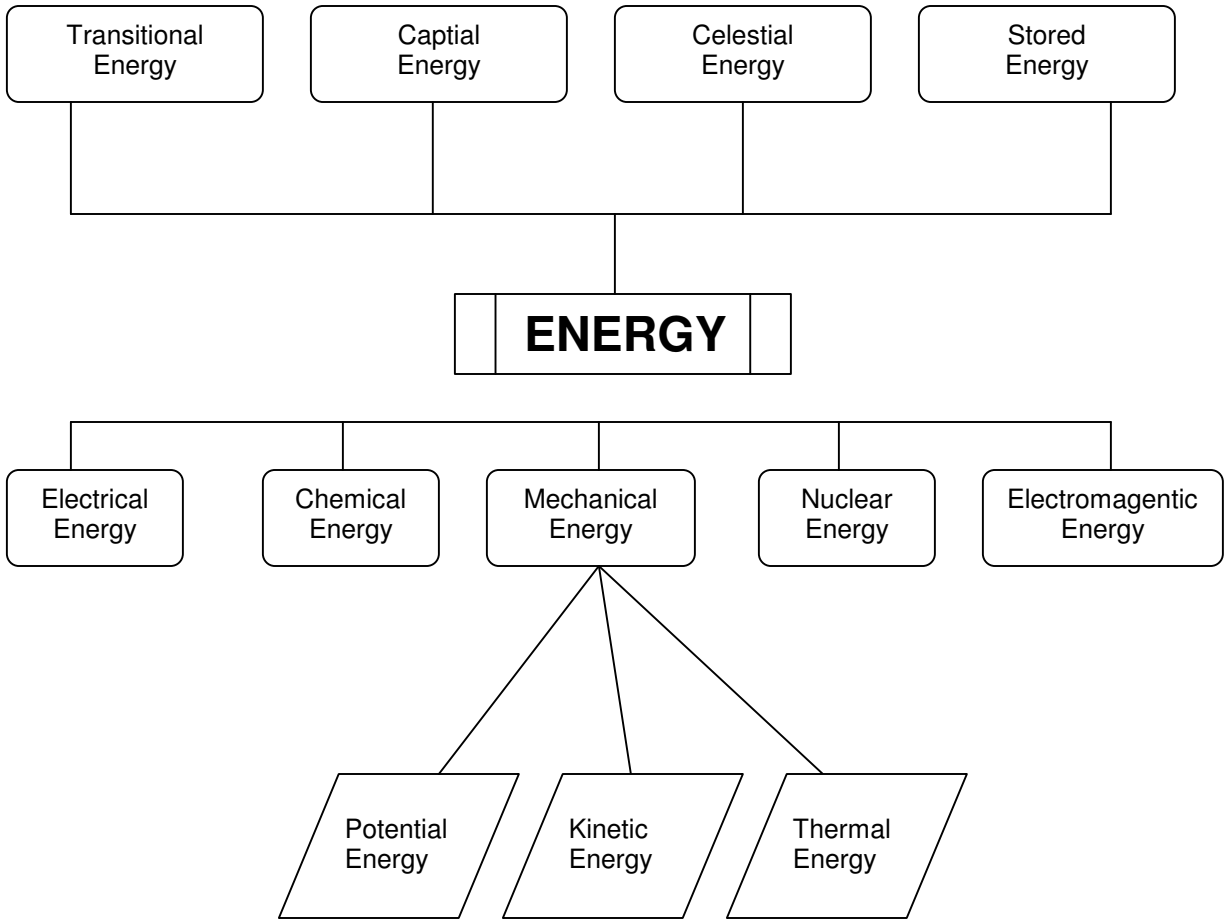


INTRODUCTION

Energy in a complete sense, is hard to define. however to start with, the word energy may be understood as the capability to do work.

FORMS OF ENERGY

Various forms of energy is shown in Fig 1.1. these are based on various i.e nature availability etc.,



Classification of Energy

Basis	Types
Availability and usage with respect to time and economical viability	Conventional and Non conventional energy sources.
Possibility of renew ability	Renewable and Nonrenewable energy sources.

Note: Refer glossary for other types of preliminary classifications i.e., primary, secondary, rural, industrial, commercial and noncommercial sources of energy.

Conventional and Non conventional Energy Sources

This classification based on the availability of energy sources and its usage with respect to time and economical viability.

Conventional Energy Sources

These are the sources which are being using from a very long time. i.e., fossil fuels, hydel energy, nuclear etc.

Non conventional Energy Sources

These are the sources on which attention has been focussed in the recent past. i.e., solar, wind, sea, geothermal, biomass, etc.

Based on these definitions, it will be difficult to group some of the energy sources like wind to a specific category. Hence recently some analysts consider the economical viability also. As a result, they name the energy sources which are economically viable as conventional energy sources and the sources which are not economically viable as non conventional one.

Comparison of Conventional and Non conventional Energy Sources

Conventional Energy Sources	Non conventional Energy Sources
These are widely used since economical Most of them are exhaustible Most of them are hazardous to the environment Though initial cost is more, they are reliable Energy transmission costs are high	These are rarely used since costly. Most of them are non exhaustible Most of them are environment friendly. Though initial investment is high,. they are not reliable. Energy transmission costs are low.

Renewable and Nonrenewable Energy Sources

This classification based on the possibility of renew ability of energy sources.

Renewable Energy Sources

These are the sources which are freely available in nature. i.e., solar, lunar, wind, peat^{13*} etc. As some of these sources are reaching the earth from the outer atmosphere such sources are called incoming or celestial energy. These are inexhaustible sources. Hence these are called renewable energy sources. These are environmental friendly.

Nonrenewable Energy Sources

These are the sources which can be extracted from the earth's crust due to their accumulation over the period of time. i.e., fossil fuels, nuclear fuels, heat traps etc. These have been in use for several decades. Now such sources are depleting at a faster rate and may get exhausted in the forth coming years. In such a case, these sources can not be immediately replenished. Hence these are called as exhaustible or nonrenewable energy sources. These pollute the environment. Hence these are not environmental friendly.

Comparison of Renewable and Nonrenewable Energy Sources

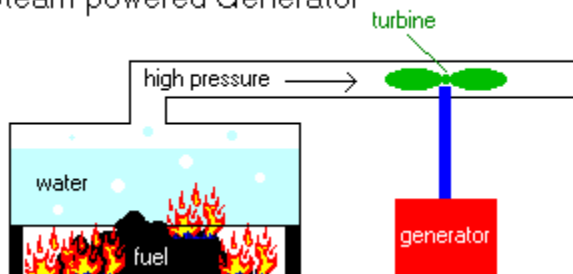
Renewable Energy Sources	Nonrenewable Energy Sources
These are nonexhaustible	These are exhaustible
Freely available and environmental friendly.	Not freely available and hazardous to environment.
Initial cost is high but maintenance cost is minimum	Both initial and maintenance costs are high.
The energy concentration varies from region to region.	It is almost constant in all regions.
Perfect energy utilization equipments are yet to be designed.	Competitive designs are progressing satisfactorily.

Conversion or Utilization of Energy Sources

(1) Fossil Fuels

These are rich in hydrocarbons. On combustion, they produce heat. It is then converted into mechanical energy to drive prime movers. When such prime movers are coupled to electrical generators in thermal power plants, mechanical energy will be converted into electrical energy.

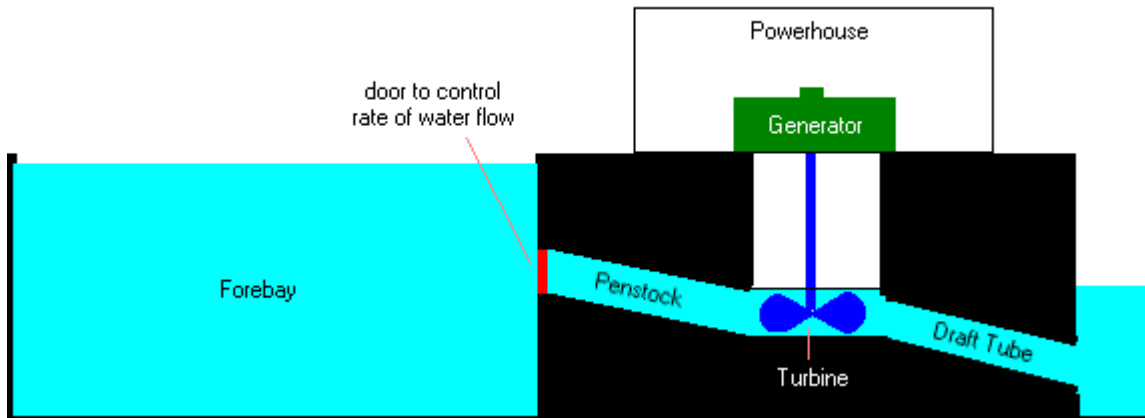
Steam-powered Generator



(2) Hydel Energy

The available water from hydrological cycle is stored in reservoirs at high head. The potential energy of such water is converted into mechanical energy by allowing it to flow

through water turbines. By coupling such turbines to electric generators, mechanical energy is converted into electrical energy.



Advantage

It is environmental friendly.

Disadvantage

The massive civil construction results in a lot of inconvenience to the people living at that site.

(3) Solar Energy

It is the enormous heat energy directly obtained from the sun by intercepting the earth. Solar radiation and sunshine could be measured using special solar instruments . Solar energy could be utilized directly as well as indirectly. Three such possible ways of utilization are as follows:



(i) Chemical Energy (Helio Chemical Process)

The biological conversion of solar energy utilized by plants and animals called biomass followed by the photosynthesis process results in the production of starch, cellulose and oxygen. The energy thus derived is known as biomass energy.

(ii) Electrical Energy (Helio Electric Process)

It is generated by photovoltaic effect caused when the sun is beamed on the semiconductors. When a p-n junction of a semiconductor is exposed to sunlight, its p-region becomes positively charged and the n-region becomes negatively charged. If an external load is applied, this charge difference will drive a current through it till the sunlight is effective. This principle is used in developing a solar cell.

(iii) Thermal Energy (Helio Thermal Process)

Here the radiant solar energy is collected with the help of either flat plate collectors or focussing collectors, which is then directly converted into thermal energy. To facilitate the process, blackened sheets and glass plates are used for flat plate collectors and parabolic reflectors (mirrors or lenses) focussing collectors. In flat plate collectors, the incident solar rays are absorbed by its surface. Hence, it is called as the non concentrated type. In focussing collectors, the sun rays form concentrated narrow beams. Hence, it is called the concentrated type.

Advantages of Solar Energy

- (i) Freely available in adequate quantity (1.8×10^{16} MW)
- (ii) Environmental friendly.

Disadvantages of Solar Energy

- (i) Very costly because it needs large collecting devices
- (ii) Non uniform availability due to seasonal change and day and night cycle.

(4) Wind Energy

Wind energy is the kinetic energy of large masses of moving air currents over the earth surface (which is due to the unequal heating of the atmosphere by the sun). Such air currents produce a force when they are deflected through an angle. Thus, it can be converted into mechanical energy and later as electrical energy. Wind speed increases with height because of reduction in drag effect of the earth surface. Hence, they are greater in hilly and coastal areas than on normal land surfaces. Since the wind power (P) drops rapidly with decrease in velocity, well-designed wind energy equipments have not yet been produced. As a measure if air blowing velocity is V, m/s and kinetic energy of wind is E, then wind power is, $P = EV$, W/m^2 . It is concluded that to get maximum output power, wind exit velocity should be one third of the entrance velocity.

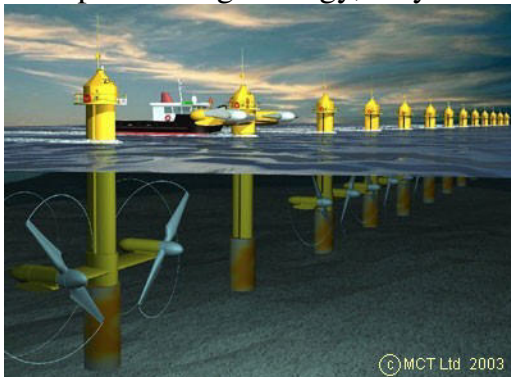


Conversion of Wind Energy

The wind energy may be converted into mechanical energy by deflecting the air currents through an angle. This principle is used in wind mills. It consists of a rotor fitted with blades. As air currents flow over the blades, the rotor rotates, thus producing energy. These are used to grind grains, milling, pumping water etc. Serious efforts are being made to obtain electrical energy from it in a effective way.

(5) Tidal Energy

Tides are the periodic rise and fall of open sea waters, ocean waters etc. They are caused due to the joint action of attractive forces of sun and moon along with gravitational pull and the rotational action of the earth. Tides are classified as high tides and low tides depending on the length of their rises. During new moon and full moon i.e., when the sun, earth and moon fall in a line, a largest tidal range results. It is known as Spring tide. During half moon, the gravitational forces of the sun and moon are in quadrature i.e., when they act at right angles to one another. As a result minimum tidal range exists. It is known as Neap tide. The tidal range varies from region to region based on geographical location and solar distances. The tides are also classified as lunar tides and solar tides as the tides result towards the earth's sides or directly below the moon respectively. As these tides possess high energy, they can be converted into electrical energy.



Conversion of Tidal Energy

The potential energy of tides increases with an increase in their rise. Due to some practical problems, it is not feasible to convert these into mechanical energy. But these can be directly converted into electrical energy. Already in U.K and French coast, such tidal power plants are in use. In India, efforts are going on to construct installations at Gujarat and West Bengal. The plant consists of a barrage built across the tidal reach to create pool in which water can be stored. Inside the barrage, water turbines and flood gates are installed. During the occurrence of high tide and low tides, the flood gates open and close respectively. One Tide cycle is identified as the shift from a low tide to high tide and back to low tide. the time duration to complete one tidal cycle is approximately 12.5 hours. During this period the pool is filled and emptied. These may be classified into single basin system and double basin system.

Advantages

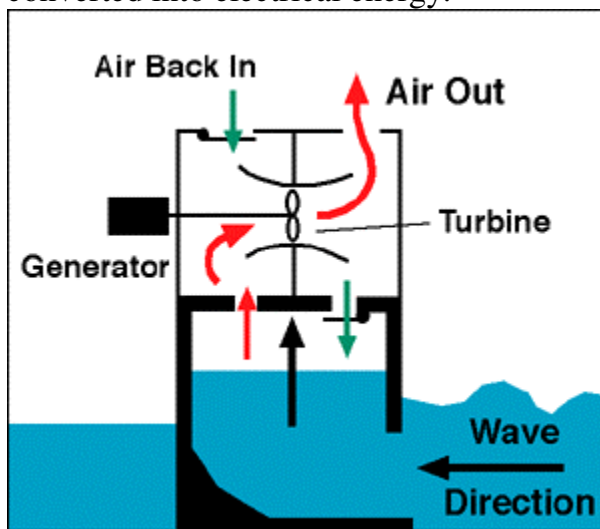
- (i) These are totally independent of rain.
- (ii) Power supply is almost uniform due to definite tide cycle.
- (iii) Do not require large lands.

Disadvantages

- (i) Cost of power generation and transmission are comparatively high.
- (ii) Power generation is less since the entire potential energy cannot be harnessed.

Ocean Thermal Energy

The solar heating of upper layers of ocean water combined with earth's rotation produces large convection currents while the deep water remains relatively cold. The difference in these two temperatures could be used to generate mechanical energy. Later, it can be converted into electrical energy.



Ocean Thermal Energy Conversion (OTEC)

Here the closed cycle system principle is used. The unit consists an evaporator, a turbine generator, a condenser and a pump. A low boiling point liquid i.e., ammonia is taken in the evaporator as a working fluid. The upper layers of ocean water which need to be heated by solar energy are made to flow through the evaporator. As a result, ammonia evaporates and flows to the turbine at high pressure and propels it. Later, the low pressure exit ammonia vapor passes through a condenser where it is condensed to liquid ammonia by the cold water drawn from the bottom layer of the ocean. It is then pumped back to the evaporator. The cycle repeats thereafter.

In India, it is planned to install such plants in Tamil Nadu and Andaman and Nicobar Islands.

Advantages

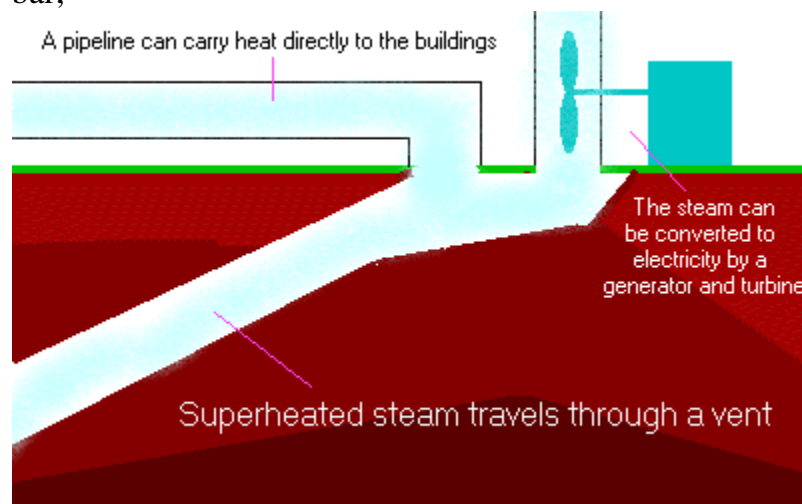
- (i) It is steady and independent of the vagaries of water.
- (ii) It has simple assembly and less accessories.

Disadvantage

Installation, maintenance and power transmission costs are high.

(7) Geothermal Energy

It is the energy which is trapped beneath and within the solid crust of the earth due to temperature of about 400°C . This vast amount of thermal energy rushes through the weak or fractured surfaces of the earth in the form of hot springs, volcano, Fumarole and geysers. Such forms exist inside the earth due to the decay of radio active material. In case, if such a hot zone is identified and the earth surface is strong, then by artificial means i.e., drilling, the available sources can be extracted using pumps. At Tuscany in Italy about 26,000kg of steam is available per hour at a pressure varying from 4 to 16.5 bar,



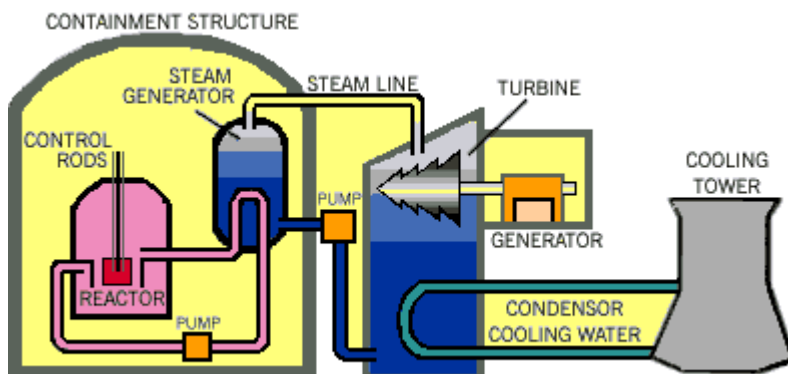
Conversion of Geothermal Energy

steam from a geothermal well can be used directly to run steam turbines. The available heat from such zones can be transferred to a working fluid to evaporate it, which then flows to a turbine at high pressure and propels it. Later, it may be coupled to a generator to generate electrical energy. The four commonly used systems to harness this energy are (i) Dry steam system (ii) Wet steam, system (iii) Hot dry rock system and (iv) Magnetic or Molten rock chamber system.

Nuclear Energy

It is the chemical energy released" during nuclear fission. The produced energy will be in the form of rays. Fission of heavy nuclei is an exothermic process in which enormous amount of heat liberates. Uranium 235 atoms will be ideal for this purpose.

Alternatively the nuclear energy may be obtained by fusing the atomic nuclei. When the nuclei i.e., deuterium and tritium are combined and heated to 100 million degree celsius fusion occurs. Since this heating process is tedious, this method is not popular.



Conve Energy

rsion of Nuclear

The enormous amount of heat liberated due to nuclear fission or fusion may be utilized by special heat exchangers for the generation of steam. This steam may then be used to drive turbo generators to generate electrical energy.

Disadvantage

It result in various types of pollutions i.e., radio active, thermal, wastes from reactor etc.