Non Conventional Methods of Power Generation for Future Power Outage Problems

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Abstract: ***Recent scenario reveals the imbalance in power generation and power demand in many of the countries. Major amount of power is generated through thermal power plants across the globe. For Thermal power plants we need non-renewable fuel sources some of them are Coal, Nuclear materials etc., As we know the percentage Coal depreciates continuously, we need different ways of power generation using renewable energy sources like solar energy, wind energy, Tidal energy, Geo thermal energy etc. This paper presents different Non Conventional methods for Power generation. The capacity of generation ranges from few mega watts to hundreds of megawatts. Different advantages and applications of each method given in detailed concepts.***

Keywords: Bio fuel, Geo thermal Energy, Photo voltaic (PV) module, Renewable Energy Technology (RET).

1. Introduction

Energy is the key input to drive and improve the life cycle. The consumption of energy is directly proportional to the progress of mankind. The primary source of energy is Fossil fuel. However the finiteness of fossil fuels is causing degradation of environment. So the non conventional, Renewable Energy Technologies [1] are very important in present and future generations for generating power and many other purposes. Different methods are proposed already for power generation using Non Conventional energy resources. Mainly the non conventional energy sources are Solar Energy, Wind Energy, Tidal Energy, Biomass Energy, Fuel Cells and Geo Thermal Energy.

2. Solar Energy

Sun is the ultimate source of all the power which man has at his disposal; the conversion of solar radiation directly into electrical power by some cheap and efficient means has been sought for several decades. For the conversion of solar radiation directly to electrical power we need Photo voltaic plates or PV modules. Photo voltaic effect is the main reason for the power generation using these Solar PV modules.

2.1 Solar Photo Voltaic

The photo voltaic effect is considered as the generation of the electromotive force as a result of the absorption of ionizing radiation energy conversion devices which are used to convert sun light to electricity by the use of the photo voltaic effects are called solar cells. Photo voltaic cells are made of semi conductors that generate electricity when they absorb light. As photons are received, free electrical changes are generated that can be collected on contacts applied to the Surface of the semi conductors. Because solar cells are not heat engines, and therefore do not need to operate at high temperatures, they are adapted to the weak energy flux of solar radiation, operating at tome temperature. These devices have theoretical efficiencies of the order of 25 percent. Actual operating efficiencies are less than this value, and decrease fairly rapidly with increasing temperature.

The best known applications of photo voltaic cells for electrical power generation have been is spacecraft, for which the Silicon cell is the most highly developed type. The Silicon cell consists of a single crystal of silicon into which a doping material is diffused to from a semi conductor. Since the early day of solar cell development, many improvements have been manufactured with areas 2x2Cm, efficiencies approaching 10 percent, and operating at 28 ^{o}C. The efficiency is the power developed per unit area of array divided by the solar energy flux in the free space (1.353 KW/m2).

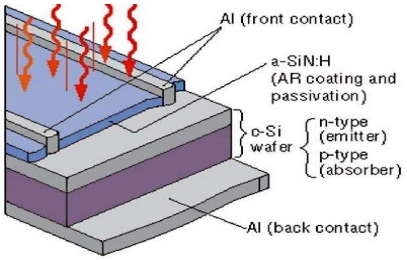


Figure 1: Silicon Photo Voltaic cell

Photo voltaic cells could be applicable to either small or large power plants, since they function well on a small scale, and may be adaptable to local energy generation on building roof tops. The cost of the energy storage and power conditioning equipment might, however, make generation in large stations the most economical method; solar cells have also been used to operate irrigation pumps, navigational signals high way emergency call system, rail road crossing warnings, automatic meteorological stations, etc., Crystalline silicon Photovoltaic Cell Construction is shown in Fig. 1.

2.2 PV Array and Solar Inverter

PV Array is also referred as group of Photo Voltaic module. Due to low voltage of individual solar cell about 0.5V, several solar cells are wired in series while forming the

laminate. The laminate is assembled into a protective weatherproof enclosure, thus making a photovoltaic module. These Modules may then be strung together into a photovoltaic array. A model PV array is shown in Fig. 2.

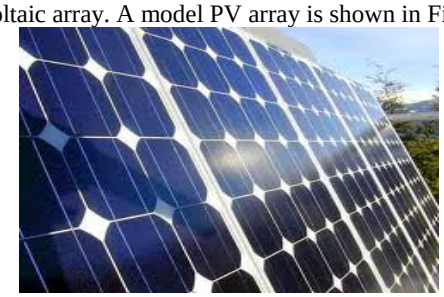


Figure 2: Photo Voltaic Array

A solar inverter, or PV inverter, converts the variable DC output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid. In some cases Solar Micro Inverters are used for individual solar cells. Solar Inverters use Maximum Power Point Tracker (MPPT) for obtaining maximum output from the PV module. A Circuit Breaker is used Protection purpose along with these inverters. Different Circuit topologies are proposed for solar inverters. The best preferred topology is Boost H-bridge Topology which is a two-stage non isolated topology. This circuit topology is shown in Fig. 3. Solar Inverters are classified into different types. Classification is shown below

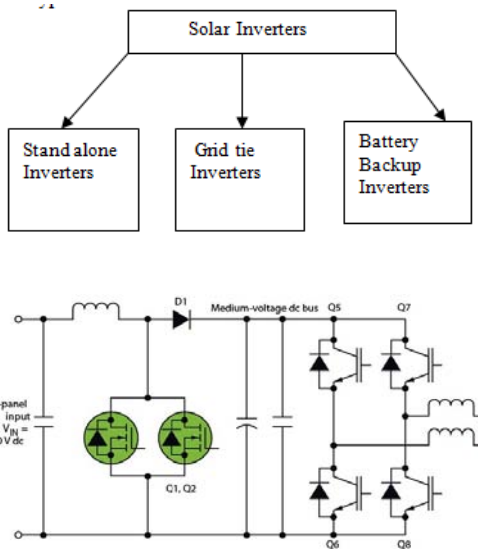


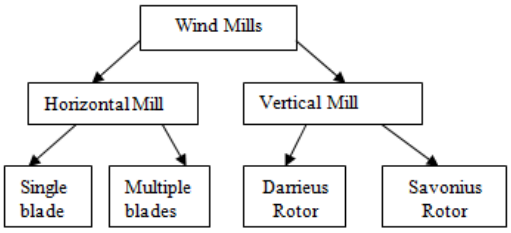
Figure 3: Boost H-bridge solar inverter Circuit Topology

Solar Inverters and PV modules are very economical and Installation is very easy for every application only input we required is plenty sunlight.

3. Wind Energy

A wind mill converts the kinetic energy of moving air into mechanical energy that can be either used directly to run the machine or to run the Induction generator to produce electricity. Wind mills and Wind Turbine is shown in Fig. 4.

3.1 Classification of Wind Mills



Horizontal-axis wind turbines (HAWT) have the main rotor shaft and electrical generator at the top of a tower, and must be pointed into the wind. Small turbines are pointed by a simple wind vane while large turbines generally use a wind sensor coupled with a servo motor. Most have a gearbox, which turns the slow rotation of the blades into a quicker rotation that is more suitable to drive an electrical generator. Vertical axes Wind Turbine (VAWTs) have the main rotor shaft arranged vertically. Key advantages of this arrangement are that the turbine does not need to be pointed into the wind to be effective. Wind Turbine and Wind mill Construction is difficult compared with PV module Installation. Lot of Mechanisms involved in Wind turbine installations which require through survey of site under the installation. However so many advantages are there with Wind Turbines and Wind Mills. In 2010 2.5 % of total world energy is supplied by these Wind Turbines.

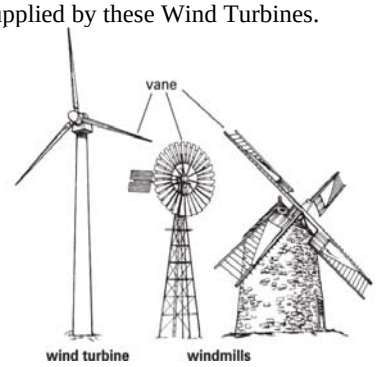


Figure 4: Wind Mill and Wind Turbine

4. Tidal Energy

Tide is periodic rise and fall of the water level of the sea. Tides occur due to the attraction of seawater by the moon. These tides can be used to produce electrical power which is known as tidal power. When the water is above the mean sea level, it is called flood tide and when the level is below the mean level, it is called ebb tide. A dam is constructed in such a way that a basin gets separated from the sea and difference in the water level is obtained between the basin and sea.

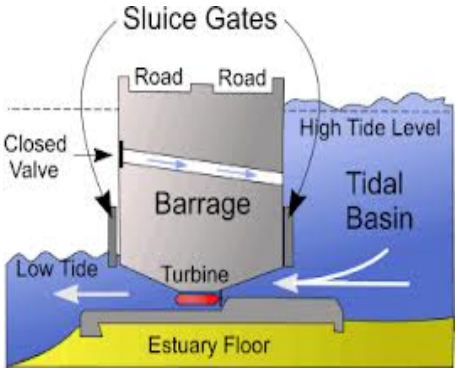
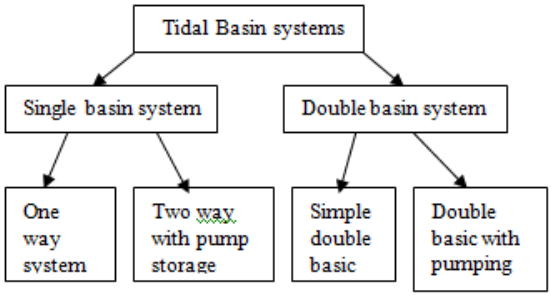


Figure: 5 Tidal basin constructions

The Constructed basin is filled during high tide and emptied during low tide passing through sluices and turbine respectively. The Potential energy of the water stored in the basin is used to drive the turbine which in turn generates electricity as it is directly coupled to an alternator. Tidal power has been a dream for engineers for many years and it Remained dream because of large capital cost involved in its development. A typical tidal basin plant is shown in Fig. 5.

4.1 Classification of Tidal power Plants

The tidal power plants are generally classified on the basis of the number of basins used for the power generation.



Tidal power plants are complex and costly compared to solar silicon crystalline cells. Tidal power plants need lot of engineering design. The schematic layout of Tidal power house is shown in Fig. 6

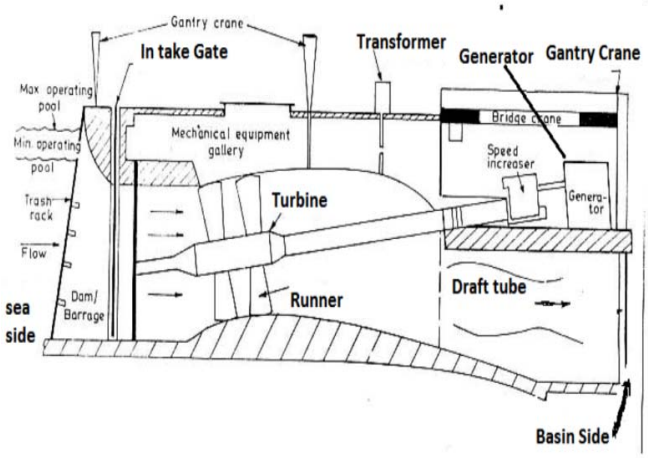


Figure 6: Schematic Layout of Tidal Power house

Since small heads only are available, large size turbines are needed; hence, the power house is also a large structure. Both the French and Soviet operating plants use the bulb type of turbine of the propeller type, with revisable blades, bulbs have horizontal shafts coupled to a single generator. The cost per installed kilowatt drops with turbine size, and perhaps larger turbines might be installed in a future major tidal power plant.

5. Geo-Thermal Energy

Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. The Geothermal energy of the Earth's crust originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%). The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface.

Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate_boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels.

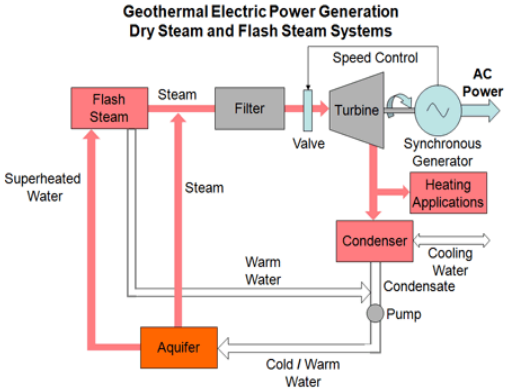
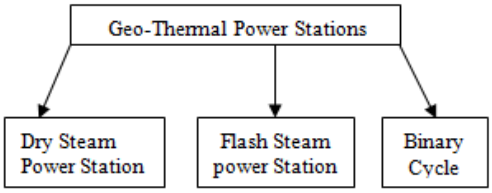


Figure 7: Dry Steam and Flash Steam Systems

Geothermal electricity is electricity generated from Geothermal Energy. Technologies in use include dry steam power plants, flash steam power plants and binary cycle power plants. Geothermal electricity generation is currently used in 24 countries. Geothermal power is considered to be sustainable because the heat extraction is small compared with the Earth's heat content.

5.1 Classification of Geo Thermal Power Stations



Dry steam plants are the simplest and oldest design. They directly use geothermal steam of 150°C or greater to turn turbines. Whereas Flash steam plants pull deep, high-pressure hot water into lower-pressure tanks and use the resulting flashed steam to drive turbines. They require fluid temperatures of at least 180°C, usually more. This is the most common type of plant in operation today. Binary cycle power plants are the most recent development, and can accept fluid temperatures as low as 57°C. The moderately hot geothermal water is passed by a secondary fluid with a much lower boiling point than water. This causes the secondary fluid to flash vaporize, which then drives the turbines. This is the most common type of geothermal electricity plant being constructed today. Block Schematic of Dry Steam and Flash Steam Systems is shown in Fig. 7.

6. Bio Mass Energy

Bio Mass energy is renewable energy made available from materials derived from biological sources. Biomass is any organic material which has stored sunlight in the form of chemical energy. As a fuel it may include wood waste, straw, manure, sugarcane, and many other byproducts from a variety of agricultural processes. By 2010, there was 35GW of globally installed biomass energy capacity for electricity generation [4]. One of the advantages of biomass fuel is that it is often a by-product, residue or waste-product of other processes, such as farming, animal husbandry and forestry. Biogas is formed by fermentation of biodegradable materials such as manure, sewage and crops. Biogas comprises primarily methane (CH_4) and carbon dioxide (CO_2) and may have small amounts of Hydrogen sulphide (H_2S).

6.1 Biomass Gasification

Bio gas system contributes to maintain clean and healthier Environment by processing human growth. More transportation means have increased the pressure on environment. The scientists are worried about environmental protection and looking for appropriate means for the same, which are locally available. In present circumstances bio gas utilization would be a solution for environmental protection for healthy and prosperous society. Biomass Gasification Block diagram is shown in Fig. 8. Out of several sources of renewable energy like solar, wind, tidal, wave energy, geothermal energy, nuclear energy, energy through bio mass are important features in our Country.

7. Fuel Cells

Fuel Cells are efficient and quiet, operate on a variety of hydrocarbon fuels, and produce almost no objectionable emissions energy.

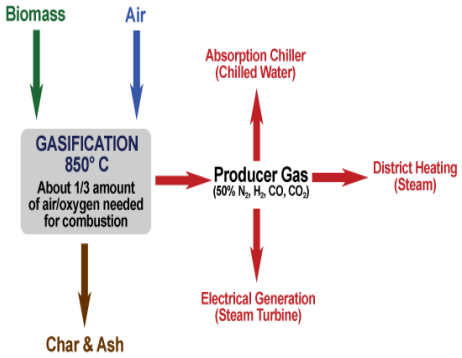


Figure 8: Biomass Gasification Process

7.1 Working of Fuel Cell

The fuel cell consists of an anode, a cathode and an electrolyte Hydrogen fuel is fed into the anode side of the cell. Positive H2 ions move from the anode-side and enter the electrolyte through porous cell walls. The anode is left with a negative charge. Air is fed into the cathode side. O2 ions enter the electrolyte leaving the cathode side with a positive charge. Excess anode electrons flow to the cathode creating a current flow H2 and O2 ions combine in the electrolyte to from water which leaves the cell as steam. The equations of Chemical reaction are shown below (1), (2).

$$2H_2 \longrightarrow 4H \quad (1)$$

$$4H + 4OH \longrightarrow 4H_2O + 4e^- \quad (2)$$

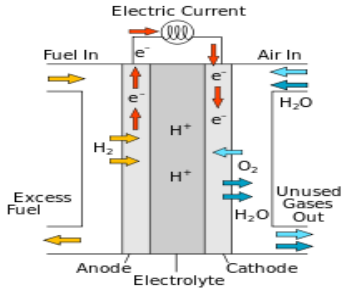


Figure 9: Hydrogen Fuel cell

The above reactions indicate H2 molecules break up into H Atoms at the anode and they combine with OH ion to form water and free electron at anode. The hydrogen Fuel cell block diagram is shown in Fig. 9. The main things required for a fuel cell to operate are Processor, Electrolyte, and Inverter. Fuel Cell is very economical and eco friendly way of Power generation. the greatest advantage of the fuel cell is its high operating efficiency. Present-day fuel cell efficiency is 38% and it is expected to reach to 60% before the end of this century. Fuel cell diagram is shown in Fig.9. The fuel cell represents one of the successful ways by passing the heat cycle and converting the chemical energy of fuels directly into electricity.

8. Conclusion

Power outage problems are very often in future due to lack of Non-renewable inputs. So for the un interrupted power utilization we have to adapt Non Conventional methods of power generation. In this paper several Non Conventional methods are proposed along with their principle advantages.

Also explained are different processes with clear Block Schematics. Energy saving is not our aim it should be our attitude. We have to depend on Renewable energy sources in future otherwise several environmental disasters we have to observe. Moreover need of power demand is increasing day by day and efficient power Transmission is fatigue now because of nonlinear loads. Ultimately the Non conventional resources will help us in many ways if we use them in a perfect and efficient way of operation and utilization. Solar and Biomass power plants are cost effective and very efficient where as Wind turbine and Tidal Basin constructions are very complex require so much capital cost. Fuel cells are most Environmental friendly power Generating options compared to other Renewable Sources.

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