Unit- 1

NON CONVENTIONAL ENERGY RESOURCES

ENERGY DEFINATION

Energy resources are very important as they are required in every field of our life. All development activities depend on energy. Energy consumption of a nation is an index of its development. Energy resources that can be regenerated during our life span are called renewable energy resources or non conventional energy resources. The country's economic growth and its development in different fields such as in scientific fields, transportation, communication, space technology, industries and agricultural fields etc. are well judged by how much energy is consumed and produced so we can give result that the developed countries has a higher rate of consumption of the energy. In comparisons to other nations Our countries per capita consumption of energy is only 1/8 th of global average, which shows that our country has low rate of per capita consumption of energy as compared to developed countries. To enhance our present energy production we require a alternative source of energy to improve our economic condition, for this renewable energy resources or non conventional energy resources is the effective and fruitful source.

Two Main Sources of Energy:

1-conventional energy resources (Coal,petroleum,nucleur,water)

2- Non- conventional energy resources(*Solar energy, Wind energy tidal,geothermal,Mhd Bio-mass)*

Availability of Non- conventional energy resources and thei definition:-

1-TIDAL ENERGY

All flowing waters carry with them kinetic energy. When such water encounters a turbine, part of the momentum of the flowing water is transferred on to the turbine, causing it to rotate. The rotation of the turbine can then be used to generate electricity. Whether the water is in the open ocean, an estuary or a river, its motion can thus be utilized in generating energy. The tides occurring in the oceans are one such source of energy based on the movement of water. Tides are generated by the action of gravitational forces of the sun and the moon on the oceans, due to the spinning of the earth around its axis and the relative positions of the earth, moon and the sun.
The tides are the periodic vertical rise and fall of ocean water. The period between consecutive high tides is 12.5 hours. The tidal rise and fall of water is accompanied by periodic horizontal to and fro motion of water called tidal currents. Tides and tidal currents are intimately related.

The amplitude of tides covers a wide range from 25 cm to 10 m. Tidal power schemes in India .The most attractive tidal power sites are the Gulf of Cambay and the Gulf of Kutch where the maximum tidal range is of the order of 11 m and 8 m respectively and the average tidal range is of the order of 6.8 and 5.2 m, respectively. The techno-economic feasibility of the Gulf of Kutch Scheme was taken up by the Central Electricity Authority, Government of India. The scheme envisages a single basin, single effect development with an installed capacity in the range 800-1000 MW.

The promising sites for tidal power plants are located in Gujarat state and West Bengal state. Survey of other sites in Orissa, Tamil Nadu, Kerala, Karnataka and Maharashtra, Andaman Nicobar etc .

Advantages and limitations of tidal power generation

Advantages :

1. The biggest advantage of tidal power, besides being inexhaustible, is that it is completely independent of the uncertainty of precipitation (rain). Even a continuous dry spell of any number of years will have no effect whatsoever on the tidal power generation.
2. Tidal power generation is free from pollution, as it does not use any fuel and also does not produce any unhealthy waste like gases, ash, etc.
3. These power plants do not require large areas of valuable land because they are on the bays (sea shore).
4. Peak power demand can be effectively met when it works in combination with thermal or hydroelectric systems

Limitations :

1. The fundamental drawback to all methods of generating tidal power is the variability in output caused by the variations in the tidal range.
2. The tidal ranges are highly variable and thus the turbines have to work on a wide range to head variation. This affects the efficiency of the plant.
3. Since the tidal power generation depends upon the level difference in the sea and an inland basin, it has to be an intermittent operation, feasible only at a certain stage of the tidal cycle.
4. The tidal range is limited to a few metres. As the bulb turbine technology was not well developed for this range, use of conventional kaplan runners was the only alternative. This was found to be unsuitable. Now with the development of reversible flow bulb turbines, this difficulty is overcome.
5. The duration of power cycle may be reasonably constant but its time of occurrence keeps changing, introducing difficulties in the every day planning of the load sharing in the grids. This handicap can be removed now with the help of computerized programming.
6. Sea water is corrosive and it was feared that the machinery may get corroded. However, stainless steel with a high chromium content and a small amount of molybdenum and the aluminium bronzes proved to be good corrosion resistant materials at La Rance project. The vinyl paint exhibited good results.

2-WIND ENERGY

For centuries wind has been used to move ships, grind grains, pump water, and do other forms of work. In recent times, wind has been used to generate electricity. There is enough wind energy available on the earth to generate more than ten times the electricity now used worldwide. Global wind generating capacity has expanded at an annual rate of 25.7 per cent

Wind Energy Development in India

In India wind power is untapped but potentially very important source of energy. It appears to be the most feasible and cost-effective for supplementing these conventional means of power generation on a large scale. Its advantage are :

- It is perennial source, available all over the day and night;
- It is an ideal source of energy for the small farmers cottage, micro and small industries;
- It is most useful source of energy for those living in isolated hilly, coastal and other regions which are far away from electric transmission network;

- It is inexhaustible, Eco-friendly, non-polluting and freely available

3-HYDROPOWER

Hydropower is recognized as a renewable source of energy, which is economical, non-polluting and environmentally benificial. Hydropower projects involve the construction of dams to produce the waterfalls that power turbines. Although hydropower is renewable, the dams and reservoirs needed to capture this energy have limited life spans. The reservoirs behind dams invariably filled with sediments, giving the typical dam a life span of 20 to 100 years. Once a hydropower site is filled with sediments, it is gone forever. Dams also often create many environmental problems. This means that hydroelectric power is unlikely to expand much faster in developed as well as developing countries. Hydel power has several advantages :

- It is a clean source of energy;
- It provides irrigation facilities; and
- It provides drinking water to people living, particularly in desert of Rajasthan and Gujarat.

The large hydropower projects, however, involve several environmental and socio-economic problems:

- Submerge forest and agricultural land;
- Cause loss of biodiversity;
- Displace local people and create problems of rehabilitation;
- Cause water logging and siltation;
- Affect adversely fish population and other aquatic organisms; and

Hydel Power Potential in India :

India has a large hydel potential totaling about 84,044 MW, which can be tapped. However, 75% of it is concentrated in the Himalayan region, which is tectonically very unstable. Out of the total potential, only about 23,627 MW installed generating capacity has been achieved as of January 2000. The history of hydropower generation in India is more than 100 years old. The first-hydropower station in India was a small hydropower station of 130 kW commissioned in 1897 at

Sidrapong near Darjeeling in West-Bengal. Subsequently, many small hydropower stations were set up. With the advancement in technologies and increasing requirement of electricity, emphasis was shifted to large sized hydropower stations. The growth of hydropower in the country since 1990 to 2000 is shown in Fig 1.6. This hydropower capacity is about 25 percent of the total installed capacity for electricity generation. Ministry of Power in the Government of India is responsible for the development of large hydropower projects in India.

4- GEOTHERMAL ENERGY The earth contains large amounts of geothermal energy with temperature as high as 4400^0C. This energy comes from magma, molten rock material beneath the surface of the earth or from radioactive decay of thorium, potassium and uranium dispersed throughout the earth's interior. In some regions of the earth this molten material sometimes breaks through the earth's crust and produces volcanoes. In other regions, the hot material is close enough to the earth's surface to heat the underground water trapped by impermeable rock and form steam. Geysers and hot springs are natural areas where hot water and stream come to the surface. In such areas geothermal energy is tapped by drilling wells to obtain steam. At present, geothermal energy is only practical in areas where the molten mass is near the surface.
There is large scope for utilization of geothermal energy to uplift the socio-economic status and the life style of the people, particularly those living in far remote areas of the country and where this source of energy is in abundance. Besides space heating and power generation, the energy could be utilized:

- In small and cottage industries;
- Drying and processing of conventional and cash crops;
- Animal husbandry, dairy, poultry and fishery development;
- Silviculture;
- Spinning, weaving, painting and garment industry;
- Hard and soft board manufacturing and pulp making; and
- Brewing of low alcoholic beverages.

Geothermal Energy Prospects in India

Keeping in view the severe energy crisis which is going to occur in the near future as a result of rapidly growing population in India, much attention has been paid by the planners and scientists to exploit alternate energy resources to supplement the existing conventional energy potential. Geothermal energy has received much attention for exploitation since 1973 and sufficient scientific studies relating to places of occurrence, geotectonic associations, geochemical and thermal characteristics were carried out by scientists. On the basis of these studies, certain geothermal areas/fields have been identified, giving energy potential of each area and prospective use Based on tectonic and thermal histories, the following seven major geothermal regions have been identified after conducting studies by the scientists of National Geographical research Institute (NGRI) with regard to occurrence of geothermal water manifestations. In each region the use of this energy for various purposes have been also mentioned.

The Himalayan Geothermal Region: Thermal springs in Himalayan region manifest themselves mostly along the banks of certain rivers or their tributaries. They are found even in Karakoram-Kailash mountain region beyond the Northern Himalayas . In fact a belt of thermal springs starting from North-Western Himalayas continues through Nepal and Bhutan towards

North-Eastern Himalayas to Burma and finally to Barren island. Due to continuing uplift of Himalayas, a large fracture system has developed in them, which facilitated the emergence of thermal springs of which some have even high temperature. Some of them have mild geyser activity emitting steam at regular intervals alongwith hot water. The temperatures range from 120^0C to 240^0C $\pm 20^0$C.

The West-Coast Konkan Region: A chain of mountains running parallel to the west coast of India between latitude 16^0-30^0 N and 20^0 N have thermal springs mostly in groups at 21 different locations. These are controlled by shear zones, fractures or dykes of Deccan trap and manifest in various river basins along stream courses. Many earthquakes occur in the west coast. The hot springs of this belt are oriented in N-S and NNW-SSE directions indicating that the belt has suffered strong crustal movements and the fractures which control the thermal springs are still active. The temperatures of geothermal systems of this belt are around 100^0C $\pm 20^0$C.

Narmada-Tapti Geothermal Region : Thermal springs mostly in cluster with temperature varying from 32^0C to 98^0C are found at sixteen locations in this region which is a permanent ancient geological feature of the peninsular India between 21^0 N and 24^0 N in a NNE-SSW direction. The estimated reservoir temperature of this region range from 60^0C to 110^0C except in one case, that is Tatapani Geothermal field (where hot springs having temperature is upto 98^0C) whose estimated reservoir temperature is 160^0C $\pm 20^0$C. In Tapti basin of M. P. where the estimated reservoir temperature is 110^0C $\pm 20^0$C and the thermal spring temperature is about 60^0C, the energy can be utilized for electricity generation, sericulture, refrigeration and processing industries.

The Damodar Graben Region : There are a few hot spring areas in Gondwana grabens adjacent to Damodar river valley. All along, the estimated reservoir temperature is about 100^0C $\pm 20^0$C and the observed temperature of springs is upto 80^0C. The energy can be used for electricity generation, rice para boiling, drying of agricultural products and paper pulp manufacture.

Combay Graben Geothermal Region: In the Combay and Kathana fields, the estimated reservoir hot eruptive springs (mixture of water and steam) of temperatures over 100^0C occur. The energy from these springs can be used for electricity generation, refrigeration, processing and drying industries.

Delhi-Mobile Belt Geothermal Region : Springs in Sohna valley in Haryana with estimated reservoir temperature about 90^0C $\pm 20^0$C and observed temperature of 47^0C are found. These springs are found along the pre-Himalayan alignment towards south-west of Delhi with the areas of Delhi folding. The energy can be used for refrigeration and tourism.

Wardha-Pranahita Godavari Valley Graben Geothermal Region : The valley of the river Godavari along with those of Pranahita and Wardha rivers represent a prominent linear graben structure of Indian land mass. It is one of its main Gondwana basins of Permo-carboniferous to lower cretaceous geological periods. Most of its hot springs have temperature slightly over mean annual air temperature. Its hottest spring Agnigundata occurs in the bed of river Godavari and its temperature reached upto 62^0C. Hot water also has been tapped through holes drilled for exploration of coal and ground water resources in various parts of this graben.

5-Solar energy

Solar energy equivalent to almost 75000 TkWh hits the earth surface every day. A mere 0.1% of this staggering figure is sufficient to meet world energy needs. Use of solar energy has grown steadily at the rate of 16% every year. According to Worldwatch the solar market is expected to reach 10600 MW if there is a constant annual growth of 25% each year. Japan is the largest solar power-utilizing nation. India is one of the few countries blessed with plenty of sunshine with an annual insolation of 5000 TkWh and with 300 clear sunny days in most parts of the country. The average insolation incident over India in about 5.5 kWh/m^2 over a horizontal surface. With this, it is possible to generate 20 MW solar power per square kilometer land area.

About SOLAR CELLS

Topics to be covered----1} Theory of solar cells.

2} solar cell materials

3}solar cell array

4}solar cell power plant

5}limitations.

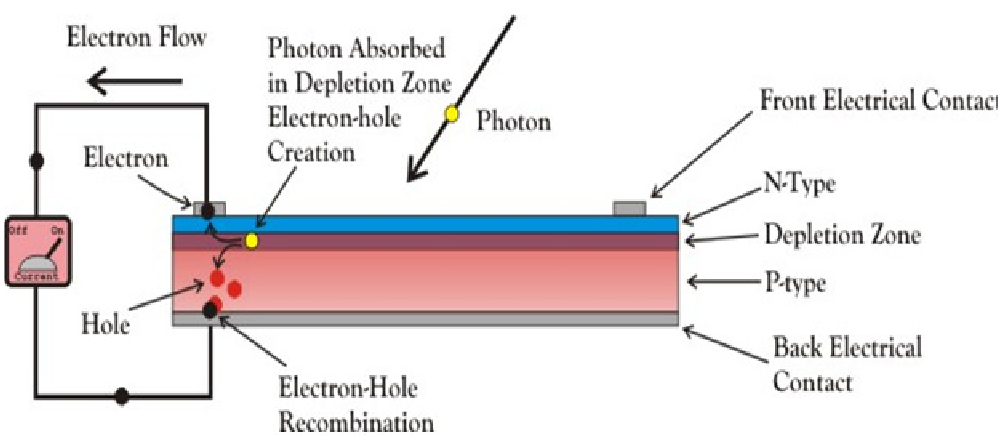
Theory of solar cells.

Solar cells and photodetectors are devices that convert an optical input(light energy) into current. A solar cell is an example of a photovoltaic device, i.e, a device that generates voltage when exposed to light The functioning of a solar cell is similar to the photodiode (photodetector). It is a photodiode that is unbiased and connected to a load (impedence) 1. Solar cells need to work over a broad spectral range (solar spectrum).

2. Solar cells are typically wide area devices to maximize exposure.

3.Solar cells is the power conversion e□ciency, which is the power delivered per incident solar energy.

A simple solar cell is a pn junction diode.The n region is heavily doped and thin so that the light can penetrate through it easily. The p region is lightly doped so that most of the depletion region lies in the p side. The penetration depends on the wavelength and the absorption coe□cient increases as the wavelength decreases. Electron hole pairs (EHPs) are mainly created in the depletion region and due to the built-in potential and electric field, electrons move to the n region and the holes to the p region. When an external load is applied, the excess electrons travel through the load to recombine with the excess holes. Electrons and holes are also generated with the p and n regions.The shorter wavelengths (higher absorption coe□cient) are absorbed in the n region and the longer wavelengths are absorbed in the bulk of the p region. Some of the EHPs generated in these regions can also contribute to the current. Typically, these are EHPs that are generated within the minoritycarrier di□usion length, Le for electrons in the p side and Lh for holes in the n side. Carriers produced in this region can also di□use into the depletion region and contribute to the current. Thus, the total width of the region that contributes to the solar cell current is wd + L e + Lh, where wd is the depletion width. The carriers are extracted by metal electrodes on either side. A finger electrode is used on the top to make the electrical contact, so that there is su□cient surface for the light to penetrate. . Consider a solar cell made of Si. The band gap, Eg, is 1.1 eV so that wavelength above 1.1 μm is not absorbed since the energy is lower than the band gap. Thus any λ greater than 1.1 μm has negligible absorption. For λ much smaller than 1.1 μm the absorption coe□cient is very high and the EHPs are generated near the surface and can get trapped near the surface defects. So there is an optimum range of wavelengths where EHPs can contribute to photocurrent.



solar cell materials

Monocrystalline Silicon Solar Cells

Monocrystalline solar cells, also called "single crystalline" cells are easily recognizable by their coloring. But what makes them most unique is that they are considered to be made from a very pure type of silicon. In the silicon world, the more pure the alignment of the molecules, the more efficient the material is at converting sunlight into electricity. In fact, monocrystalline solar cells are the most efficient of all; efficiencies have been documented at upwards of 20%.

Monocrystalline solar cells are made out of what are called "silicon ingots," a cylindrically shaped design that helps optimize performance. Essentially, designers cut four sides out of cylindrical ingots to make the silicon wafers that make up the monocrystalline panels. In this way, panels comprised of monocrystalline cells have rounded edges rather than being square, like other types of solar cells.

Beyond being most efficient in their output of electrical power, monocrystalline solar cells are also the most space-efficient. This is logical since you would need fewer cells per unit of electrical output. In this way, solar arrays made up of monocrystalline take up the least amount of space relative to their generation intensity.

Another advantage of monocrystalline cells is that they also last the longest of all types. Many manufacturers offer warranties of up to 25 years on these types of PV systems.

The superiority of the monocrystalline cells comes with a price tag - in fact, solar panels made of monocrystalline cells are the most expensive of all solar cells, so from an investment standpoint, polycrystalline and thin film cells are often the preferred choice for consumers. One of the reasons monocrystalline cells are so expensive is that the four sided cutting process ends up wasting a lot of silicon, sometimes more than half.

Polycrystalline Solar Cells

Polycrystalline solar cells, also known as polysilicon and multisilicon cells, were the first solar cells ever introduced to the industry, in 1981. Polycrystalline cells do not go through the cutting process used for monocrystalline cells. Instead, the silicon is melted and poured into a square mold, hence the square shape of polycrystalline. In this way, they're much more affordable since hardly any silicon is wasted during the manufacturing process.

However, polycrystalline is less efficient than its monocrystalline cousin. Typically, polycrystalline solar PV system operated at a 13-16% efficiency - again, this is due to the fact that the material has a lower purity. Due to this reality, polycrystalline is less space-efficient, as well. One other drawback of polycrystalline is that has a lower heat tolerance than monocrystalline, which means they don't perform as efficiently in high temperatures.

Thin Film Solar Cells

Another up and coming type of solar cell is the thin film solar cell with growth rates of around 60% between 2002 to 2007. By 2011, the thin film solar cell industry represented approximately 5% of all cells on the market.

While many variations of thin film products exist, they typically achieve efficiencies of 7-13%. However, a lot of research and development is being put into thin film technologies and many scientists suspect efficiencies to climb as high as 16% in coming models.

Thin film solar cells are characterized by the manner in which various type of semi-conducting materials (including silicon in some cases) are layered on top of one another to create a series of thin films.

The major draw of thin film technologies is their cost. Mass production is much easier than crystalline-based modules, so the cost of mass producing thin film solar cells is relatively cheap. The product itself is also flexible in nature, which is leading to many new applications of solar technologies in scenarios where having some type of flexible material is advantageous. Another perk is that high heat and shading have less of a negative impact on thin film technologies. For these reasons, the thin film market continues to grow.

One major drawback is that thin film technologies require a lot of space. This makes them less of an ideal candidate for residential applications where space become an issue; as a result, thin film is taking off more in the commercial space. And thin film solar cells have a shorter shelf life than their crystalline counterparts, which is evidence by the shorter warranties offered by manufacturers.

Thin film technology using various photovoltaic substances, including amorphous silicon, cadmium telluride, copper indium and gallium selenide. Each type of material is suitable for different types of solar applications.

Amorphous Silicon Solar Cells

Thin film solar cells made out of amorphous silicon are traditionally used for smaller-scale applications, including things like pocket calculators, travel lights, and camping gear used in remote locations. A new process called "stacking" that involves creating multiple layers of amorphous silicon cells have resulted in higher rates of efficiency (up to 8%) for these technologies; however, it's still fairly expensive.

Cadmium Telluride Solar Cells

Cadmium Telluride is the only of the thin-film materials that have been cost-competitive with crystalline silicon models. In fact, in recent years, some cadmium models have surpassed them in terms of their cost-effectiveness. Efficiency levels result in a range of 9-11%.

Copper Indium Gallium Selenide Solar Cells

Copper Indium Gallium Selenide cells have demonstrated the most promise with respect to their efficiency levels that range from 10-12%, somewhat comparable to crystalline technologies. However, these cells are still in the nascent stages of research and have been commercial deployed on any wide scale. That said, the technology is most used in larger or commercial applications.