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HYBRID POWER PLANT VIA SOLAR AND WIND ENERGY RESOURCES

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ABSTRACT

As the population is increasing day by day, the demand of electricity is also increasing. The non-renewable resources are decreasing day by day, that's why we have to use the renewable resources on the place of non-renewable resources. For that purpose, two energy resources are combined which are wind and solar energy which makes the hybrid energy. [1] ***By this method we can produce the energy without damaging the nature or environment. The hybrid power is beneficial as it gives uninterrupted supply of electricity. This system includes two energy resources for generation of electricity, the first one is solar energy which converts the radiant energy of sun into electricity and another one is wind energy which converts the kinetic energy of wind into usable electrical energy. The generation of electricity by using hybrid energy is in reasonable cost. In this paper, we are going to discuss about generation of electricity by hybrid energy via solar and wind energy.*** [2]

Keyword: - hybrid, solar energy, wind energy, renewable energy, radiant energy.

1. INTRODUCTION

Electricity is very essential in our day to day life; either it is generated by renewable energy resources or non-renewable energy resources. As population increasing day-by –day, demand of electrical energy is also increasing, for that purpose we need to generate the electricity. The conventional method of generating electricity is by using non-renewable resources such as coal, diesel, petrol, etc. [1] there are so many disadvantages of using this method for generating electricity. For e.g. in the first method, we use coal for generation of electricity which produces fumes and so many gases which are very harmful for the environment and for human beings. In the next method we use chemicals for generation of electricity which are very harmful. All these wastage from the coal power plant and nuclear power plant are very harmful for human beings, and handling of all these wastage is very expensive. This non-renewable energy are decreasing day-by-day. In some years, this non-renewable energy will be fade away completely. So for that purpose we need to use any alternating method for these. The source which we are going to use it must be economical, pollution free, etc. the renewable energy resources are good alternative for the non-renewable Energy resources.

There are so many renewable energy resources which are used for generation of electricity such as wind energy, solar energy, geothermal energy, biomass, tidal. The tidal and geothermal are the one which needs some special spaces for generating electricity and some new method is needed to be used for extracting energy from the earth heat. On the other hand, the wind and solar energy are the most reliable and easily available from the nature. These two energy sources i.e. solar and wind are best alternative for the non-renewable energy resources. There is one disadvantage point of using solar energy is that it doesn't produce electricity in cloudy days and in rainy season, for that purpose we use two energy resources as a hybrid energy resources in which whether one source can't generate energy then the other one will produce electrical energy.[2]

1.1 Hybrid energy system:

The hybrid energy system is the one which uses two energy resources for generation of electricity, the first one is wind energy and second one is solar energy. The wind energy converts the kinetic energy of wind into usable electrical energy and solar energy converts radiant energy from sun into DC electrical energy and then this DC electrical energy is converted into AC electrical energy by using some electronic circuits. The hybrid system is a combination of two or more renewable energy system as per the geographical location, requirement of

customer, reliability and cost of installation of such type of plant. The hybrid power plant via solar and wind energy are developing very rapidly in some recent years. Solar energy and wind energy resources are irregular source of energy, for that purpose storage system are used. Solar and wind are combined to form hybrid system, that's why they strengthen and support each other regularly. Wind blows all the time whereas the sun does not shine in the night. [4] Hybrid energy system is one type of standalone system and its output is based on some factors such as the speed of the wind, climate and the solar radiation by the sun. The hybrid power plants are the alternate source of energy on the place of conventional power plants such as thermal power plant, diesel power plant, and other non-renewable energy sources plants.

1.1.1 Location for hybrid power plant:

The location where the hybrid power plant is to be located is totally depend on the solar energy potential and wind energy potential. The site for this power plant is located where these resources are mostly available. The site selection for hybrid power plant via solar and wind is very important and complex decision-which makes so many problems such as the factors like wind and solar energy resources.

1.1.2 Solar energy:

Solar power is a non-vanishing source of energy in the world which is renewable one and it is very friendly with the environment and it is produced by the solar radiation of sun. In Today's world, electrical energy is the essential one and production of energy from solar system is very important. The Solar power is generated based on the application of the system such as industrial, commercial and in residential areas. The solar power is very effective and free from the environmental pollution. In recent years, the amount of renewable energy is depleting rapidly. The solar energy is becoming an economical and important in recent years as well as in coming year. This technology is better than any other technologies as per the cost and the application area of this system. The benefit of the solar power generation is that it generates solar power directly from the sun, for that purpose it uses the photovoltaic effect of photovoltaic cells. [7] Solar power is the conversion of sun radiation into electricity through the use solar photovoltaic cells. This conversion takes place in the solar cell by the photovoltaic effects. As said by experts that the amount of solar energy reaching the earth is more than the 10000 times the current energy consumption by man. Solar energy is the one which is given by the sun in the form of radiant energy. The radiation of sun is converted into usable DC electrical energy, and then it is converted into AC electrical energy by using electronic circuits. Solar energy is one of the renewable resources which is freely available and pollution free that means it doesn't produce any type of gases that's why it is not harmful for the environment and for human beings. The biggest drawback of using this energy is that it doesn't produce energy in cloudy days and in rainy seasons as well as in bad weather condition. We need invest in this then there are so many benefits of it. Its life is long and there is no emission of it.

There are two types of solar energy system;

a. Solar photovoltaic system
b. Solar thermal system.

In our project, solar photovoltaic system is used for the solar power generation. The photovoltaic system converts the solar radiation of sun into electrical energy via different technology. The most usable panels are silicon panels which produces current when the sun shines upon it. The solar photovoltaic system is majorly applicable in rural areas where it is prohibitively costly to supply the electrical power from the utility grid.

1.1.3 Wind energy:

Wind turbine are the one which generates electrical power that uses the energy of wind for generating the clean and pollution free energy for the consumers such as farms, domestic purpose, for industrial and commercial purpose. This is the technologies which produce power individually and help to protect the environment from other emissions and because of this the other energy charges are also less. [4] Wind energy is the one which produces electrical energy from the kinetic energy of wind, for that wind mills are to be installed. This is one of the renewable energy resource, which is available at affordable cost and also the maintenance of this plant is very less so maintenance cost is also less. [2] It generates electricity 24 hours of the day. As the wind is renewable resource, it doesn't emit any type of gases, fumes, etc. so it is also a pollution free energy. The initial cost of it is somehow less. The generation of electricity is totally depends on speed of the wind. Whether the speed is high then the generation of electricity will be greater and if the speed is less, in that case the generation will be lesser. When the wind turbine produces energy, then the output of the turbine matches with the utility grid and then fed to homes for utilization purpose. As the wind speed increases, the output from the wind turbine also increases as this both quantities are directly proportional to each other. Because of the generation of electricity by the wind turbine the energy charges/ utility bills are reduced by 50 to 90%. [4]. the biggest drawback of using

renewable energy resources separately is that in some conditions it can't produce electricity. This drawback can be filled by using these energy resources together. As we use solar and wind energy for generation of electricity. So at a time, one source of energy is used for generation of electricity and another one is used as a standby. Because of this the initial cost is increased. But there are so many advantages after this installation such as low maintenance cost, it is environment friendly, efficiency of this plant is much more than another one, life span is also better than other plants and also the main it gives the continuous power supply.

There are two types of wind turbine,

a. Horizontal Axis Wind Turbine
b. Vertical Axis Wind Turbine

In our project, Horizontal Axis Wind Turbine is use for the generation of electricity. The blades of Horizontal Axis Wind Turbine are look like a propeller shape and spins on Horizontal axis. The assembly of turbine and generator is at the top of the tower and the blades of the turbine are pointed towards the direction of wind. [4] Whether the blades are not in the direction of wind then this are get towards it by some mechanism such as yaw control. There are so many control mechanism used for the Horizontal Axis Wind Turbine. The wind turbine uses gearbox assembly for increasing the rotational speed, as required for the generator because the wind speed is not so high and the generator need 1500 rpm for generating electricity for that purpose the gearbox assembly is used.

1.2Execution of hybrid power plant:

The solar energy and wind energy came together and then this hybrid energy is fed for utilization purpose.

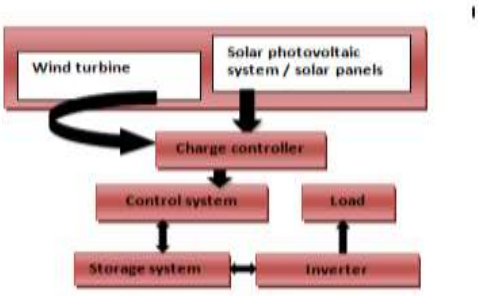

Fig-1 Execution of hybrid power plant

The main components of hybrid power plant are as follows,

1. Wind turbine.
2. Solar photovoltaic cell/ solar panel.
3. Control system.
4. Charge controller.
5. Storage system.
6. Inverter.

Hybrid power plant is very reliable, has high efficiency, has less emission of gases and fumes and the cost is also less.

1.2.1 Wind turbine:

There are two types of wind turbine,

a. Horizontal axis wind turbine.
b. Vertical axis wind turbine.

The kinetic energy of wind is converted into electrical energy. Generally horizontal axis wind turbine is used for generation of electricity. The generation of electricity is totally depends on the speed of the wind. Wind is not constant, it is a fluctuating medium. Because of this we need to store the energy first and then remove its fluctuations, and then supply it to the load.

1.2.2 Solar photovoltaic cell/ solar panel:

The sun is very important source of renewable energy. Solar panels are made up of photovoltaic cell; these photovoltaic cells are used to convert the solar radiation into DC electrical energy. The photovoltaic cells are made up of semiconductor material. Mostly the silicon is used for making these solar panels. When the sun shines, these

solar panels absorb the radiation from sun and then convert it to the electrical energy or in the form of heat. [3] The solar panels are made up of arrays and modules which are connected in series and parallel connections

1.2.3 Control system:

Control system of hybrid power plant is done by adjusting the amount of voltage or electric current based on the need of the battery charging. The making of control system needs some software and hardware. Some of the main components are ATMEGA 16 micro-controller and voltage sensor. The control system that has been made is tested by monitoring the voltage and current during the control process. The test result shows that the control system that has been made is able to work properly in controlling the input voltage from the source and larger voltage on the battery. [6]

1.2.4 Charge controller:

The function of the charge controller is to control the system whether it is active or inactive. This is the device which does the work of charging the battery and to supply the electricity to the load. The overall protection of the system is in the charge controller such as short circuit protection, over charge protection and also the automatic dump load protection. The power from wind and solar is combined in the charge controller and then it is fed to the load. So we get the uninterrupted power supply. If any of the system does not work then it collects the supply from the battery bank and then it is supply to the load. A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against overvoltage, which can reduce the battery performance or lifespan and pose a safety risk. It may also prevent completely draining ("Deep discharging") a battery, or perform controlled discharges depending on the battery technology, to protect battery life.

1.2.5 Storage system:

Hybrid power plants often contain renewable energy components (such as PV) that is balanced via second form of generation or storage such as a diesel generator set, fuel cell or battery storage system. They can also provide other forms of power such as heat for some applications. Storage system is the one in which the energy is stored. In the storage system battery banks are used. This battery banks are selected as per the load requirement. As the load goes on increasing then we need to increase the size of the battery banks by connecting cells in series or in parallel. For selecting battery set, firstly we need to calculate the load on the line i.e. how much the load can consume in one day and the backup of the battery set. [6]

1.2.6 Inverter:

Inverter is the device which converts the DC electrical power into AC electrical power. This is very important component in hybrid power plant. As we know, we highly required the AC electrical power than DC electrical power. AC electrical power is fed to utility grid. So for that purpose the inverter is needed. The size of the inverter must be high than its usual rating because to increase the life span of the inverter. The voltage which is supplied to load is totally depends on this device. The input voltage, output voltage and frequency and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC Source. The power inverter can be entirely electronic or may be a combination of mechanical effects and electronic circuitry. Static inverters do not use moving parts in the conversion process. 12 V DC as an input for smaller consumer and commercial inverters that typically run from a rechargeable 12V lead acid battery.

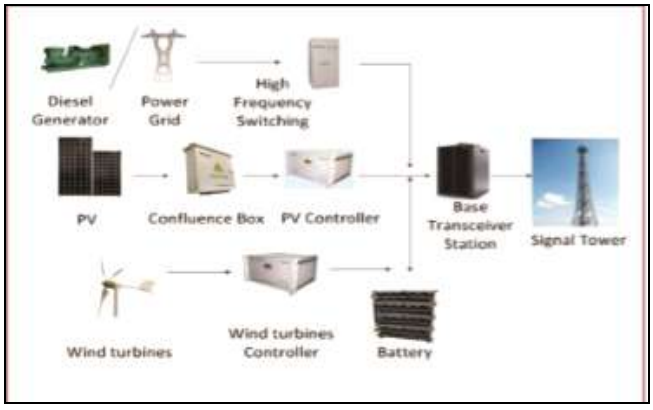

Fig-2 Hybrid power generation system

2. PROPOSED METHODOLOGY

The components required for the hybrid power plant:

1. 1x CD4047 IC
2. 2x N channel MOSFET (75N75 or IRFP3205)
3. 2X 220 Ω Resistors
4. 1X 14 PIN BASE
5. 1X 10K Variable Resistors
6. 1X 0.1µF Non-Polar Capacitor
7. 1x 1000 µF 25V CAPACITOR
8. 2X 10KΩ Resistors
9. 1X 2 PIN terminal block optional
10. 1X 3 PIN terminal block optional
11. 2X Heat Sink
12. Piece of Vero board
13. Jumper wires
14. 12V-0V-12V Transformer

The hybrid power plant involves two energy resources, one is solar energy and another is wind energy. When the power from both the energy resources is generated then it is stored in batteries and then it goes for the utilization purpose.

2.1 Power generation from solar energy:

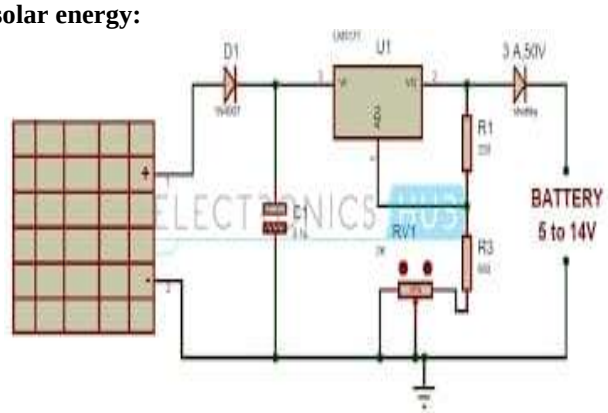

Fig-3 Solar charger circuit

The above figure is of solar charger circuit. The circuit is used for charging the rechargeable lead acid battery by the solar panel. This solar charger has current and voltage regulation and also has over voltage cut off facilities. This circuit may also be used to charge any battery at constant voltage because output voltage is adjustable. The solar radiation by the sun is absorbed on the solar panel. And then this solar radiation are converted into DC electrical energy and stored in the Battery chargers. Here the solar panel produces 12 V DC. The charging current passes through LM317 voltage regulator through diode D1. The output voltage and current are regulated by adjusting the adjust pin of LM317 voltage regulator. Solar panel consists of 1.2V rated solar cells. Pot RV1 is used to set the output voltage to the battery. Diode D2 prevents the discharge of battery. In this the power is limited because of thermal resistance of LM317 voltage regulator and the heat sink. To keep the temperature below 125 Degree Celsius, the power must be limited to 10 W. LM317 voltage regulator internally has temperature limiting circuit so that if it gets too hot then it shut downs automatically. In this circuit, C1 capacitor protects from the static discharge. Diode D1 protects from reverse polarity and the voltage regulator IC provides voltage and current regulation.

The specification of solar charger circuitry:

a. Solar panel rating: 20W (10V)
b. Voltage output range: 5 to 14 V.
c. Maximum power dissipation: 10W
d. Typical drop out valve: 2 to 2.75 V (depends on load current)
e. Maximum current: 1.5A (internally it limited at 2A).
f. Voltage regulation: +/- 100mV

2.2 Power generation by wind energy resource:

A wind turbine works the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity. Wind is a form of solar energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and the rotation of the earth. As the wind passes through the blades of the wind turbine, the kinetic energy of the wind is converted into the electrical energy. The generated AC electrical energy is rectified by the rectifier circuit and then provide to battery charger for storing the energy. Then from the battery charger the DC electrical energy is supplied to Inverter circuit. CD4047 is a low power IC capable of operating in either in a stable or mono-stable mode. Here it is wired in a stable mode. It works by charging a capacitor (C2) through a resistor (RV1) as in every a stable multi-vibrators. Variable resistor (RV1) is provided for adjusting the output frequency to exact 50Hz.

The time period of the oscillation is given by,

$$T = 4.40*R*C.$$

CD4047 has two outputs (pins 10 and 11) which are complementary to each other. These square wave pulses are pre amplified by TIP122 transistors. This amplified current is used to switch 2N3055 transistors to drive the inverter transformer. Two 2N3055 transistors are connected in parallel to increase the current driving capabilities. The zener diode ZD1 and capacitor C2 is used to provide constant 9V for the IC. When output at pin 10 is low, pin 11 will be high, Q1 turns on, current starts flow through the upper winding of the transformer and we will get positive half cycle output. When the output at pin 10 is high, pin 11 will be low Q2 turns on and current starts flow through the lower winding of the transformer and we will get negative half cycle output. This circuit is only preferred for the resistive loads such as bulbs, for driving inductive load, it is better to use pure sine wave inverters. For the inverter transformer, use a normal 12-0-12 transformer; use its secondary as a primary and primary as a secondary. If you don't get a10A transformer, use a 5A instead provided that the maximum power output decreases proportionally.

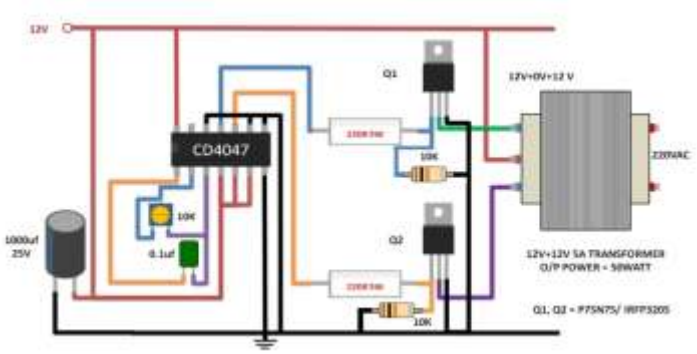

Fig-4 wind energy conversion

2.3 Power generated by both solar and wind energy resources.

The basic idea behind the idea of our project is to design a simple, energy-converting windmill that can take incoming wind energy and convert it to electrical energy as well as solar energy that can take incoming solar radiation from suns energy and convert it to electrical energy. Our goal was to get the device to put out enough electric volts to light a small light bulb. The device was to be made from readily available materials to minimize costs and if money was to be spent on the project. We were encouraged to use readily available materials to save costs and completely build the windmill out of scratch and minimize the time spent as much as possible

3. RESULT:

Calculations:

$P_T=N_W*P_W+N_S*P_S$

P_T= total power

N_W=number of wind turbine

P_W= power generated by wind turbine

N_S= number of solar panels.

P_S= power generated by solar panels.

$P_w = V_w*I_w =7*1.5=10.5$ W

$P_s = V_s * I_s =10*2=20$ W

$P_T = N_W*P_W+N_S*P_S = 1*10.5+1*20= 30.5$

3.1 Advantages of hybrid power plant:

1. Fuel saving up to 50%
2. Lower atmospheric contamination.
3. Saving in maintenance.
4. Silent system.
5. Connection to other supplies.
6. It is portable.

3.2 Application of hybrid power plant:

1. Used in commercial installation.
2. Used in industrial installation.
3. Used in domestic installation
4. Used in remote rural installation.
5. Used in small commercial installation.

Our project is applicable for the loads such as resistive bulb, inductive loads, and mobile charger. Our project is small so its output is also less. So we have connected a small bulb and the socket for charging the mobile.

4. CONCLUSIONS

The overall world is concern about the security and the sustainable developments in the generation system. For that purpose the renewable energy is the most significant. For developing the world, we have to come out from the non-renewable energy resources and we must involved new technologies such as renewable energy and the more energy efficient technologies. Hybrid power generation system is one of the most effective methods of generation of electricity. The efficiency of this plant is more than the conventional methods. Because of this system we can supply electricity on remote areas also where the grid/government cannot be connected. Because of this technology the transmission losses are reduced that's why the overall cost is also reduced. Everyone must use the renewable resources, it is very safe and environment friendly as it doesn't produce any type of gases and not also the nuclear waste. The hybrid power generation system only needs the initial investment. The use hybrid power generation via solar and wind is increasing day-by-day. Some difficulties arise in this system, so for that purpose new researches are going on.

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