Highway lighting by use of wind turbine and solar energy

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***Abstract*—The present work reviews the use of wind turbine and solar energy in highway lighting. The vertical axis wind turbine along with solar cell gets installed on the divider provided between two lanes of highway. When the vehicle passed on the highway it produces a considerable amount of air blow due to its high speed typically in range 90-110 km per hour. This air tangentially strikes on the blade of the vertical axis wind turbine and its makes a rotation of the turbine in only one direction. The solar system is coupled to vertical axis turbine to generate electrical energy and also installed in a way that it diverts the vehicle air towards the turbine. The generator with the gear mechanism is connected to the shaft of the vertical axis wind turbine to generate electricity. The electrical output of vertical axis turbine and the solar system is stored in a battery. This stored energy which can be further used for street lighting, toll gates, etc. purposes on highway to lessen dependence on the main supply grid.**

***Key words*—Vertical axis wind turbine, Renewable solar energy, Highway, Battery.**

I. INTRODUCTION

Energy is the key for the development of a country. First world countries have large amount of energy so that they made revolutionary change in every sphere of their countries. In India, conventional sources especially oil, natural gas and coal are greatly contributing to the power generation. But the conventional sources are depleted day by day. So, it may be wiser to increase the power generation using the renewable energy sources [1-3]. The demand of electricity supply increases over day by day due to modern civilization and industrialization. Mostly the electricity produced by use of fossil fuel like as coal, gas etc. in thermal power stations. The fossil fuel play a major role in production of carbon dioxide which is responsible for global warming, a greenhouse gas, etc. currently 67 percent of the electrical energy produced by the thermal power plant and remaining 23 percent included hydropower plant, nuclear power plant, gas power plant and as we realized the fossil fuel is finished in one day. Solar and wind both are renewable energy sources. Solar energy available begins of day and the wind energy is maximum on the highway due to the speed of the vehicle [4-7]. The motivation of the present study contributes the global trend toward clean energy. The main motive behind this study is to use a vertical axis wind turbine effectively for highway power generation for lighting by application of the wind to generate energy by the vehicle speed. So the maximum wind energy can be extracted by the vertical axis wind turbine as compared to the horizontal axis wind turbine. In vertical axis turbine we twisted the blade of the turbine to gain maximum spin on low pressure of the wind at the same time try to achieve less vibration at gear moment .This turbine works under all the environmental condition and cyclone also. The design of the blade enables the turbine to rotate in both clockwise and anticlockwise directions. The arrangement of solar plats is in such a way that they divert the vehicle air towards the turbine for effective use of vehicle air. The solar system generates the electrical energy by sun radiation in day mode and from vehicle headlight during night mode the generated electrical energy we can use street lighting, toll gates etc.

II. WORKING OF WIND TURBINE

In its simplest form it is essentially two cups or half drum fixed to a central shaft in opposing direction. Each cup or drum catches the wind and so turns the shaft, bringing the opposing cup or drum into the flow of the wind. This cup or drum then repeats the process, so causing the shaft to rotate further and completing a full rotation. This process continues all the time wind blows and turning of the shaft is used to drive a pump or small generator. The wind speed of the turbine is usually measured by the anemometer. Modern design has evolved into fluted bladed device, which have a higher efficiency and less vibration than the older twin cup or drum machine. The vertical axis wind turbine

is used to convert the kinetic energy of wind due to motion of vehicle into mechanical energy. The light weight blade materials (usually mica sheet) are used for making the vertical axis wind turbine. The height of blade is approximately 1 meter and width of blade is 1/3 meter. The whole turbine is assembling with collar and blades which is fitted by nut bolts. To achieve the unidirectional motion of the turbine the blades are bended by angle curve shape and shaft of the turbine connected to the shaft of generator as shown in Fig. 1.

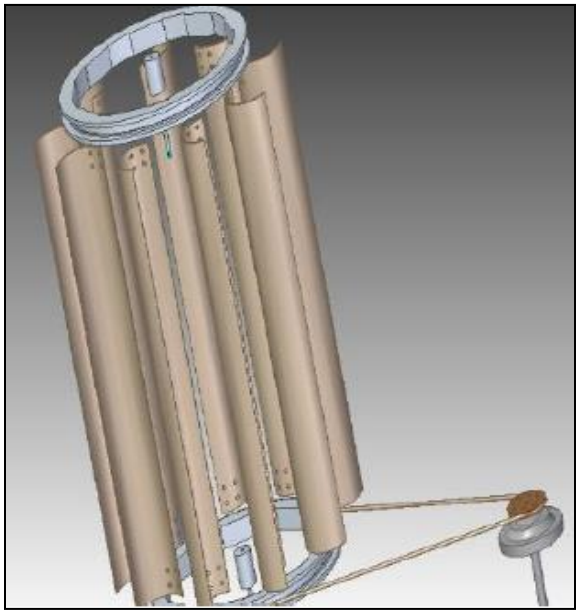

Fig. 1. Working of vertical axis wind turbine.

We strongly recommend having some solar panels besides the turbine. These panels will add more power and easy to install. For this combination of solar panel with turbine, it is suggested to use aero leaf model where median is available. This hybrid system consists of a metallic tree body that contains turbine as well as solar panel. When medians are not available, a solar panel alongside the turbine is suggested. The moving vehicle on highway may be all types such as small or heavy vehicles. Whenever vehicle moves on both side of the highway divider then some pressurized air is produced due to the speed of vehicle. This pressurized air is strike on the blade of vertical axis wind turbine and turbine makes a rotation. The shaft of the vertical axis wind turbine is connected to generator with the help of gear mechanism. The generated electricity is an alternating quantity; the output of the generator is rectified by rectifier and stored in the battery as shown in Fig. 2. The solar system is mounted on besides of the vertical axis wind turbine, the function of the solar system not only generate the electricity but also provides the constant air flow towards the blade of vertical axis wind turbine. The position of solar plates is in inclined nature at an angle 45 degree [8-11].

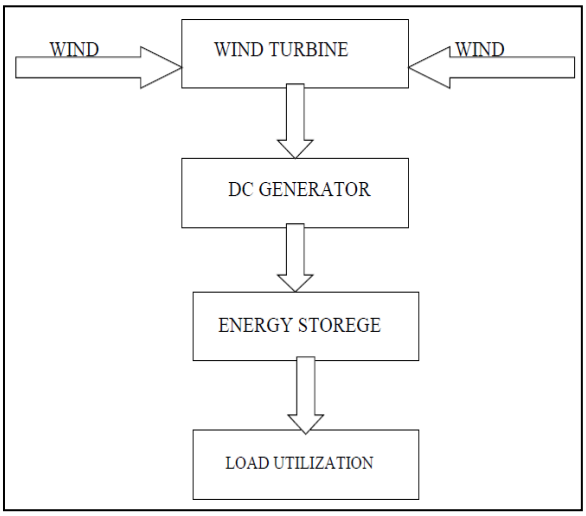

Fig. 2. Layout of power generation by use of wind turbine

A solar cell or photovoltaic cell is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is the physical and chemical phenomenon. It is photoelectric cell, defined as a device whose electrical parameter such as current, voltage or resistance varies when exposed light. Solar cells are the building blocks of photovoltaic modules. The generated electricity is stored in the battery. The stored energy used as a street lighting and domestic purpose [12-17].

The power out of the turbine is given as

$$P_a = \frac{1}{2}\rho A V^3 \; watts \qquad (1)$$

r=Air density (kg/m^3)

A=Area swept by blades of turbine (m^2)

V=Wind velocity (m/s)

The Table 1 below shows the power generation at various wind speeds.

Table 1. Power generation at various wind speeds.

Sr. No.	Wind velocity (m/s)	Power (Watt)
1	3	2
2	4.5	7
3	5.5	15
4	6.5	21
5	7.5	33
6	10	77

The following are the merits of the highway wind turbine system.

- It is a renewable source of energy.
- Wind power systems are non-polluting so it has no adverse influence on the environment.
- Wind energy system avoids fuel provision and transport.
- On a small scale up to a few kilowatt system is less costly.
- On a large scale costs can be competitive conventional electricity and lower costs could be achieved by mass production.
- They are always facing the wind - no need for steering into the wind.
- Have greater surface area for energy capture -can be many times greater.
- Are more efficient in gusty winds – already facing the gust.
- Can be installed in more locations - on roofs, along highways, in parking lots.
- Can be scaled more easily - from mill watts to megawatts.
- Can have low maintenance downtime - mechanisms at or near ground level.
- Produce less noise - low speed means less noise
- The rotor can take wind from every direction.

Major factors that have accelerated the wind turbine highway-power generation technology are as follows:

- High-strength fiber composites for constructing large low-cost blades.
- Falling prices of the power electronics.
- Variable-speed operation of electrical generators to capture maximum energy.
- Improved operation, pushing the availability up to 95 percent.
- Economy of scale, as the turbines is getting larger in number.
- Accumulated field experience (the learning curve effect) improving the capacity factor.

III. CONCLUSIONS

The highway wind turbine system assisted by solar energy is environmental friendly. The working of the same is combined energy source with solar system and vertical axis wind turbine system which is a good and effective solution for power generation, basically this system involves the combination of two energy system, suppose anyone source fails to generate another source will keep generating the electricity and will give the continuous power to the load. The renewable energy sources such as solar and wind energy are used to generate the electricity. If these type of turbine can be installed on long high speed express highways like golden quadrilateral, a considerable amount of electrical energy can be generated , which can solve the issue of energy crisis to a large extend.

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