International Journal of Research in Engineering, Science and Management
Volume-3, Issue-1, January-2020
www.ijresm.com | ISSN (Online): 2581-5792

A Review on Recent Trends of Non-Conventional Energy Sources

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***Abstract*: After 21st era energy is the most important component for increasing economic infrastructure. Due to increase in population as well as industrialization the power demand has also increased very rapidly, as a result to supply their adequate power demand conventional energy sources are gradually depleting in order and after some years it will obsolete. So to retain the adequate supply of power demand in future we are dependent on non-conventional energy like solar, wind, geo-thermal etc. Now days due to some good impact on human life as well as environment we are very much dependent to use renewable energy sources. In this paper we have shown some modern & advanced ways to produce more power from renewable energy. Here we have introduced a new solar cell material calls "perovskites" which is economically cheaper than silicon solar material & efficiency increases more than 20% and other some related ways in wind energy we have concentrated on use of "Vertical axis wind turbine" (VAWT) for generate more electric power from wind velocity & increase the system efficiency. Lastly at geothermal energy some modern ideas have been discussed to use geothermal energy sufficiently for heating purpose, grow plants at green house process and effect on environment.**

***Keywords*: Geo-thermal, Perovskite, Renewable energy, Solar energy, Wind energy, VAWT.**

1. Introduction

Renewable energy is a kind of energy obtained from regenerative sources of energy in the natural environment like solar, wind, geo-thermal etc. Availability of renewable energy we use natural resources to harnessing the power & supply it depends on the load demand as well as it is pollution free. Gradually development of modern technologies & increasing of population, load demand will increase day by day. As a result resources of conventional energy are depleting rapidly. From the past decades to till, uses of conventional energy sources creating environmental pollution which causes the creation of global warming, natural ecological imbalance. For that reason use of renewable energy is gradually increased throughout the whole world.

In this paper we have evaluated on solar, wind & geo-thermal energy sources. The radiation of solar energy is directly converted into electrical energy with the help of photo voltaic(PV) cell. PV cell is generally made of semiconductor materials like Silicon (Si), Gallium Arsenide (GaAs) and Copper sulphate (Cu2S). A new solar cell material calls "Perovskite" is introduced here. At present it is under research. In this paper we have tried to show how to increase solar efficiency with the help of this material.

Now wind is a source of energy is inexhaustible and pollution free. In recent years the wind could supply a significant portion of the world's energy demand. Due to some disadvantages like large volume of availability and uncertainty of air to produce adequate amount of power depending on the load demand. So vertical axis wind turbine is used to produce electrical power when velocity of wind over a certain speed & it is independent of direction of wind flow.

And the last one is Geothermal, it is coming from two Greek word "geo" means earth and "thermal" means heat [1]. The main layer of earth is formed under surface Lithosphere (is made up of crust), mantle and core. In modern technique earth like a boiler in which geothermal fluids can achieve from the core of the earth and utilized generation of electric powers for heat purpose. In this research paper we show advance ways - heating purpose, plantation through greenhouse technology. Indirect generation of electricity by drilling wells into known geothermal reservoir. Where temperature more than 350°cand then the energy in the form of steam is utilized to produce electricity with the help of electrical generator. As a result, atmospheric temperature of earth can be reducing by geo-thermal process.

2. Solar Energy

Through a good deal of observation it is found that the energy is the back bone of technology economic development of nation. According to current data India has increased its solar power capacity four times from 2650 MW on 26th May 2014 to 12289 MW on 10 March 2017 [2].

Table 1
Comparative chart of power capacity of solar power of India

Year	Cumulative Capacity (in MW)
2010	161
2011	461
2012	1,205
2013	2,319
2014	2,632
2015	3,744
2016	6,763
2017	12,289

Perovskite is a material which is known from past but no one can apply this material properly in case of manufacturing solar

call. It is less than one micrometer but capturing same amount of light like 180 micrometer thick silicon solar cell. It is basically lead-halide based material.

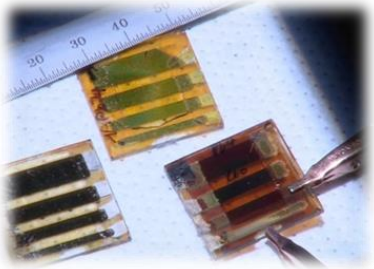

Fig. 1. Perovskites solar cell

The solar efficiency of perovskite material can be increased to more than 20% than mono-crystalline silicon solar cell. As a result, we can produce more electrical energy than the past decades with respect to recent load demand. According to National Center of Photovoltaic (NCPV), of the US department of energy gives some significant technical research on perovskite. According to them perovskite is a kind of material if we implement it in case of solar cell, the efficiency, stability of the cell can be increased with respect to silicon solar cell [3]. The cost of the perovskite solar cell is much cheaper than silicon solar cell. The cost of the perovskite solar panel is near about (5 to 10) rupees per watt (approx..), whereas at present silicon solar panel cost near about 35 rupees per watt (approx.).

A. Material of Perovskite solar cell

Perovskite solar cell is a combination of Lead Halide and a Methyl ammonium Iodide solution can be dissolved in a solvent and spin coated on surface. According to general material form of perovskite is ABX_3.

where,

A = stands for an organic cat ion methyl ammonium (CH_3NH_3+).

B = An inorganic cat ion generally lead (II) (Pb_2+).

X_3 = A smaller Halogen anion generally chloride (Cl-) or iodide (I-). [5].

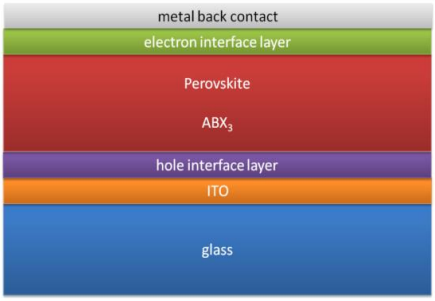

Fig. 2. Basic structural layers of Perovskite cell

In the fig. 2, a standard perovskite solar cell structural layers are given. It is based upon a standard glass with Indium Tin Oxide (ITO) coated substrates with a metal back contact. A hole interface layer is placed above the ITO which is made of "Poly (triaryl amine) Poly [4-phenyl) (2,4,6-trimethylphenyl) amine]" (PTAA) [6] or "Poly (styrene sulfonate)" (PSS) class of polymers. PTAA is a polymer of opto-electronic hole transport material for organic light emitting diodes (OLEDs). On the other hand ZnO and TiO_2 is used for electron interface layer. In between these two layers' perovskite ABX_3 is placed.

3. Wind Energy

Wind energy is one of the fastest growing energy technologies in 1990s. It is not a new concept it was started from tenth century in Persia. But there is a specific speed of air flow needed to run the wind turbine, minimum speed needed for generation of power is 15 m/s to 25 m/s. So this particular speed of air flow is not available everywhere. In case of wind energy production the rotation of wind turbine blade due to the flow of wind and converts it into electrical energy, the rotor turbine is coupled with ac generator for production of electrical power. In wind energy, the electrical power is generally produced by horizontal axis wind turbine (HAWT) which rotates along a horizontal axis. But due to some disadvantages of HAWT, in last 8 to 10 years the using of vertical axis wind turbine (VAWT) has rapidly increased. The fig. 3 shows some main components of HAWT.

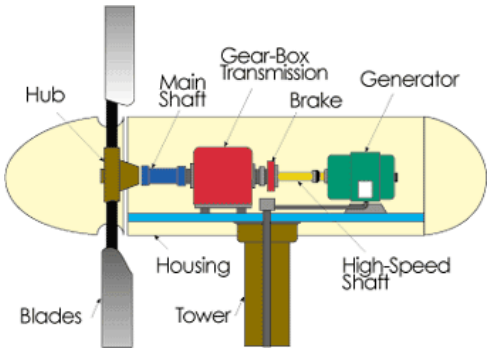

Fig. 3. Main components of (HAWT) wind turbine

A. Advantages of VAWT over HAWT

There are several advantages of VAWT over HAWT, some these are as follows,

1) VAWT receives air from any direction where as HAWT rotates only when air flows towards the direction of rotation.
2) Another advantage of VAWT is that it does not need yaw mechanism which an important part of HAWT.
3) All the important equipments i.e. gear box, generator etc. are placed to ground so no need of nacelle.
4) VAWT is less noisy than HAWT.

B. Formulae of optimal power extraction from air

The rotor blades must rotate at a rotational frequency that is related to the speed of the incoming wind. This rotor rotational frequency reduces as the radius of the rotor increases. The optimal power extraction is closely related with tip speed ratio

(λ) of wind turbine.

$$\text{So, } \lambda = \frac{(v)wind\ rotor\ speed(m/s)}{(u)wind\ speed(m/s)}, \quad (1)$$

Where, v=ω*r, ω=angular velocity in radian/sec, r=radius of wind turbine in meter, f= frequency in Hz(1/sec). For VAWT always λ>1.

It can be shown that for optimal power extraction the tip speed ratio i.e. λ, is related with number of rotor blades.

So, it can be written as $\lambda_{optimal} = \frac{4\pi}{n}$

Where, n= no. of rotor blades.

The power generation diagram of wind turbines with respect to the wind velocity is shown in the below figure,

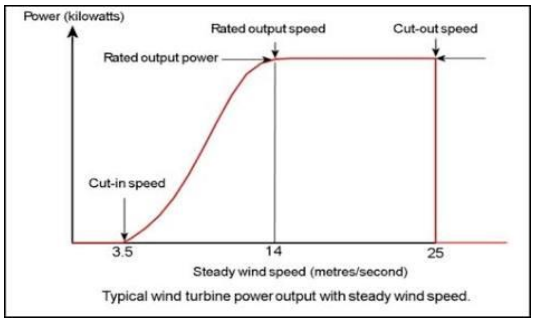

Fig. 4. Graph between power vs. wind speed

C. *Types and details about VAWT*

At initial development stage the VAWT were generally five type's viz. (i) Cup type (ii) Savonius rotor (iii) Darrieus rotor (iv) Musgrove & (v) Evans rotor [8].

(i) Cup type: It is the easiest form of VAWT. Three or four cup type structures are joined symmetrically to a vertical axis(shaft). Usually it does not carry the load because drag forces on the concave surface of the cup forcing the wind more than that on convex surface. So therefore it cann't be used as power generation station. Its rotational speed is directly proportional to the wind speed. For this reason, it is used as wind velocity transducers called "Anemometer".

Fig. 5. Anemometer (Cup type)

(ii) Savonius rotor: It consists of two half cylinders which are directly connected to a vertical shaft & facing opposite direction to each other. Its starting torque is high, low speed and low efficiency. This can harness power from very slow wind speed & making it working of the time. These are generally used for low power application specially for pumping application.

Fig. 6. Savonius rotor

(iii) Darrieus type of rotor: This type of VAWT is used for huge power generation. It runs at a large tip speed ratio. The wind force on the blade reverses in every revolution causing fatigue. One main disadvantage is that it is not self-starting. Initially its movement is initiated by an electrical motor. Its pitch is not changed so, power is uncontrollable. For better performance & for safety of blades, gear box & generator, it is desirable to limit the output to a level much below its maximum possible value.

Fig. 7. Darrieus type of rotor

(iv) Musgrove: It is an H shaped rotor where blades with a fixed Pitch and attached vertically to a horizontal cross arm. Power control is achieved by controlled folding of the blades. Inclining the blades to the vertical provides an effective means of alternating the blades angles of attack and hence controlling the power output.

Fig. 8. Musgrove type rotor

(v) Evans rotor: It is modified rotor of H shaped rotor. Its power can be controlled by controlling the pitch cyclically. It has some mechanical complexities. So some modern Technologies have been developed and some are under research.

D. Some modern VAWTS

Researchers are always trying to develop VAWTs such as which will produce more electrical power when a certain speed of air is flowing in any direction. Now we will discuss about some very recent technology of VAWTs which are already invented.

(a) Quiet revolution (QR5) & (b) Wind spire

(a) Quiet revolution (QR5): The QR5 [7] VAWT is developed for an urban environment with low speeds & charging with wind direction. While the manufacturer rated the turbine at 6.5 kW, the QR5 is equivalent to a conventional wind turbine 4.4 meters in diameter rated at 3.2 kW to 4 kW approx.

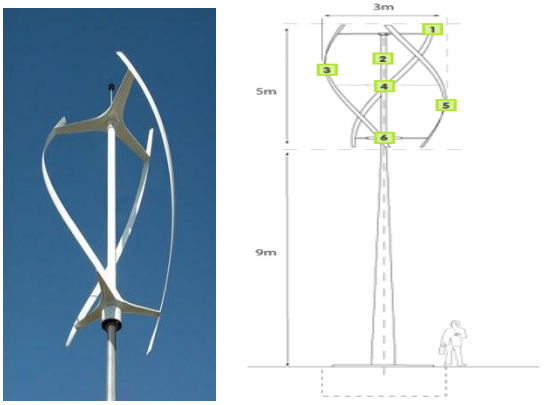

Fig. 9. Quiet revolution VAWT (QR5)

Working principle:

1. The 'S" shaped blades are tapered to shed noise.
2. The vertical axis is easy to integrate with existing masts and buildings.
3. The helical (twisted) design captures turbulent winds and eliminates vibration.
4. Central compression spar, dependent on conditions.
5. The blades, spars and torque tube are made of robust carbon fiber, and all moving parts are sealed to minimize maintenance.
6. The direct drive in-line generator has auto-shut down and peak power tracking and is incorporated into the mast [9]. The conventional HAWT catches wind horizontally & rotates horizontally corresponding to the rotor axis. The QR5 is helical design allows the turbine to collect the wind from all direction.

(b) Wind spire: It is a vertical axis wind turbine same as the QR5. This is generally 30 feet tall and 4 feet wide wind turbine. Produces 2000 KW hours per year in (12-15) mph average wind speed and it can tolerate the wind speed up to 100 mph. Wind spire has tall thin propeller less rotor. It generates power when wind spins its vertical airfoils.

Application: This type of wind turbine can be installed in museums, business and schools.

Fig. 10. Wind spire VAWT

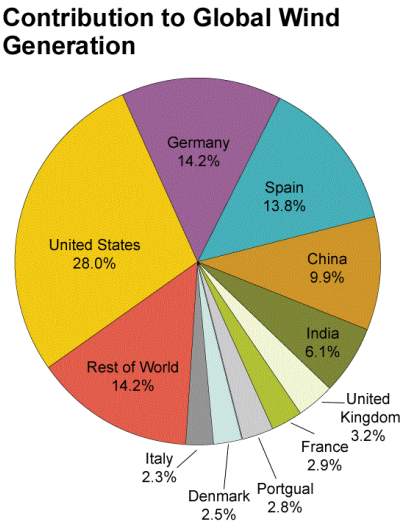

Fig. 11. Global wind generation

4. Geothermal Energy

Geothermal energy is nothing but the enormous heat contained in earth that generates due to geological phenomenon occurs in the planetary system. As a result, the earth serves as a boiler in which geothermal fluids can achieve the high temperature and pressure. This fluid occurs in reservoirs at depths of up to 3000 meters and can be recovering by drilling wells. This heat inside the earth core is generated continuously by the decay of long lived radio isotopes of uranium, thorium and potassium of which are present in the earth. According to the scientific view after a good deal of investigation the geo-thermal gradient expresses the increase in temperature with the depth in Earth's crust. It is found that in some places the geo-thermal gradient is higher than ten times the average value.

Geo-thermal power plant can be built usually at the junction of continental tectonic plates from where we can harnessing geo-thermal energy from the core of the earth called "Magma" and utilized the hot air of the core for generation electrical

power. Usually earth has a different layers from the upper to lower surface like Crust (Lithosphere), Mantle (Asthenosphere) & Mesosphere below the Asthenosphere which is shown in fig. 13.

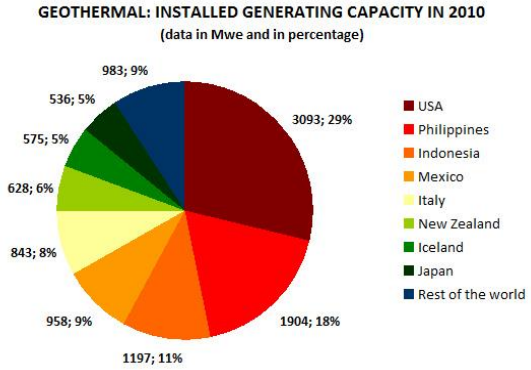

Fig. 12. Geo-thermal installed capacity in 2010

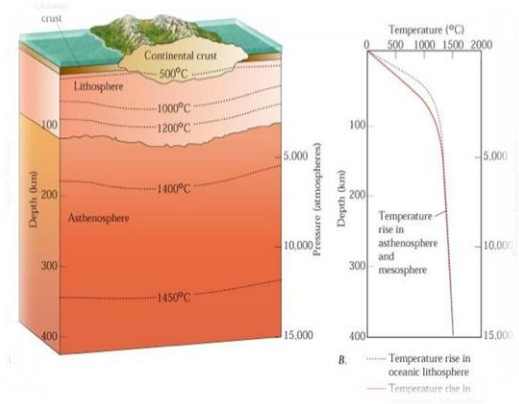

Fig. 13. Earth layer with temperature & graphical analysis

Depends on the geo-thermal electricity production power plant can classified in three ways like in fig. 14,

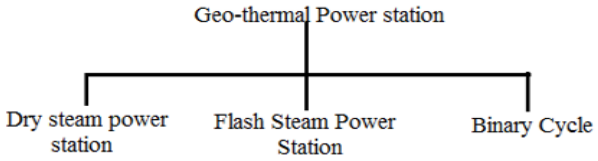

Fig. 14. Classification of geo thermal plant

In direct dry steam process hot steam flow through the pipe and fed to the turbine which drives the generator and produce electricity. Currently it is use in Geysers in northern California, in the US, world's largest single source power plant.

Flash steam is the most common type power plant, here hot high pressure fluid enters into a lower pressure tanks to flashed the steam to operate the generator and produce electricity as per required. In this process temperature is near about 180°c.

At last Binary cycle is the recent development for producing geo-thermal energy. Here temperature is 100°c to 130°c. It is a closed loop system where hot geothermal fluid passes through a heat exchanger, during this time working fluid flashed to vapor and operate the turbine. Comparatively cooled water vapor back to the reservoir. So we can use it for recycle purpose.

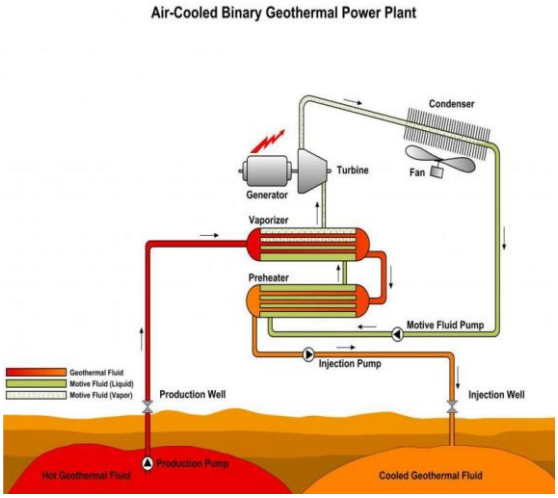

Fig. 15. Binary cycle of geo thermal plant

5. Results

After discussing these are three non-conventional energies with the help of their utilities and need with respect to load demand, they create a revolution with the help of these innovative technologies, which has been discussed in our research paper elaborately. Thus we see in case of producing solar energy "perovskit" material is much better and cheaper material than silicon solar cell. In case of wind and in earth centre (i.e. geothermal energy) that is below the earth crust there are enormous energies can be used for producing power through innovative devices developed by new technologies. Therefore, this type of ceaseless research is required throughout the world to have the good result how to use the renewable energy for the betterment of the mankind because fossil fuels are going to be reduced with in a very short time.

6. Conclusion

The renewable energy sources are the only the substitutes of conventional energy sources. The main advantage of it, that it is pollution free and ecofriendly. In this paper we have discussed about three types of non-conventional energy sources viz. solar, wind and geothermal. We have also discussed in details about modern and updated inventions in these fields.

In this research paper we have proposed some innovative ideas by which the increasing load demand can be met. This paper also gives some new idea about this field by which the electrical power generation can be increased effectively.

7. Future scope of work

There are several scopes to research in this field. First one, in case of perovskite solar material it is basically lead halide based. We know that Lead is a pollutant which creates cancer. So there is opportunity to develop a perovskite solar cell which will lead free.

For wind energy there are some modern VAWTs are under developed viz. Spiral drag wind turbine, Mageen air rotor system(MARS) etc. It is expecting that after completion of development of the above mentioned wind turbines, a large revolution will come in the wind power sector.

Lastly for geothermal energy sources, it can be used for reduction the atmospheric temperature by injecting the temperature into the earth. This energy can also be used for heating the room, for plantation purpose in agriculture farm greenhouse etc.

References

[1] http://www.mnialive.com/articles/an-introduction-to-geothermal-power.
[2] www.mnre.gov.in
[3] https://www.nrel.gov/pv/perovskite-organic-photovoltaics.html
[4] Kevin Bullis, A Material That Could Make Solar Power "Dirt Cheap"
[5] https://www.ossila.com
[6] http://www.solarischem.com
[7] http://www.popularmechanics.com/science/energy
[8] B. H. Khan, "Non-convention energy resources," McGraw Hill publication, 2nd Edition, 2012.
[9] http://www.reuk.co.uk
[10] Ashish Saxena et. al., "Development of vertical axis wind turbine: case studies review," IJAERV, Vol. 10, No, 57, (2015).
[11] K. Gurney, D. Mendoza, Y. Zhou, M. Fisher, C. Miller, S. Geethakumar, and S. De La Rue Dy Can, "High Resolution fossil fuel combustion emission fluxes for the United States," Enviromental Sci. Technology, 2009.
[12] R. Lal, "carbon emission from farm operations," Environ. Int., vol. 30, pp. 981–990, 2004.
[13] K. Caldeira, A. K. Jain, and M. I. Hoffert, "Climate sensitivity uncertinity and the Need for Energy Without CO2 Emission," Science, vol. 299, pp. 2052–2054, March 2003.
[14] T. Conference, "The Kyoto Protocol: Co2, Ch4 and climate implications," vol. 25, no. 13, pp. 2285–2288, 2010.
[15] "Trends, prospects and R&D directions of the global wind energy sector," Lab soft energy Appl. Environ. Prot., pp. 1–9, 2013.
[16] D. G. Shepherd, "Historical development of the windmill." 1990.
[17] P. N. Shankar, "Development of vertical axis wind turbines," Sadhana, vol. 2, pp. 49–66, March 1979.