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Hybrid Power Generation System – A Review

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Abstract – *In this paper we have studied Solar and Wind energy which will be used for the development of electricity. This paper provides a review on the hybrid power generation i.e. combination of two or more energy sources. The hybrid power generation system will in turn be used for the charging of batteries. The hybrid system is more economical and sustainable source of energy generation. The power generation capacity of hybrid system is more than the power generation capacity of the individual system.*

Key Words: Renewable energy, Hybrid system, Solar energy, Wind energy

1. INTRODUCTION

The world is eager to find new solutions for the increasing energy demand as the majority of this need is being fullfilled by burning coal in thermal power plants. In order to keep this world running and the nature in order, we need to find more sustainable ways of energy generation.

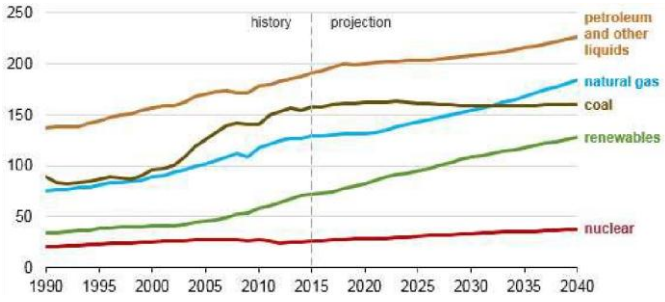

Fig -1: Energy Demand Trends

The recent boom of investments that we are witnessing all over the world by governments into renewable sources of energy is surely a big step forward. But so far these energy sources haven't proven themselves as the most reliable source of energy. These power plants are generate a very minimal amount of electricity in comparison to the world energy needs. These renewable power plants are facing one of the biggest issues i.e. the problem of weather uncertainty. We all know that power utilization is different during the different parts of the day. In the morning and the evening, the power consumption is the highest. During the night time, it drops of drastically. The problem discussed above is out of our control, we need to find better solutions that will eliminate the uncertainty and will provide fairly constant power output during any time of the day.

The hybrid Solar and Wind Power Plant will try to eliminate the very problems. The output from the solar energy keeps changing throughout the day. This can be affected by multiple reasons such as cloud weather for a long time, monsoon season can ruin generation plans for pretty much the entire day. The wind speed, direction can also be predicted only upto a certain extent. Same goes with the hydro power plant. The next problem is finding a suitable geographical location which suits the power plant both in terms of energy generation and financially.

But in order to shift the entire world energy consumption towards a cleaner and sustainable source of energy generation, every single city, town and village must be included under the plan. But, majority of the cities and villages do not have an appropriate location for any of the three individual power generation. This is the problem that is tackled by installing a hybrid power generation system. Installing a full-fledged power plant will cost a lot with lot less gains at these locations due to a number of reasons.

2. POWER POTENTIAL

Hybrid power systems constitutes of variety of storage components and power generators. It is designed to meet the energy demand of rural area. To fit the local geographic conditions and other specifications, small hydro plants wind generators, PV generators and other sources of electricity are added. For developing a hybrid system for a specific location, it is essential to know the particular energy demand and the resources available for that place location. So, for a particular site location the energy planners must study the potential available resources on solar, wind and hydro energy.

2.1 SOLAR ENERGY POTENTIAL

India has an average annual temperature ranges between from 25°C – 27.5 °C. Hence India has enormous solar energy potential. Photovoltaic (PV) cells are placed on the roof top of homes or commercial buildings, to gather the solar power . Solar collectors like mirrors or parabolic dishes which will move and track the sun throughout the day also are used. For concentrated lighting in buildings similar mechanism is employed .

Solar has numerous domestics, industrial application. India being a tropical country receives solar radiation about 3,000 hours of sunshine in a subsequent year which is equal to more than 5,000 trillion kWh. In all a part of India, it receives 4 – 7 kWh of radiation per square metre .

2.2 WIND ENERGY POTENTIAL

The strong south-west summer monsoon, which starts in May-June, influences the wind energy in India. during this time cool, humid air moves towards the land .in October the north east winter monsoon starts, when the cool, dry air moves towards the ocean. within the months march to August, the winds are uniformly strong over the entire Indian Peninsula region but it except the eastern peninsular coast. Wind speeds in month November to march are relatively weak though higher speed winds are on the Tamil Nadu coastline.

2.3 HYBRID ENERGY POTENTIAL

The current energy consumption rate proved that coal resources should last for about 200 years, oil and natural gases for 40 years and 60 years respectively.

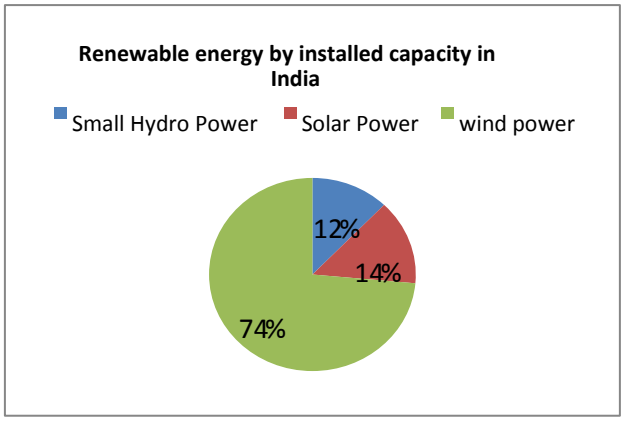

Fig -2: Renewable energy by installed capacity in India

It is predicted that there would be 40% increase in the renewable energy production over the span of next 5 years. Wind energy is expanded globally over 25 % to 35 %. So, it's named as world's fastest growing energy source. Hydro is the second largest available renewable resource and its energy market is around 20% to 30% annually. Solar power technologies are predicted to be 4.9 % of global renewable energy sources.

Total energy of the hybrid are going to be the availability from the solar PV, turbine and hydro.

As show in the equation below

PHY = PPV + PW

PHY = PPV +PHYDRO

PHY = PW +PHYDRO

Where PHY is power generated by the hybrid system PPV is that the power generated by the solar PV system Pw is the power generated by hydraulic turbine.

3. SOLAR, WIND AND HYBRID WIND-SOLAR FARMS AND LAND AREA USAGE

Along with the rise in world demand for energy from renewable sources, a multitude of information is easily obtained concerning operators of large scale solar, wind and hybrid wind-solar energy for the public. These corporations have a public obligation to inform the public on the specifications of their plants. Table 1 shows five operational large scale solar power plants.

Table -1. Operational Large Scale Solar Power Plants.

Operation Start Year	Location	Number of Panels (million)	Output Capacity (MW)	Area (Hectar^2)
2016	Kamuthi, India	2.5	648	1000
2017	Qinghai, China	4	850	300
2017	Kurnool, India	4	900/1000*	2352
2016	Datong, China	NA	1000/3000*	NA
2016	Ningxia, China	NA	1500	4300

It is clear that the area required is large to produce MW capacity plants. For example, the solar power facility in Kurnool with a targeted capacity of 1GWatt requires an area of 2,352 hectars. Once a piece of land has been commissioned to build a mega scale solar plant, it is rendered unusable for agriculture and settlement for at least a 20 year period which is as long as powers purchase agreement. This is one of the disadvantages of large scale solar energy generation.

Table -2. Operational Large Scale Wind Power Plants.

Operation Start Year	Location	Number of Wind Turbines	Output Capacity (MW)	Area (Hectar^2)
NA	Gansu, China	7,000	6,000/20,000*	NA
NA	California, USA	750	3,000	12,950
1986	Tamil Nadu, India	3,000	1,500	NA
2001	Rajathan, India	NA	1,064	NA
2012	Oregon, USA	NA	845	20,720

Table 2 shows five existing mega scale wind farms, their locations and output capacity. These farms are installed with large HAWT rated around the 1 MW capacity each. Again it is seen that the area requirements

is extremely high. For example, 12,950 hectars2 of land is required to produce 3GW from the facility in California . This is mainly to adhere to safety regulations for placement distances between adjacent wind turbines.

Table -3. Operational Large Scale Hybrid Wind-Solar Power Plants.

Name/Location	Solar Cap. (MW)	Wind Cap. (MW)	Total Cap. (MW)	Area (Acres)
SECI-NREDCAP/India	120	40	160	1000
Arena Gullen/Australia	10	165.5	175.5	70
Fakken Wind Farm/Norway	20	54	74	NA
Hero Future Energies/India	28.8	50	78.8	NA

Recently, several hybrid wind-solar power plants have also been reported and are shown in Table 3. Information on its respective solar, wind and total output capacity is presented. These hybrid plants have dedicated land to house PV cell arrays and wind turbines to produce electricity. Similar to the solar and wind RE plants, the area required to produce hybrid RE power is also quite large. However, when compared to pure large scale solar or wind farms, the usage of land for the generation of hybrid RE power is much more efficient since only 0.16 acres to 2.5 acres of land is required to produce a capacity of 1MW. The use of large amounts of land for generating green power is seen as a social-economic problem because once a piece of land is commissioned for a large scale solar, wind or hybrid wind-solar power plant, it cannot be used for agriculture or residential purposes for a period of at least 25 years or is based on the period of a power purchase agreement between the RE power producer and the government where the plant is erected. The land requirement for generating RE energy is large due to the dimensions of the devices used to produce electricity. For example, the most efficient and well-designed large scale solar or wind farms require on average 4 acres of land to generate 1MW of electricity at full capacity.

4. CONCLUSION

As mentioned in the paper the power produced by the combination of solar- wind; is much greater in comparison to the individual systems. The hybrid RE plants have a much smaller PPF, making them much more area efficient. However, these RE power plants use the traditional hybrid wind-solar topology where dedicated PV cell arrays and wind turbines are used separately to produce hybrid renewable energy. Nontheless, it is noted that hybrid type farms are more area efficient and in the long term will lower the negative socio-economic impact such as shortage of land for agriculture and housing.

Fig. 10. THWS Generator Power Plant Land Size Comparison

The recent emergence of hybrid wind-solar RE generators into the market have opened the opportunity for the development of large scale true hybrid wind-solar plants. However, either the generation capacity is too low or the PPF is too high in the existing models.

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