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Role of Nonconventional Energy Sources in Electricity Generation: A Review

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ABSTRACT: Renewable energy is energy generated from natural resources and includes wind power, solar radiation as well as energy from other naturally and constantly replenished sources (sunlight, rain, wave, tides, geothermal heat, etc.). Renewable energy sector has one very big advantage over fossil fuels, the fact that it is highly ecologically acceptable compared to fossil fuels, because renewable energy sources release very little CO₂ emissions into atmosphere compared to fossil fuels as the convincingly biggest pollutants.

KEYWORDS: Renewable Energy Sources, Solar Energy, Wind Energy, Geothermal Energy, Applications.

I. INTRODUCTION

Renewable or non-conventional energy resources can be classified as below: Solar Energy, Wind Energy, Geothermal Energy, Bio-Mass Energy, Bio-Gas Energy, Hydropower, Wave Energy, Tidal Energy, OTEC etc. [1] The Earth receives 174 Petawatts (PW) of incoming solar radiation (insolation) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is absorbed by clouds, oceans and land masses.[2] The total solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately 3,850,000 exajoules (EJ) per year. In 2002, this was more energy in one hour than the world used in one year. Sun is our closest star and the source of almost all available energy on Earth. Sun's energy originates from nuclear fusion in its core, where temperature reaches 15 millions °C. Nuclear fusion is process of joining two light atoms into one heavier atom.[3] Sum of all masses before reaction is larger than sum of all masses after reaction - difference is transformed into energy by famous Einstein's Equation, $E = mc^2$, Where, E = Energy, m = Mass and c = Speed of light on Sun, light atoms are hydrogen atoms (input) and resulting atom is helium atom (output).[4] Thanks to nuclear fusion on Sun, every second about 600 million tons of hydrogen is transformed into helium, having 4 million tons of hydrogen transformed into energy as side effect. This energy in form of light and heat spreads itself into the universe with one small part of that energy reaching the Earth. Under optimal conditions, on earth's surface can be gained 1 kW/m², and real value depends upon location, season, day time, weather conditions, etc[5]

1. Solar Energy

Amount of energy in the form of heat and radiations called solar energy . It is radiant light and heat from sun that is natural source of energy using a range of ever changing and developing of technology such as solar thermal energy, solar architecture, solar heating, molten salt power plant and artificial photosynthesis.[6] The large magnitude of solar power available makes highly appealing source of electricity. 30% (approx.) solar radiation is back to space while the rest is absorbed by ocean, clouds and land masses. [7]

Source	Total Installed Capacity (MW)	2022 target (MW)
Wind Power	27,441.15	60,000.00
Solar Power	8,062.00	100,000.00
Biomass Power (Biomass & Gasification and Bagasse Cogeneration)	4,860.83	*10,000.00
Waste-to-Power	115.08	
Small Hydro Power	4,304.27	5,000.00
Total	44,783.33	175,000.00

Figure 1: Installed Grid Interactive Renewable Power capacity in India July 31 2016

WORKING OF SOLAR ENERGY

PV cells Convert Sunlight to Direct Current (DC) electricity. Charge Controller work as control the power from solar panel which reverse back to solar panel get cause of panel damage. Battery System act as storage of electric power is used when sunlight not available (i.e. night).From this system connected to inverter for convert Direct Current (DC) into Alternating Current (AC).

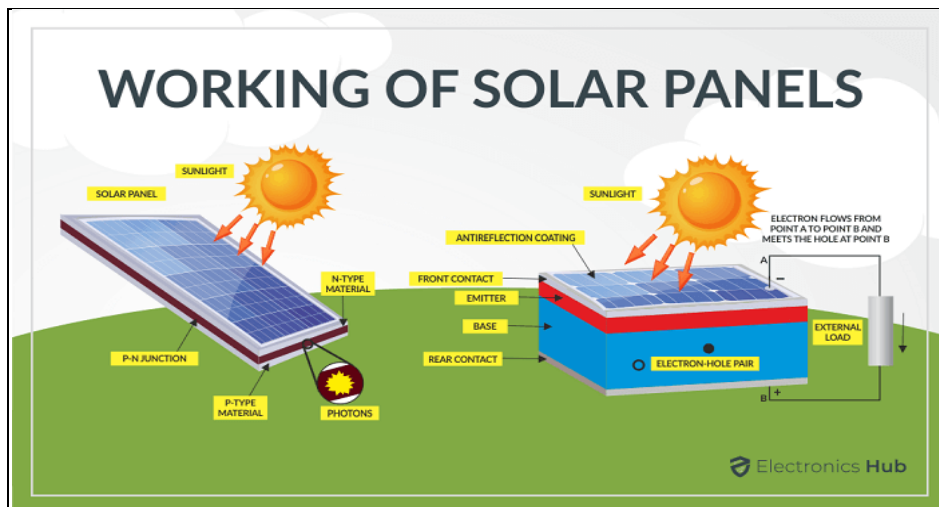


Figure 2: Working Of Solar Energy

2. Wind Energy

The terms "wind energy" or "wind power" describe the process by which the wind is used to generate mechanical power or electricity. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth.[8] Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used to run a generator and thus generator converts this gure some 100,000 MW nameplate capacity in September 2012, while the United States surpassed 50,000 MW in August 2012 and China passed 50,000 MW the same month. [9]

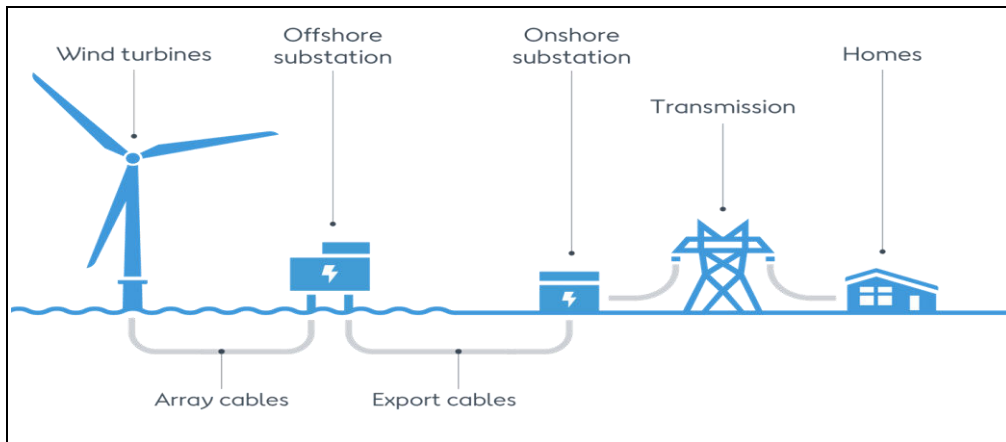


Figure 3: Wind Energy

3. Bio-Energy

Biomass is renewable energy source that consists of many animal and plant products.[10] It can be directly transformed by combustion in energy and produce water steam for industry and household's heating and to gain energy in smaller thermal power plants. So far the most advanced chemical conversion of biomass is fermentation to alcohol.[11] Biogas as the result of fermentation without presence of oxygen consists of methane and carbon and can be used as fuel, and other modern procedures of energy biomass include pyrolysis, gasification and getting hydrogen. Main biomass advantage relating to fossil fuels is less damaging gases emission as well as less waste waters. [13]

A .Biomass: Wood's Energy

European Union has 58% of primary energy gained from renewable energy sources that are coming from wood. That large part is traditional exploit of forest's potentials. France produces most primary energy from wood.[14] In year 2000 France had 9.8Mtoe) of energy gained on this way. Sweden (8.3Mtoe) and Finland (7.5Mtoe) are also representing significant use of wood's energy. Although thermal consumption (heating households, heating water) represents main part of energy's consumption, small part of wood's energy transform itself in to an electrical energy as well. [15]

B .Biogas Energy

Biomass is biological material derived from living, or recently living organisms. In the context of biomass for energy this is often used to mean plant based material, but biomass can equally apply to both animal and vegetable derived material. [16]Biomass is carbon based and is composed of a mixture of organic molecules containing hydrogen, usually including atoms of oxygen, often nitrogen and also small quantities of other atoms, including alkali, alkaline earth and heavy metals. [17] Plants may subsequently be eaten by animals and thus converted into animal biomass..

The estimated biomass production in the world is 146 billion tons a year, consisting of mostly wild plant growth. Biomass can be converted to other usable forms of energy like methane gas or transportation fuels like ethanol and biodiesel.[18] Rotting garbage, and agricultural and human waste, all release methane gas and is called "landfill gas" or "biogas." Crops, such as corn and sugar cane, can be fermented to produce the transportation fuel, ethanol. Biodiesel, another transportation fuel, can be produced from left-over food products like vegetable oils and animal fats. Between 1990 and 2000 number of bio-gas power plants constantly increased.[19]Today is about 3000 power plant in Europe, with also 450 garbage disposals which are valorizing biogas.

Year production of those installments is about 2304 ktoe, and that is about 5% totally manufactured Europe's biomass energy. Biogas is the result of anaerobic transformation of organic materials (biocomposable waste, energy substances) with the help of anaerobic organisms, and when produced it contains methane and carbon dioxide.[20] Biogas can be used as the source of electricity and to heat buildings and water. As the fuel its primary use is in engine with internal combustion. Figure 7 shows a typical Gobar Gas plant.

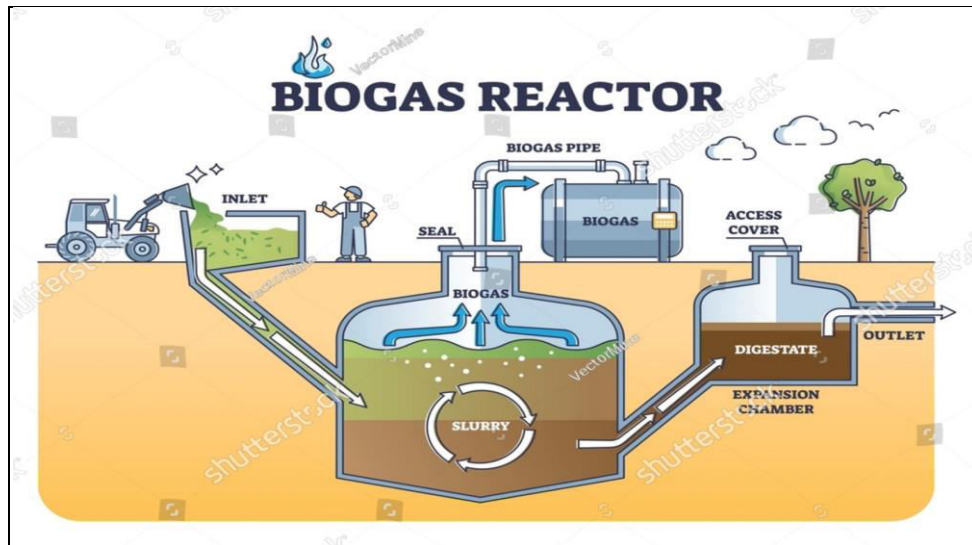


Figure 4: Bio Gas Reaction

4. Bio-Fuels

Bio-fuels are liquid fuels which have been derived from other materials such as waste plant and animal matter. There are two main types of bio-fuels: Bio-ethanol and Bio-diesel. [21]

Manufacturing of Bio-Fuels

Bio-fuels or bio-diesels are manufactured from vegetable oils, waste cooking oils, animal fats or tall oil (a by-product of the pulp and paper industry). These oils undergo a process called transesterification whereby they are subjected to a reaction with an alcohol (usually methanol or ethanol) using a catalyst such as sodium hydroxide.[22] The resulting chemical reaction produces an ester called bio-diesel and a by-product called glycerin. Pure bio-diesel fuel is significantly less flammable than petroleum diesel which burns at 50 degrees Celsius. Biodiesel's flashpoint is about 150 degrees Celsius.[23] Pure bio-diesel tends to lose its viscosity or to gel at lower temperatures when compared to petroleum. This can be a concern for its use in colder climates. Bio-diesels are often used in combination with petroleum diesel and are referred to as bio-diesel blends. [24] These blends will have a flashpoint and a gel point somewhere between the two pure fuels depending on the mixture.

Use of Bio-Fuels

Bio-diesel can be blended with diesel in any concentration but that which is used in Canada at the present time is usually a 5% or a 20% blend. In France, however, where bio-diesels are more commonly used, even for heating fuels, blends of up to 50% are employed. France is currently the world's largest producer of biodiesel10. [25]

A .Bio-Ethanol

Bio-ethanol is used as a replacement for gasoline and bio-diesel is used as a replacement for diesel. Bio-fuels have an important role to play in displacing the types of fuels the world has used in the past9. [26]

B .Bio-Diesel

Bio-diesel is the first bio-fuel that became known to wider audience and is the mostly used bio-fuel in Europe. It is manufactured from oil or fats with the process of transesterification and its chemical structure is very similar to mineral diesel. Table 3 shows the top ten European Countries consumption of Bio-diesel in 2010[27].

Bio-diesel is using in the United States of America besides the conventional diesel and petrol. Even they are available in fuel station at convenient way.

C .Benefits of Bio-diesel

The major benefits of Bio-diesel are listed below9:

1. The major reduction in greenhouse gas emission. The manufacturing of pure bio-fuel produces 60 to 100 percent fewer greenhouse gas emissions compared with that of petroleum diesel.[28]

2. Many food and animal waste products that now end up in our landfill sites decompose naturally to produce methane gas which also contributes negatively to climate change. By diverting these products into bio-diesel instead, we can further impact the environment in a positive way. [29]

3. Bio-diesel is composed of 11 percent of oxygen by mass which when added to petroleum diesel, allows it to burn more efficiently.[30]

4. Bio-diesel has mild solvent properties and is thus considered to be a clean fuel. These factors allow bio-diesel to help reduce the emissions of fine particulates and unburned hydrocarbons into the air, some of which have been associated with cancer causing properties.[31]

E. Hydropower, Hydroelectric power

The term Hydroelectricity is referred to electricity generated by hydropower. Hydropower is the production of electrical power through the use of the gravitational force of falling water. It is the most widely used form of renewable energy, accounting for 16% of global electricity generation in 2010 and is expected to increase about 3.1% each year for the next 25 years[1]. [32] Hydropower is produced in 150 countries, with the Asia-Pacific region generating 32% of global hydropower in 2010. China is the largest hydroelectricity producer, with 721 terawatt-hours of production in 2010, representing around 17% of domestic electricity use[1]. [33]

Calculating the Amount of Available Power A hydropower resource can be evaluated by its available power. The power available from falling water can be calculated from the flow rate and density of water, the height of fall, and the local acceleration due to gravity.[34] In SI units, the power is: $P = \eta \rho Qgh$, Where, P = Power in watts, η = The dimensionless efficiency of the turbine, ρ = The density of water in kilograms per cubic metre, $\sim 1000 \text{ kg/m}^3$, Q = The flow in cubic metres per second, g = The acceleration due to gravity, 9.8 m/s^2 , h = The height difference between inlet and outlet Hydroelectric Power at a Glance The cost of hydroelectricity is relatively low, making it a competitive source of renewable electricity.[35] Hydro is also a flexible source of electricity since plants can be ramped up and down very quickly to adapt to changing energy demands. However, damming interrupts the flow of rivers and can harm local ecosystems, and building large dams and reservoirs often involves displacing people and wildlife[1]. [36] Once a hydroelectric complex is constructed, the project produces no direct waste, and has a considerably lower output level of the greenhouse gas carbon dioxide (CO₂) than fossil fuel powered energy plants. Table 4 shows ten of the largest hydroelectric power station in the world . [37]

From the table it is seen that The Three Gorges Dam is the world's largest hydroelectric Dam which is located in the heart of the Yangtze River. More than a mile wide and over 600 feet long, the dam is the most extensive and most expensive engineering project in the world. It meets up the 3% of China's total energy needs.[38] Three Gorges Dam is also intended to control flooding of the Yangtze River Basin and enable more efficient navigation along the river to increase trade along the port cities. A graphical representation of the top ten Hydraulic Power Plants with their installed capacity [39]

The project has used a world record of 16 million cubic meters of concrete, flooded 100,000 acres of farm land, and relocated more than 1 million people from the Yangtze River Basin. Despite the economic benefits, the Three Gorges Dam has been referred to as "The most environmentally and socially destructive project in the world" (Dai Qing).[40] Now, China's government has finally acknowledged the vast environmental destruction associated with the dam, and has started to develop extensive plans to address these problems[12].

In the last thirty years or so, production of energy in water power plants has tripled, but hydro energy's share was only increased for 50 % (from 2.2% to 3.3%)[41] That is because of the restrictions that hydro energy has. It can't be used in all areas because it needs abundance of fast flowing water, and also is very desirable to have it enough throughout all year, because electricity can't be cheaply stored.[42] To negate effect of water-levels' oscillations, water gates as well as accumulation lakes are being built. That significantly increases the whole power plant's expenditures, and also raises the level of underground waters near the accumulation. Underground water level has large influence on flora and fauna, so hydro energy isn't completely harmless for environment. [43]

Geo Thermal

The term Geothermal originates from two Greek words 'GEO' and 'THERM'. The word 'GEO' means the earth and the word 'THERM' means heat from the earth. Geothermal energy is energy derived from the heat of the earth. The earth's centre is a distance of approximately 4000 miles and is so hot that it is molten.[44] Temperatures are understood to be at least 5000 degrees centigrade. Heat from the centre of the earth conducts outwards and heats up the outer layers of rock called the mantle. When this type of rock melts and becomes molten it is called magma. Magma can reach just below the earth's surface.[45] Inner Earth's heat is the result of forming planets from dust and gases that happened more than 4 billions years ago, and since radioactive decompose of elements in rocks continuously regenerates this heat, geothermal energy is renewable energy resource..[46]

Geothermal energy has huge potential because its quantity is 50000 times bigger from all energy that can be gained from oil and coal across the world.[47]

II. CONCLUSION

Now a day besides the conventional sources non conventional sources becoming popular. World trend is now on the use of non conventional sources of energy. There are lots of non conventional sources of energy

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