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Modeling and Design of Hybrid Power Plants

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Abstract: - This paper aims to present a suggestion to construct a hybrid power plant that can generate continuously power all the time. The plant depends mainly in using traditional generators using diesel or gas as the source of power, on the other hand renewable sources of energy are adopted. In the usual case when there is no wind or solar sources, the plant can generate the power using gas or diesel. It is found that the power generated from such firms depends mainly on both number of photovoltaic panels and wind speed. Also on the solar radiation of that area. As the speed of the wind increases the power generated increases. Also the power increases as the number of photovoltaic increases the power also increases.

Keywords: *power plants, renewable energy, solar, wind energy.*

I. INTRODUCTION

Power plants are those stations give us the power as electrical energy or any other form of energy, figure 1 shows the main construction of typical power plant.

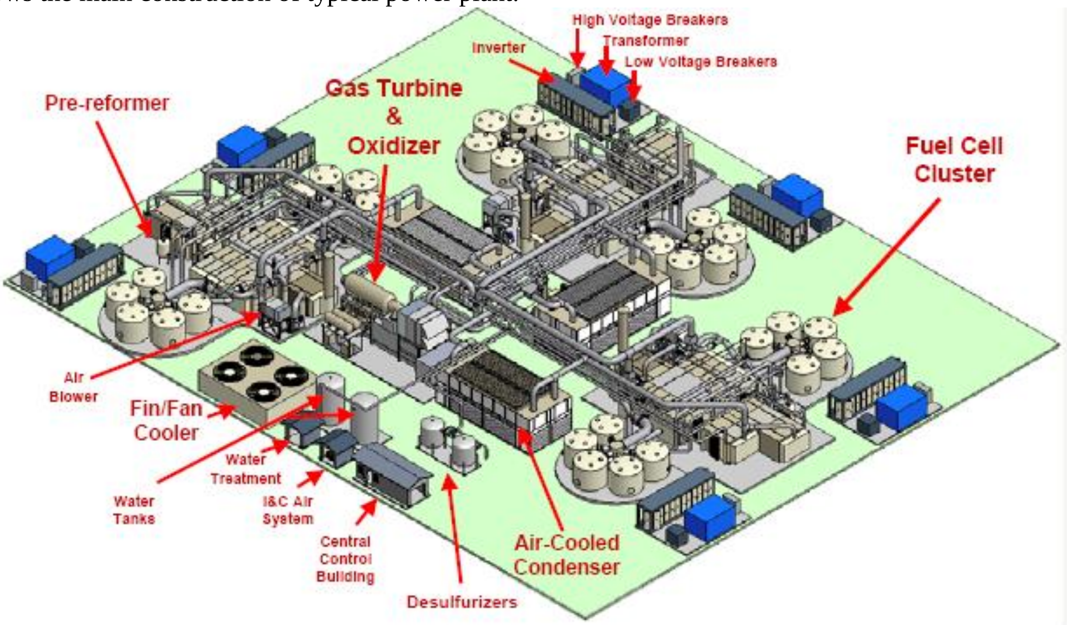

Fig.1 typical power plant

The traditional power plants have many drawbacks, they are highly fuel consumed, having high gases emissions which affects on environment and finally on our breath and health. Hybrid models have been an effective means of producing generating electricity throughout the world. Lots of research work has been done and continuing the new accommodates advances in this system. This paper reports the probabilistic performance assessment of a wind, Solar Photo Voltaic (SPV) Hybrid Energy System. In addition to this solar/wind system with backup storage batteries were designed, integrated and optimized to predict the behavior of generating system.

The global population increase has created the need of more energy resulting, for the developed countries, in either investing in the construction of new power plants or extending the operation of the existing ones. In addition and due to the global commitments for CO_2 reduction, the majority of the new energy project investments are recommended to be for renewable sources of energy. The aim of this paper is to study the hybrid power plants, their construction, energy or power sources and their properties and thermal efficiencies and performance. Fig. 2 and 3 show the construction of hybrid power plants.

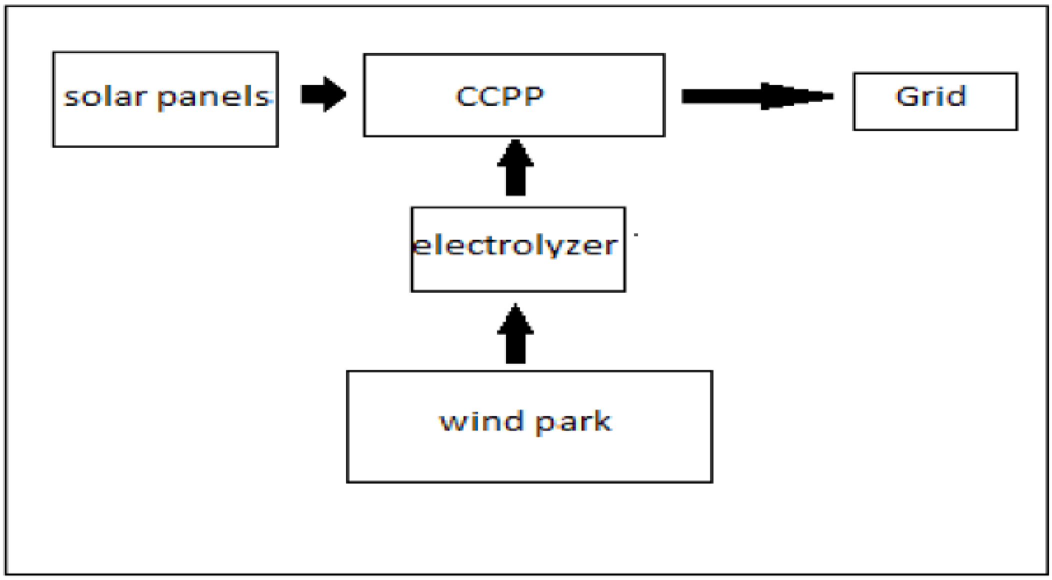

Fig.2 hybrid power plants

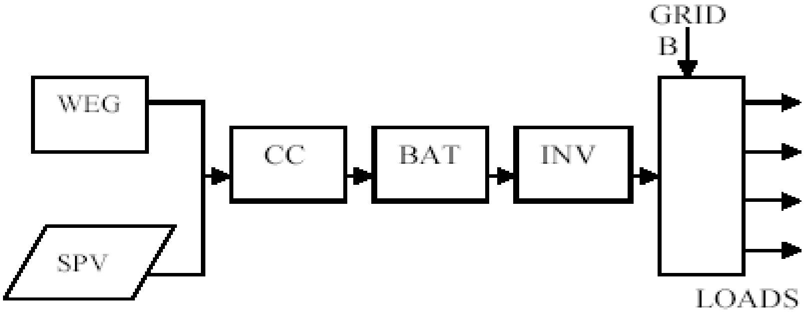

Fig.3 hybrid power plant construction

Fig. 4 shows a more detail of the hybrid power plant system components.

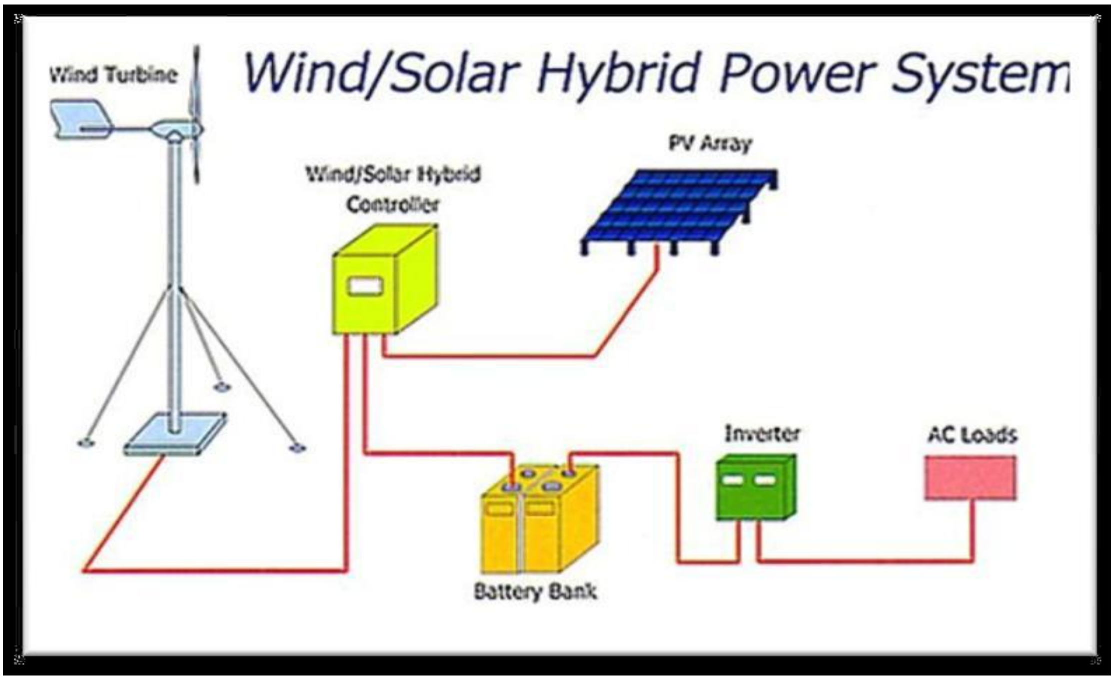

Fig.4 components of hybrid power plant.

There are many researches discussed the issue of hybrid power plants, Sandeep K. et al. (2013), discussed the detailed of a hybrid model of a solar / wind in Simulink, which is using battery as its storage system. The simulation includes all realistic components of the system, in this system power delivered by the combine system component is compared with each other and various conclusions are drawn. A comparative study of hybrid model solar /wind system has been made. They described the solar-wind hybrid system for supplying electricity to power grid.

Menelaos T. (2010), investigated ways to operate a combined cycle power plant using renewable energy sources which offer fuel independency, secure continuous functioning and most importantly produce no gas emissions. The aim was to take advantage of every available renewable energy source (sun, wind, water, earth) and to convert it into hydrogen for the power plants fuel consumption, as well as to exploit solar or geothermal energy to support the steam generation for the heat recovery system or for an auxiliary boiler. A combined cycle power plant unit (5+2 MW) is capable of supplying, in theoretical basis, a small community in Cyprus with electricity.

The total wind- and PV-generated power during each hour is first computed as follows:

$$P_{GEN}(t) = P_W + NPV \times P_S(t) \qquad (1)$$

Where NPV is the number of Photo voltaic panels, and $P_W(t)$ is the power from the wind at time, P_S is the solar energy generated by each solar photovoltaic panel.

The fundamental equation governing the mechanical power capture of the wind turbine rotor blades, which drives the electrical generator, is given by

$$P_W = 0.5\rho A V^3 C_p * EFF \qquad (2)$$

Where ρ = air density (kg/m^3), A = area swept of rotor (m^2), V = wind speed (m/s) and EFF = efficiency of the AC/DC Converter.

The theoretical maximum value of the power coefficient Cp is 0.59 and it is often expressed as function of the rotor tip-speed to wind-speed ratio (TWR). TWR is defined as the linear speed of the rotor to the wind speed.

$$TWR=wR/V \qquad (3)$$

Where R and w are the turbine radius and the angular speed, respectively.

Whatever maximum value is attainable with a given wind turbine, it must be maintained constant at that value for the efficient capture of maximum wind power. Power is directly proportional to wind speed, as the wind speed increases the power delivered by a wind turbine also increases. If wind speed is between the rated wind speed and the furling speed of the wind turbine, the power output will be equal to the rated power of the turbine. Finally, if the wind speed is less than the cut-in speed or greater than the furling speed there will be no output power from the turbine. Power output from practical turbine: The fraction of power extracted from the power in the wind by a practical wind turbine is usually given the symbol Cp, standing for the coefficient of performance. Using this notation and dropping the subscripts of Eq2. The actual mechanical power output can be written as

$$Pm = Cp\ (\tfrac{1}{2}\rho A u^3) = CpPw \qquad (4)$$

RESULTS AND CALCULATIONS

Fig.5 shows the relation between the powers generated from the hybrid power plant as a function with the wind speed.

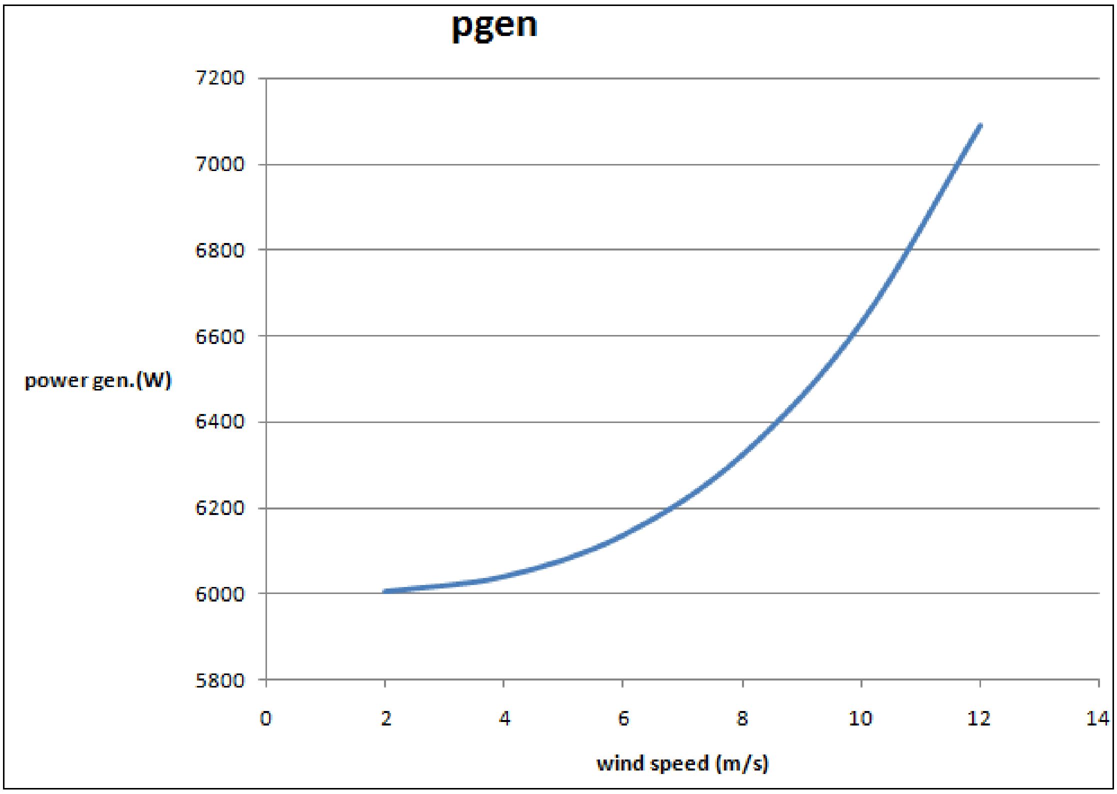

Fig. 5 power generated by the hybrid power plant as a function with wind speed at 50 photovoltaic panels and 120 watt of solar energy.

Fig. 6 shows the relationship between the powers generated from the hybrid power plant as a function with number of photovoltaic panels at constant wind energy of 120 watt from each wind turbine.

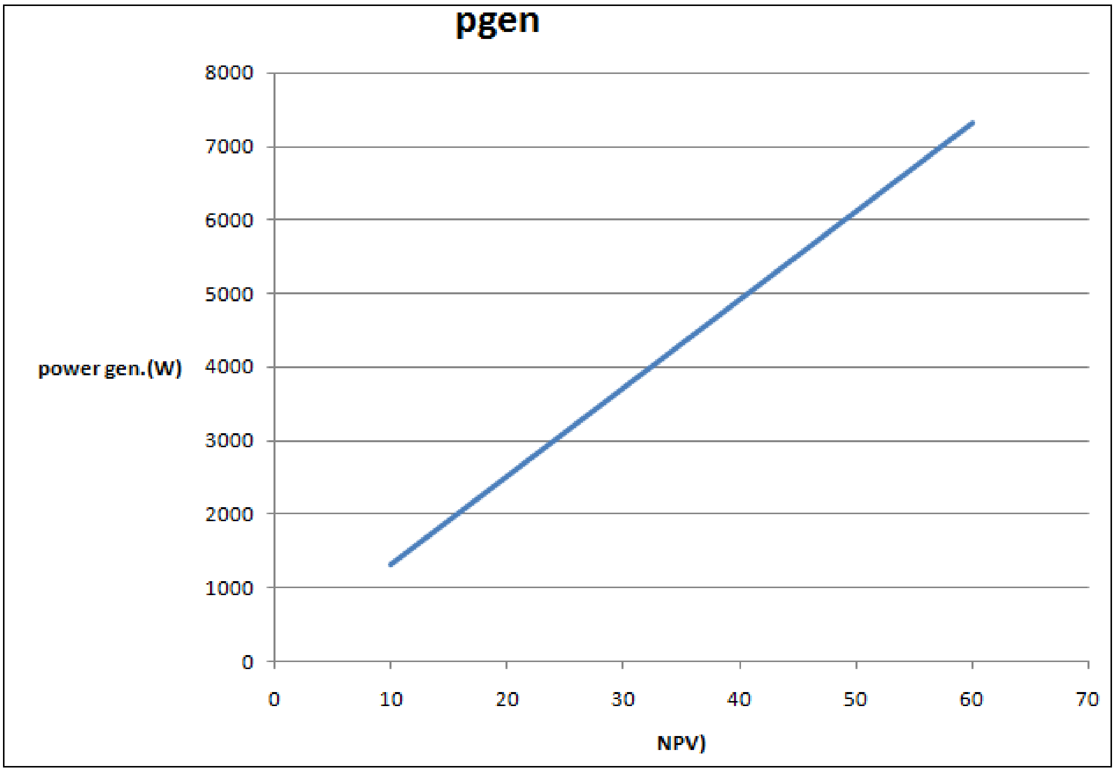

Fig.6 generated power of hybrid power plant vs. number of photovoltaic panels.

II. CONCLUSIONS

It is possible to construct a hybrid power plant any where there is a wind or solar radiation. The power generated from such firms depends mainly on both number of photovoltaic panels and wind speed. Also it depends on the solar radiation of that area. As the speed of the wind increases the power generated increases. Also the power increases as the number of photovoltaic increases the power also increases.

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