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Hybrid Power Generation Using Smart Highway

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ABSTRACT : In today's technology driven world electricity is one of the foremost things for our day to day life activities. As we all are oblivious of the fact that renewable sources of energy are depleting at a lightning fast rate. So it's time for us to shift the focus from conventional to non-conventional sources of energy to produce electricity. The output of the electricity produced by non-conventional sources is less than their counterparts. Renewable sources do not have any detrimental effect on the environment. Solar-wind hybrid system is basically an integration of solar plant and a wind energy plant. It will help in providing the uninterrupted power supply. As during bad weather conditions, the production can be shifted from one plant to another with the help of a microcontroller. Wind pressure from moving vehicles rotate blades of windmill and then utilizes to generate electricity.

KEYWORDS: Solar Energy, Wind Energy, PV Cell, Renewable Energy, Hybrid Power System, Electricity

I.INTRODUCTION

On highways, vehicle moves faster than the usual. Moving vehicles on the highway create wind turbulence. When a vehicle moves on highway, it disturbs the wind present over that highway. Vehicle creates low wind pressure field and big vertex behind it while moving. The wind disturbed by the vehicle intend to cover that space created by the moving vehicle and creates huge wind turbulence at highways. The direction of the wind turbulence is always moving along the vehicle to the centre of low pressure field. Turbulence presents at the highways along with normal breeze creates a strong wind effect near the highways. This wind effect can be easily feel by any one on the highway side.Wind turbulence at the highways is directly depends upon size and speed of the automobile along with the traffic frequency.

For highway side application, wind turbine should have capability to utilize moderate wind speed. For this purpose, it needs to have high initial torque for initial starting and high rotational capability for high wind speed. All these parameters can be obtained by the combination of two VAWT turbines- Savonius and H type Darrieus Turbine. They work on two different phenomenon Drag and Lift phenomena. Savonius has S like shaped blades, this work on the drag force which acts parallel to the direction of wind flow. Alongwith the wind turbine we have also coupled solar plate on the roof. This will convert the light energy received from the sun into electrical energy and this energy will be stored in the battery.

II. ENERGY RESOURCES AND TYPES

ENERGY RESOURCES ARE CLASSIFIED INTO NON-RENEWABLE AND RENEWABLE RESOURCES.

A. Non-renewable Energy Resources

Non-renewable energy resources are the ones which are limited and become extinct with the time , such as oil, coal and coal derivatives, natural gas, wood and radioactive material (uranium,plutonium) and also produces a lot of harmful waste.

B. Renewable Energy Resources

Renewable energy resources are the ones that are continously available and renewing itself with the time. Industrialization and ever increasing world population need the use of renewable energy resources. Solar energy, wind energy, biomass, tidal energy, wave energy, geothermal power are popular.

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1) Wind Power

The wind energy is a renewable source of energy. Wind turbines are used to convert the wind power into electric power. Electric generator inside the turbine converts the mechanical power into the electric power. Wind turbine systems are available ranging from 50W to 3-4 MW.

The energy production by wind turbines depends on the wind velocity acting on the turbine. Wind power is able to feed both energy production and demand in the rural areas. It is used to run a windmill which in turn drives a wind generator or wind turbine to produce electricity. Practically it is observed that the flexible three blades propeller about 40m in diameter, in a 62 Km/hr wind pressure with a rotation speed of 48 rpm produce maximum power 14 MW. For small wind power generation system, multiple blade type (3 - 5 number of blades) or Darrieus type (Curved Blade 3 - 5 numbers) is y suitable. The main drawback of this system is that as the wind speed or velocity is not constant with respect to time i.e. fluctuating, hence the electric power thus obtained is alsodoes not have a fixed value i.e. varying nature. Thus, it is better to feed the wind electricity to the battery or any power storage device which supply the load consecutively, rather than directly supply to the load as shown.

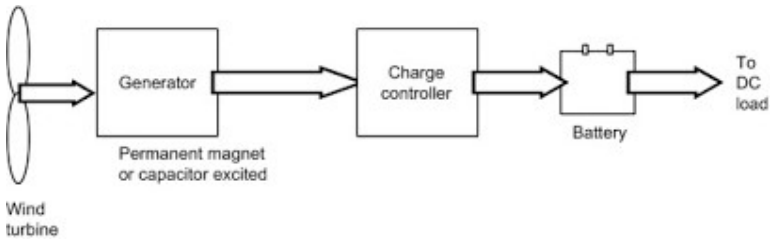

Fig1: Block Diagram of Wind Power Generation

In wind power system, the power generation increases in proportion to the cube of the wind speed. Thus it is highly affected in rainy and stormy season when the wind speed is too less to produce electricity. This power generation system is pollution free and ecologically balanced. .

2.Photovoltaic Solar Power

Solar panels are the medium to convert solar energy into the electrical energy.Solar panels can convert the energy directly or heat the water with the induced energy. PV (Photo-voltaic) cells are made up from semiconductor structures as in the computer technologies. Sun rays are absorbed with this material and electrons are emitted from the atoms .This release activates a current.Photovoltaic is known as the process between radiation absorbed and the electricity induced. Solar power is converted into the electric power by a common principle called photo electric effect.

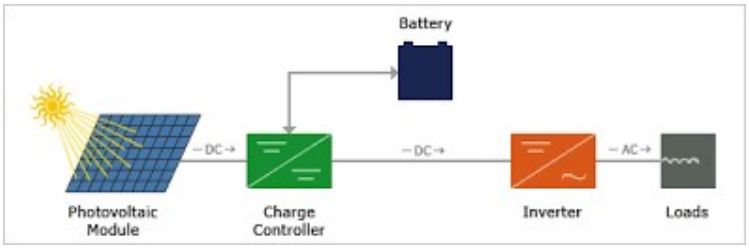

Fig2: Basic Solar (photovoltaic) system

The solar cell array or panel consists of an appropriate number of solar cell modules connected in series or parallel based on the required current and voltage.

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Storage batteries as shown in Fig. 2 provide the backup power during cloudy weather to store the excess power or some portion of power from the solar arrays. This solar power generating system is used for domestic power consumption, meteorological stations and entertainment places like theatre, hotel, restaurant etc.

Traditional p-n junction solar cells are the most convinient of the solar energy harvesting technologies. The basic physics of energy absorption and carrier generation are a function of the materials characteristics and corresponding electrical properties (i.e. band gap). A photon only need greater energy than 2eV that of the band gap in order to excite an electron from the valence band into the conduction band. However, the solar frequency spectrum approximates a black body spectrum at ~6000 K, and as such, much of the solar radiation reaching the Earth is composed of photons with energies greater than the band gap of silicon . These higher energy photons will be absorbed by the PV cell, but the difference in energy between these photons and the silicon band gap is converted into heat rather than into usable electrical energy. For a single-junction cell this sets an upper efficiency of ~20%. The current research path of implementing complex, multi-junction PV designs to overcome efficiency limitations does not appear to be a costeffective solution. Even the optimized and developed PV materials are only operational during daylight hours and require direct (perpendicular to the surface) sunlight for good efficiency.

III. METHODOLOGY

FIG 3: SCHEMETIC DAIGRAM OF WIND SOLAR GENERATION

Green energy like solar energy, vibration energy, wind energy can be converted into electricity and then we can use this electricity in many applications on highways such as for charging the vehicles using these energies, for lighting, and for monitoring the condition of the road etc. Vibration produced by vehicles can be converted into electricity and further can be used for charging the electric cars or for lightning the street lights, or can be stored in any charge storing devices. There is abundant amount of free space available between lanes and in both right and left side of lanes, which can be utilized by placing windmills and solar plates. Solar plates can also be mounted on the top surface of cars and electricity generated by them can be utilized for operating music system, air conditioner, or for any other purpose in cars. It can also be stored in any charge storing device for future use. There are streets having very less traffic in night and street lights are lightning empty roads for entire night i.e. completely wastage of electricity . So by using sensors and led, lights can be turned on only when any vehicles or passenger passes by road otherwise turned off. Fuels consumed by vehicles like petrol, diesel etc. produces harmful gases so its substitute like hydrogen cars, electric cars, or any other source of green energy must be used.

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IV. DESIGN OF HYBRID ENERGY SYSTEM

For desing of the hybrid energy system we need to find the data as follows

A. Data required for Solar System:

1. Annual mean daily duration of Sunshine hours
2. Daily Solar Radiation horizontal (KWH/m2/day)

B. Data required for Wind System:

1. Mean Annual Hourly Wind Speed (m/sec)
2. Wind Power that can be generated from the wind turbine

This system consists of following main components;

i. Solar panel

Solar 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 electronproton 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.

ii. Wind turbine

Wind turbine is that system which extracts energy from wind by rotation of the blades of the wind turbine. Basically wind turbine has two types one is vertical and another is horizontal. 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.

iii. 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 dumpload 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 the load.

iv. 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.

v. 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. or the circuitry. The inverter does not produce any power. The power is provided by the DC source.

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V. CONCLUSION

Hybrid power generation system is good and effective solution for power generation than conventional energy resources. 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.Wind is a cost effective, green, renewable energy resource for power generation. Highway side application of wind turbine with improved efficiency can help us to reduce a gap between demand and supply of power. An efficient hybrid wind turbine is designed to use in road side application for energy generation. This turbine is specially designed to generate energy by utilization of natural wind and wind turbulence created by the moving vehicles on the highway. Winds from all the direction are utilized by this turbine. This turbine is self-starting, easy to installation, low in cost and suitable for both high and low wind speed. Turbines show 2.75 and 1.57 times better efficiency than the Savonius and Darrieus turbines respectively.

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