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A Case Study of Integrated Power Generation System Using Solar and Wind Energy for Base Conventional Thermal Power Plant

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Abstract: ***The electricity is most important one for human daily life. It is the most utilised power because of easy controllable, maintenance free, easy transferable and economical. In general, the electrical power can be Generated by conventional energy sources like thermal, nuclear, gas and diesel etc. In this regard, the electrical power generation by conventional sources may be depleted for long time utilisation. So that the electrical power can also produced by non-conventional energy sources like wind, solar and hydro power etc. The wind turbine is responsible for converting wind energy into electricity and solar cells are used to convert light energy into Electric power. This paper explains the integration of wind, solar and conventional power (Thermal) will gives the reliable, uninterruptable and continuous power supply to consumer premises and also reduces the stress on the conventional(Thermal) electrical power generation.***

Key words: Electrical power, Energy sources, wind, solar.

I. INTRODUCTION.

Electricity is most needed for our day to day life. There are two ways of electricity generation either by conventional energy resources or by non-conventional energy resources. Electrical energy demand increases in word so to fulfil demand we have to generate electrical energy. Now a day's electrical energy is generated by the conventional energy resources like coal, diesel, and nuclear etc. The main drawback of these sources is that it produces waste like ash in coal power plant, nuclear waste in nuclear power plant and taking care of this wastage is very costly. And it also damages he nature. The nuclear waste is very harmful to human being also. The conventional energy resources are depleting day by day. Soon it will be completely vanishes from the earth so we have to find another way to generate electricity. The new source should be reliable, pollution free and economical. The non-conventional energy resources should be good alternative energy resources for the conventional energy resources. There are many non-conventional energy resources like geothermal, tidal, wind, solar etc[1]. the tidal energy has drawbacks like it can only implemented on sea shores. While geothermal energy needs very larger step to extract heat from earth. Solar and wind are easily available in all condition. . The most popular non- conventional power resources are solar energy power plant which converts solar energy or solar heat to electricity. Solar power generation system has some drawback, that is, it cannot generate power in cloudy or rainy days. Therefore, people using this solar system have to remain without electricity (power) after battery gets discharged during the rainy season or the sun's shortcomings, since it is totally depended on appearance of the sun in the sky Moreover, it has very much limited capacity and we cannot take all available solar energy, because it is urgently required in all other fields' also e.g. biological body or health care, agriculture, chemical reactions, industries etc [2].

Solar energy has drawback that it could not produce electrical energy in rainy and cloudy season so we need to overcome this drawback we can use two energy resources so that any one of source fails other source will keep generating the electricity. And in good weather condition we can use both sources combine to eliminate the stress on the conventional energy sources and maintain them for future needs.

II. INTEGRATED POWER GENARATION SYSTEM.

Integrated power generation system is the combination of two non conventional energy sources (Wind and Solar) in addition with one conventional energy source (Thermal) for giving power to the load. The Integrated energy system has good reliability, efficiency, less emission, and lower cost.

A. Wind Energy

The major components of a typical wind energy conversion system include a wind turbine, generator, interconnection apparatus and control systems.[3] This turbine transforms the wind energy to mechanical energy, which in a generator is converted to electrical power. An integration of wind generator, wind turbine, aero generators is known as a wind energy conversion system.[4].The schematic diagram of wind power generation is as shown in fig.1

Fig.1. Basic diagram of Wind power generation

B. Solar

The most popular non-conventional power resources are solar energy power plant which converts solar energy or solar heat to electricity. Solar power generation system has some drawback, that is, it cannot generate power in cloudy or rainy days. Therefore, people using this solar system have to remain without electricity (power) after battery gets discharged during the rainy season or the sun's shortcomings, since it is totally depended on appearance of the sun in the sky. Moreover, it has very much limited capacity and we cannot take all available solar energy, because it is urgently required in all other fields also e.g. biological body or health care, agriculture, chemical reactions, industries etc.[5] The Solar Power Generation System is planned accordingly Fig. 2. The solar cell array or panel consists of an appropriate number of solar cell modules connected in series or parallel to provide the required current and voltage.

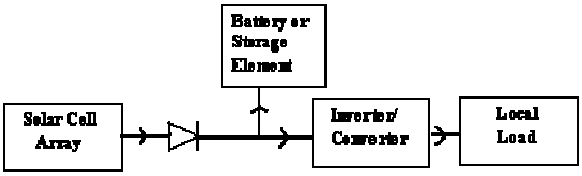

Fig. 2. Basic Solar (Photovoltaic) System

Storage batteries as shown in Fig. 1 provide the back up power during no sun shine period by storing the excess power or some portion of power from the solar arrays. This solar power generating system is used for private power consumption, meteorological stations, radio or TV relay stations, entertainment places like cinema, hotel, restaurant etc, villages and islands.

C. Conventional Energy Source (Thermal)

In the existing scenario, most of the electricity produced throughout the world is from steam power plants. Therefore, it is very important to ensure that the plants are working with maximum efficiency. Thermodynamic analysis of the thermal power plant has been undertaken to enhance the efficiency and reliability of steam power plants. Most of the power plants are designed For wind Energy System, the following data is required.

The Sunlight hours of annual mean daily duration.

The Horizontal Solar radiation for criteria based on first law of the rmodynamics only. The real useful energy loss cannot be justified by the fist law of the rmo dynamics, because it does not differentiate between the quality and quantity of energy. The present work deals with the comparison of energy and energy analysis of the rmal power plant stimulated by coal. Generally, it is predicted that even a small improvement in any part of the plant will result in a significant improvement in the plant efficiency.

Factors affecting efficiency of the Thermal Power Plant have been identified and analyzed for improved working of the rmal power plant.[6].

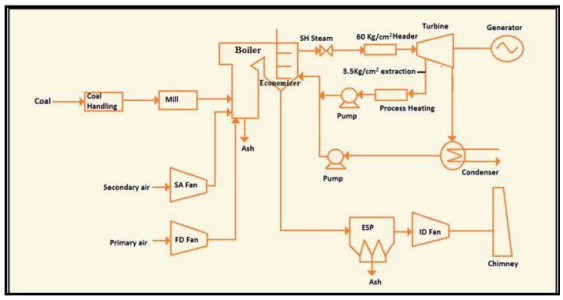

Fig.3Layout of Thermal Power Plant.

The major objective of this system is to eliminate the burden on the thermal plant and to surplus the coal for future needs.

III. DESIGN OF INTEGRATED POWER GENARATION SYSTEM.

For design of the integrated power system is required following data.
For Wind Energy System, the following data is required
The mean wind speed hours annually.
For Solar Energy System, the following data is required.
The Sunlight hours of annual mean daily duration
The Horizontal Solar radiation for every day.
For Thermal Energy System, the following data is required.
the coal is used to produce the heat content at output steam and also is produce at input heat content annually. i.e efficiency of Boiler.(ήB)
Heat pressure and heat produced data at turbine inlet and outlet annually. i.e efficiency of Turbine. (ήT)
the data for mechanical energy at input and the data for electrical energy at output annually . i.e. efficiency of Generator. (ήG)
Therefore, the overall efficiency of thermal plant is

$$\eta_{Overall} = \eta_B * \eta_T * \eta_G$$

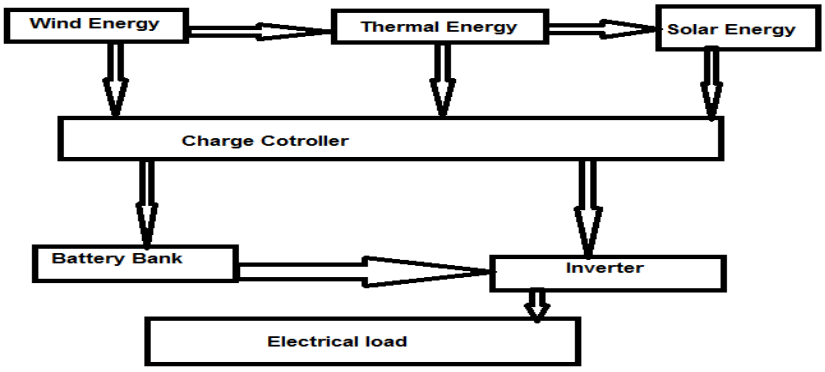

Fig.4.Schematic diagram of integrated power generation system.

The above diagram illustrates the integrated power generation system. It consists of following major blocks.

A. Wind turbine.

Wind turbine is that system which extracts energy from wind by rotation of the blades of the wind turbine. As the wind speed increases power generation is also increases. The power generated from wind is not continuous its fluctuating. For obtain the non-fluctuating power we have to store in battery and then provide it to the load.

B. Thermal plant.

The most evident problem in this world is the reduction of non-renewable energy sources. Therefore, energy security is the major concern of today's world. Improving efficiency of the energy systems is an essential option for the security of future energy. Every power plant losses their efficiency due to its continuous operation, age and many other reasons. Everything grows older with time. After years of operation, a plant will no longer be operating at best practice levels. Efficiency deteriorates. This reduction in efficiency causes an increase in the carbon dioxide emission. The optimizations of power generation systems are one of the most important subjects in the energy- engineering field. Due to the high prices of energy and the decreasing fossil fuel recourses, the optimum application of energy and the energy consumption management method i.e. Integration of power generation is very important.

C. Solar Panel.

Solr panel is use to convert solar radiation to the electrical energy. The physical of PV cell is very similar to that of the classical diode with a PN junction formed by semiconductor material. When the junction absorbs light, the energy of absorbed photon is transferred to the electron- proton system of the material, creating charge carriers that are separated at the junction. The charge carriers in the junction region create a potential gradient, get accelerated under the electric field, and circulate as current through an external circuit. Solar array or panel is a group of a several modules electrically connected in series parallel combination to generate the required current and voltage. Solar panels are the medium to convert solar power into the electrical power which is purely DC.

D. Charge Controller.

Charge controller has basic function is that it control the source which is to be active or inactive. It simultaneously charge battery and also gives power to the load. The controller has over-charge protection, short-circuit protection, pole confusion protection and automatic dump- load function. It also the function is that it should vary the power as per the load demand. It add the both the power so that the load demand can fulfill. And when power is not generating it should extract power from battery and give it to theload.

E. Battery Bank.

We have to choose battery bank size per the load requirement so that it should fulfill the requirement of load for calculating the battery bank size we need to find following data

1) Find total daily use in watt-hour(Wh).

2) Find total back up time of the battery

For increase in battery bank size we need to connect cell in series so that we can get the larger battery bank size.

F. Inverter.

We have to choose greater rating inverter than the desired rating .The pure sign wave inverter is recommended in other to prolong the lifespan of the inverter. Inverter is need to convert DC power into AC power. As our load working on the AC supply so we need to convert DC power. The input voltage Output voltage and frequency, and overall power handling depends on the design of the specific device or the circuitry. The inverter does not produce any power. The power is provided by the DC source.

IV. CALCULATIONS FOR PRAPOSED SYSTEM.

The total power generated by this system may be givenas the addition of the power generated by the solar PV panel and power generated by the wind turbine.

Mathematically it can be represented as,

$P_T = N_W * P_W + N_S * P_S + N_T * P_T$.

where,

P_T is the total power generated.

$p_W$is the power generated by wind turbines.

P_S is the power generated by solar panels.

$_W$ is the no of wind turbine.

$_S$is the no of solar panels used.

N_T is the no of Thermal power plants used.

PT is the power generated by thermal power plant.

A. Calculations for wind energy

The power generated by wind energy is given by, Power = (density of air * swept area * velocity cubed)/2

$P_W = ½. \rho (A_W) (V)^3$

Where,

P is power in watts (W)

ρ is the air density in kilograms per cubic meter (kg/m³) A_W is the swept area by air in square meters (m²)

V is the wind speed in meters per second (m/s).

B. Calculations for solarenergy

To determine the size of PV modules, the required energy consumption must be estimated. Therefore, the power is calculated as

$P_S = Ins(t) * A_S * Eff(pv)$

Where,

Ins (t) = isolation at time t (kw/ m^2)

A_S = area of single PV panel (m^2)

Effpv = overall efficiency of the PV panels and dc/dc converters.

Overall efficiency is given by,

Eff(pv)= H * PR

Where,

H = Annual average solar radiation on tilted panels.

PR = Performance ratio, coefficient for losses.

C. Calculations for Thermal power

Plant load factor (PLF) = Generation achieved in month x 100 possible generation in month

Availability factor (AF) = (Actual running hours x 100)/(possible running hours).

Loading factor= PLF/ (Availability).

Specific Coal Consumption= Coal Consumption/Generation.

Specific oil Consumption= oil Consumption/Generation.

Deemed Generation= Generation + Back down.

Deemed PLF = (Generation + Back down)/ possible generation.

Heat rate =(Weighted average CV of coal x Coal Consumption +

Weighted avrage CV of coal x oil Consumption)/ Generation x 100

D. Cost for total Integrated Power Generation System.

The total cost of the solar-wind hybrid energy system with conventional source (Thermal) is depend upon the total no of wind turbines used and total no of solar panels used and the initial cost of the base thermal plant. Therefore the total cost is given as follows

Total cost=(No. of Wind Turbine * Cost of single Wind Turbine)

+ (No. of Solar Panels * Cost of single Solar Panel)

+ (No. of Batteries used in Battery Bank * Cost of single Battery) + Initial cost of the Thermal power plant.

$C_T = (N_W * C_{WT}) + (N_S * C_{SP}) + (N_B * C_B)$

+ (NT*CIC).

Where,

C_T is the total cost in Rs.

C_{WT} is the cost of single wind turbine in Rs .

C_{SP} is the cost of single solar panel in Rs.

C_B is the Cost of single Battery in Rs.

N_W is the number of wind turbine used.

N_S is the number of solar panels used.

N_B is the number of Batteries used in Battery Bank.

NT is the no. of thermal plants.

CIC is the initial cost for each thermal plant'.

Solar-wind hybrid energy systems needs only initial investment. It will compete well in generation with the conventional energy sources(Thermal power plant). When accounted for a lifetime of reduced or avoided utility costs. The cost of the system depends on the system chosen, wind resource on the site, electric costs in the area, and the battery. For minimize the cost of the system we need to increase the use of non conventional energy sources. So that production of solar and wind power generator will be increase. That will reduce cost of the whole system.

V. CONCLUSION

The integrated power generation system is good and effective solution for power generation which will reduce stress on the existing conventional power plant. It has greater efficiency. It can provide to remote places where government is unable to reach. So that the power can be utilize where it generated so that it will reduce the transmission losses and cost. Cost reduction can be done by increasing the production of the equipment. People should motivate to use the non conventional energy resources. It is highly safe for the environment as it doesn't produce any emission and harmful waste product like conventional energy resources. It is cost effective solution for generation. It only need initial investment. It has also long life span. Overall it good, reliable and affordable solution for electricity generation.

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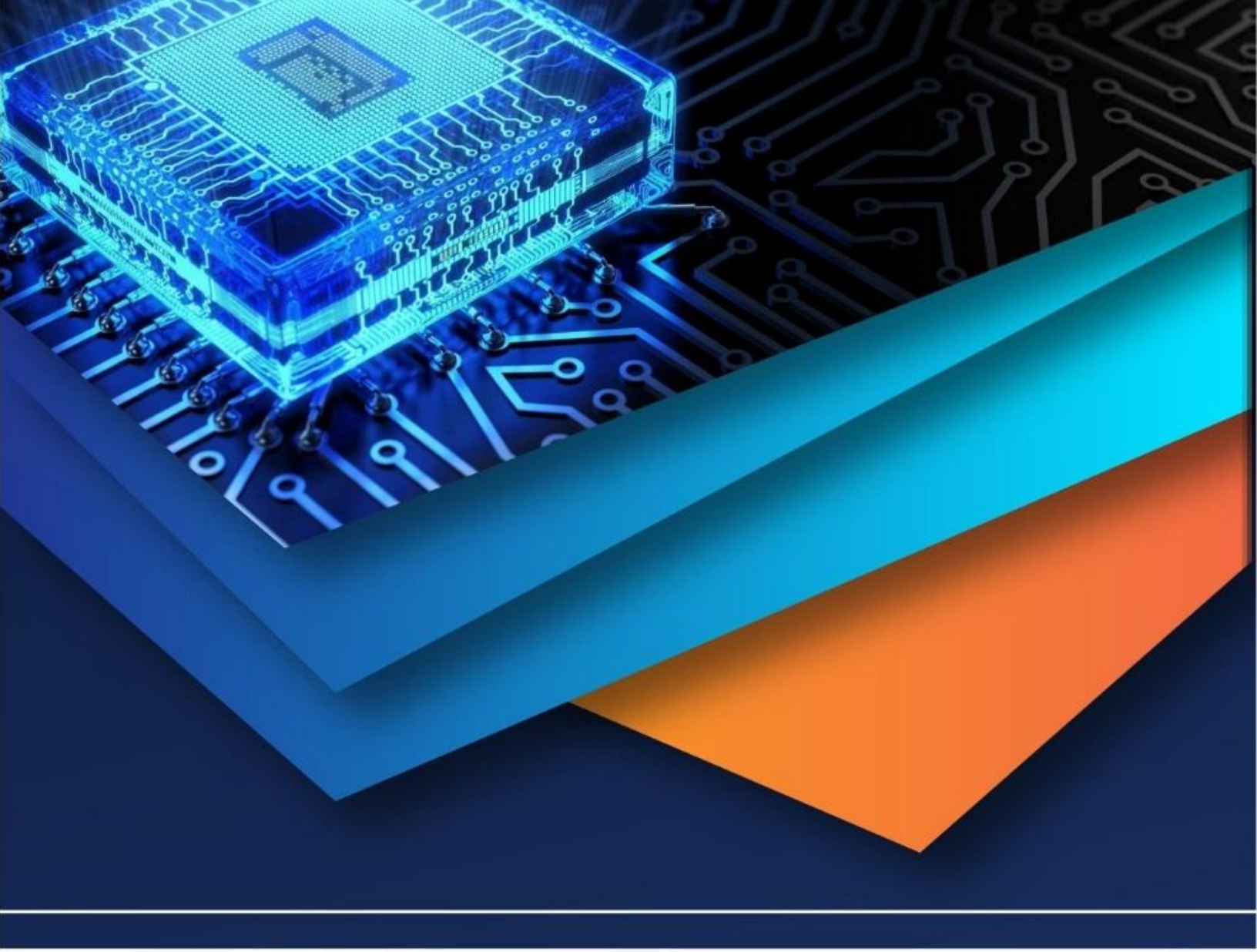

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