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Hybrid Energy Generation on National Highway 6,India

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Abstract — *We know that there is enough wind globally to satisfy much, or even most, of humanity's energy requirements – if it could be harvested effectively and on a large scale. In this research work Vertical axis wind turbines (VAWT), are designed to be placed on the medians therefore fluid flow from both sides of the highway will be considered in the design. Using all of the collected data, existing streetlights on the medians can be fitted with these wind turbines. The design of the turbines consists of blades, collars, a shaft, gears and a generator. Additionally, since the wind source will fluctuate, a storage system for the power generated was designed to distribute and maintain a constant source of power. Solar energy begins with sun. Solar panels also known as photovoltaics are used to power electrical loads. Light from the sun is renewable energy resources that provide clean energy, produced by solar panels. In this research work we analyzed and design hybrid energy system for NH-6, near Bardoli, Surat, Guharat, India.*

Keywords- *Hybrid Energy, Wind turbine, vertical axis, small wind turbine, Solar Energy.*

I. INTRODUCTION

Wind energy and solar energy is the fastest growing source of clean energy worldwide. This is partly due to the increase in price of fossil fuels and government incentives. The employment of wind energy is expected to increase dramatically over the next few years. A major issue with this clean technology is fluctuation in the source of energy. There is a near constant source of wind power on the highways due to rapidly moving vehicles. Solar energy is captured by using solar panel. Power generated by solar panel during day time, it is stored to storage system of wind turbine and this hybrid energy is use for the highway lights during night.

II. SCHEMATIC DIAGRAM OF PROPOSED WORK

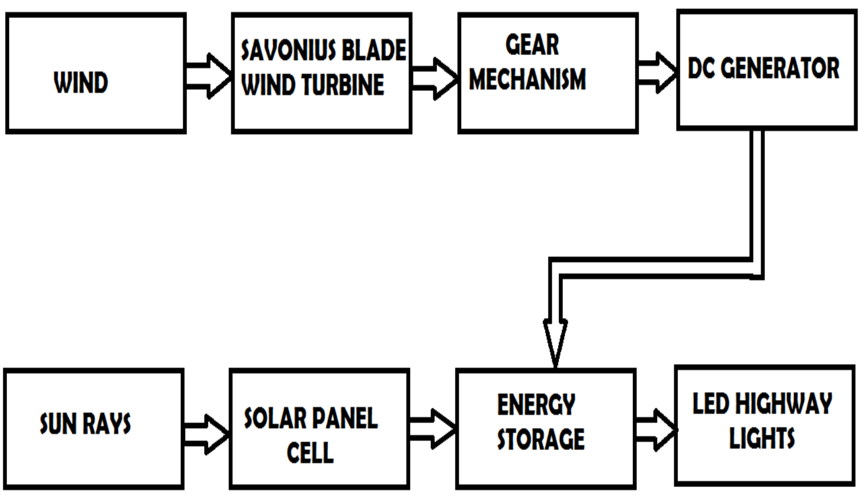

Figure 1. Schematic Diagram

A. Savonius Blade Wind Turbine

The design of Savonius blades are between 20 and 30 inches in diameter. The Savonius scoops must be configured such as in figure 2. The cylinders will be cut in half and one is offset to the center line. In this manner, air entering through one half of as coop will be recycled to the scoop attached to it on the opposite side. Additionally, a second pair of scoops can be stacked on top of the first pair and placed at 90 degrees to avoid the turbine stalling in a certain position. This greatly increases the efficiency of the Savonius components. Using Solid works, it was possible to model the fluid flow through our designed Savonius rotor. Once again the importance of offsetting the hemispheres by 1 radius was demonstrated. As the fluid flows through the inlet, it bounces off the wall and escapes through the outlet. This fluid analysis was completed after the prototype was built confirming the theory.

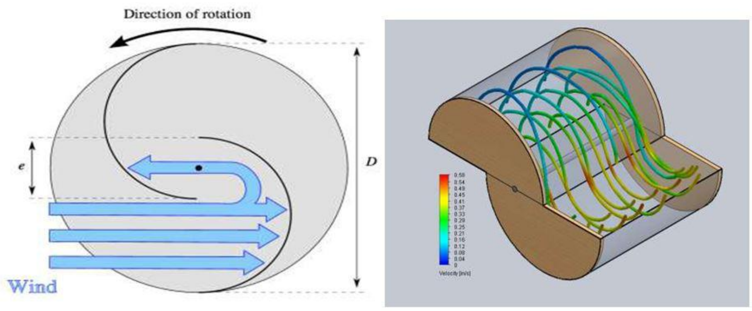

Figure 2. Wind Rotation in Savonius Turbine

B. Gear Mechanism

Most turbines have gear boxes to "step-up" the angular velocity of the turbine. This is particularly important in the design of the highway wind turbine because it is placed at lower elevations with slower moving wind. To amplify the number of rotations, we will use a simple gear train consisting of 2 gears. Initially, we wanted to produce the maximum gear ratio with one set of gears however, it would run the risk of interference.

C. DC Generator

Permanent Magnet DC motors are the most important components that can be used in place of DC generators. The magnetic fields produced as a result of the spiral movement of the magnet within the component is that which produces electricity. The most important reason is that it is cheaper than electric generators and it also contains many components we utilize in our daily lives. A motor is a device that converts electric energy into mechanical energy when electrified via its outputs; however, permanent Magnet DC motors can also have some adverse effects. The magnetic field created by the magnets causes a current to flow through a coil. We have used to use 500 RPM side shaft Johnson metal gearbox motor to generate electricity.

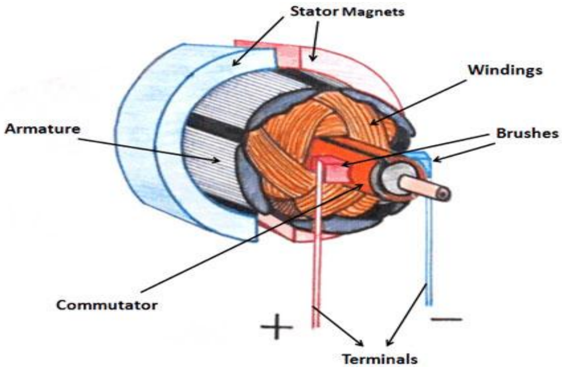

Figure 3. DC Generator

D. Solar Panel Cell

Solar cells convert the sun's energy into electricity. Whether they are a doming to your calculator or orbiting our planet on satellite, they rely on the photoelectric effect which is the ability of matter to emit electrons when a light is shone on it.

Figure 4. Solar Panel Cell

E. Energy Storage

An automotive battery is a rechargeable battery that supplies electric energy to this hybrid system. Its main purpose is to supply energy. Once the Wind turbine is running, power for the LED light is supplied by the battery.

Figure 5. Energy Storage

F. LED Lights

An LED, or light-emitting diode, is a light source based on a semiconductor – materials that are neither pure conductor nor insulators but have an electrical conductivity somewhere in between. When a voltage passes through the LED, electrons recombine with holes in the semiconductor, emitting lights in the process.

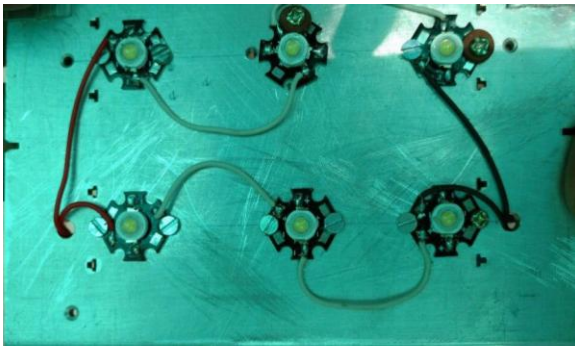

Figure 6. LED Lights

III. REQUIEMENTS OF PLACING HYBRID ENERGY SYSTEM

A. Site Selection Considerations

The power available in the wind draft increases rapidly with the speed hence wind energy conversion machines should be located preferable in areas where the winds are strong & persistent. The following point should be considered while selecting site.

B. High Annual Average Wind Speed

The wind draft velocity is the critical parameter. The power in the wind draft P_w , through a given X-section area for a uniform wind velocity is

$$P_w^3 = KV \text{ (K is constant), watt}$$

It is evident, because of the cubic dependence on wind draft velocity that small increases in V markedly affect the power in the wind.

C. Availability of Wind $V_{(t)}$ Curve

This important curve determines the maximum energy in the wind draft and hence is the principle initially controlling factor in predicting the electrical o/p and hence revenue return of the machines, it is desirable to have average wind speed **V** such that

$$\mathbf{V \geq 12\text{-}16\ km/hr} \text{ i.e. (3-4 m/sec)}$$

D. Wind Structures at the Proposed Site

Wind especially near the ground is turbulent and gusty, & changes rapidly indirection and in velocity. This departure from homogeneous flow is collectively referred to as "the structure of the wind".

E. Altitude of the proposed site

If affects the air density and thus the power in the wind draft & hence the useful electric power o/p. The winds tend to have higher velocities at higher altitudes.

F. Local Ecology

If the surface is bare rock it may mean lower hub heights hence lower structure cost, if trees or grass or venation are present. All of which tends to de structure the wind.

G. Nature of Ground

Ground condition should be such that the foundation for system is secured, ground surface should be stable.

IV. FIELD SURVEY

Wind and Solar are natural sources of energy. They depend upon the nature and it is fluctuating sources. We had done our survey work on highway. We have collected following details

Geographical details of NH 6 passing from Bardoli region:

Latitude : 21.2 N
Longitude : 75.48 E
Annual Solar radiation : 5.35 kWh/m^2 /day
Annual Wind speed : 3.12 m/s
Air Density : 1.225 kg/m^3

Table 1. Vehicle Survey

Time (a.m.)	Wind Velocity (m/s)	Car/Jeep/Van	Truck	Bus	Total Vehicle
08.00-09.00	2.70	57	76	27	160
09.00-10.00	3.65	78	83	41	202
10.00-11.00	3.54	75	71	34	180

A. Power Generated by the Wind

Wind velocity = 3.12 m/s

Area of turbine = 1.5*0.85 m^2 = 1.2755 m^2

Electrical Power = 0.5*swept area* air density * $velocity^3$ * Cp , Where Cp= 0.15
= 0.5*1.2755 * 1.225 * 3.12^3 *0.15
=3.55 Watt

B. Power Generated by the Solar Panel

Maximum power generated by used solar panel = 20 watt

Average time for high intensity Sun light is 6-7 hours per day.

So, available solar energy during day period is

P = 6 hours * 20 Watt * 1 (Panel)
= 120 watt (avg. maximum)

Average efficiency of particular Solar Panel is 30% to 40%

So efficient Power Generation = 0.40*120
=48 Watt

V. DESIGN OF BASIC WIND TURBINE

The wind mill works on the principle of converting kinetic energy of the wind to mechanical energy. The kinetic energy of any particle is equal to one half its mass times the square of its velocity,

$$K.E. = {}^{1}/_{2} * m * v^2 \quad \ldots\ldots\ldots \quad (1)$$

Where, Ke = kinetic energy of wind
M = mass of wind draft
V = velocity of wind draft

$M = \rho AV$

So, $K.E. = {}^{1}/_{2} * \rho AV*V^{2}$ ……………………………………………........ (2)

$= {}^{1}/_{2} * \rho AV^{3}$ watt

Where, ρ = density of air

m =1.225 kg/ m^3

Area for wind turbine A = d*h $meter^2$

Where, d = diameter
h = height

Now, available power

$P = {}^{1}/_{2} * \rho AV^{3}$ Watt

Here, we want to produce 12 watt power for highway lights
So, P = 12 watt
Velocity V = 4 m/s

$Pa = 1/2\ \rho A V^3$

$12 = 1/2*1.225*A*5^3$

i.e $A = 1.2755\ m^2$

Assume height h = 1.5 meter
It gives diameter d = 0.85 meter

VI. DESIGN OF SAVONIUS TURBINE IN SOFTWARE CREO

Savonius turbines are one of the simplest turbines. Aerodynamically, they are drag-type devices, consisting of two or three scoops. Looking down on the rotor from above, a two- scoop machine would look like an "S" shape in cross section. Because of the curvature, the scoops experience less drag when moving against the wind than when moving with the wind. The differential drag causes the Savonius turbine to spin. Because they are drag-type devices, Savonius turbines extract much less of the wind's power than other similarly-sized lift-type turbines. Much of the swept area of a Savonius rotor may be near the ground, if it has a small mount without an extended post, making the overall energy extraction less effective due to the lower wind speeds found at lower heights. We have designed 3 scoop Savonius turbine in CREO software which is shown in figures below.

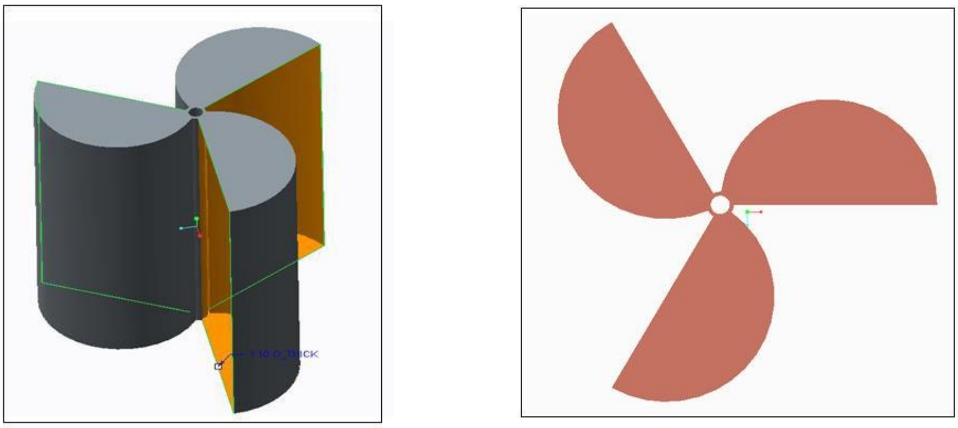

Figure 7. Savonius Wind Turbine Model with Rotor

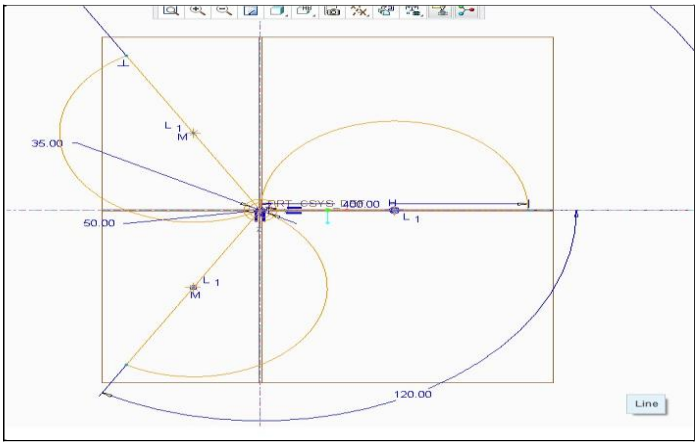

Figure 8. Design of Rotor Using CREO

Figure 9. Front view of Blades designed in CREO

VII. FEASIBLE REPORT

Wind and Solar are natural sources of energy. They depend upon the nature and it is fluctuating sources. We had tested our project on NH 6 near Bardoli, Gujarat, India. We have done all the survey work and mentioned above and on that basis we have prepared various comparison charts.

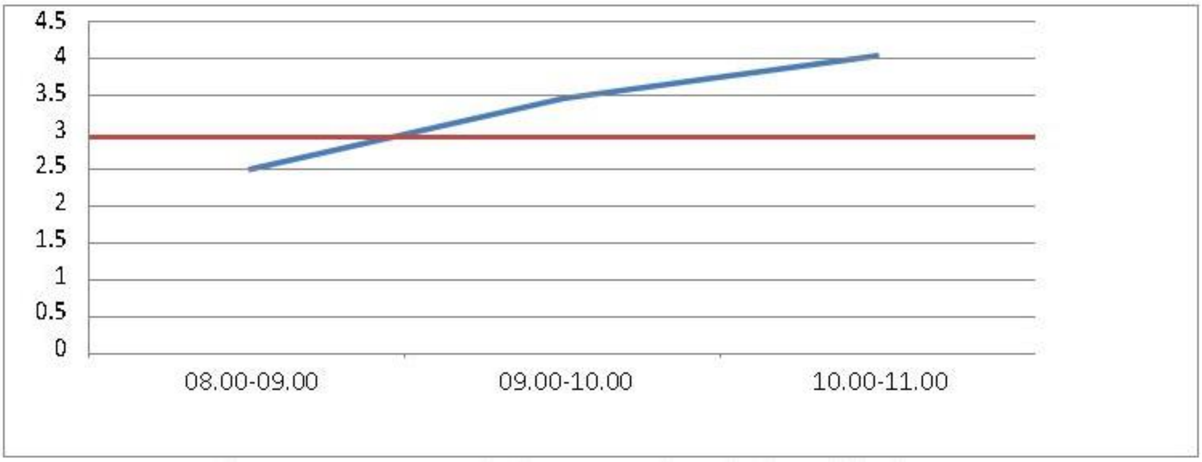

Chart 1.Average Velocity to Hourly Velocity with Time

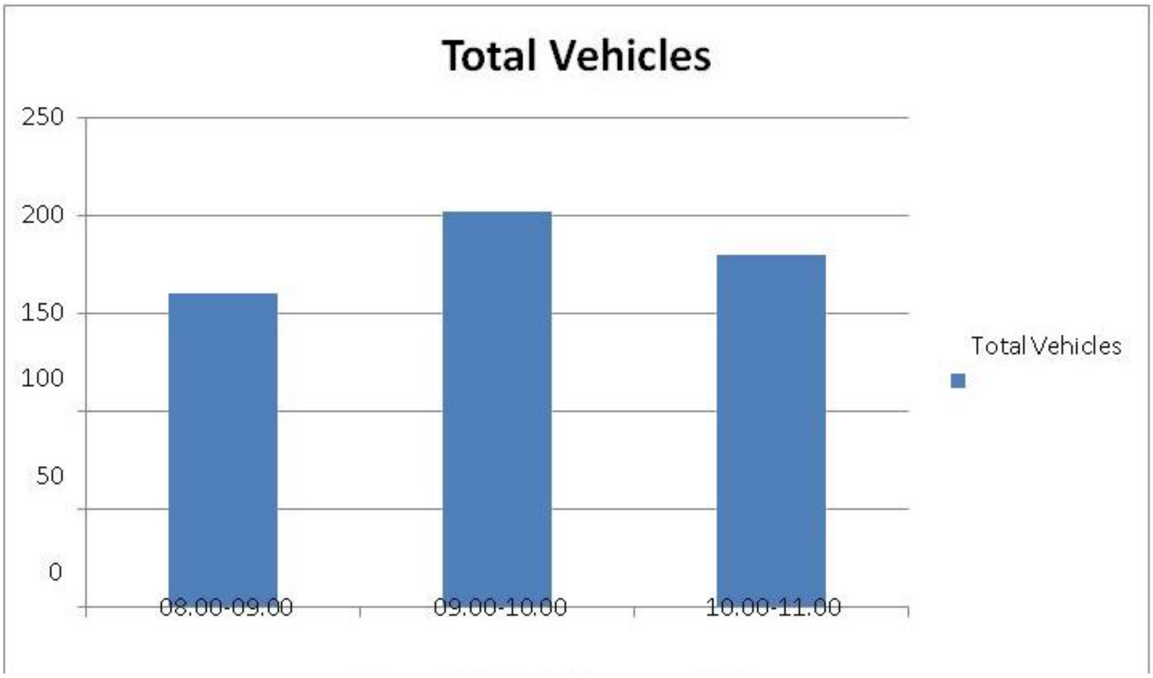

Chart 2. Vehicle Survey with time

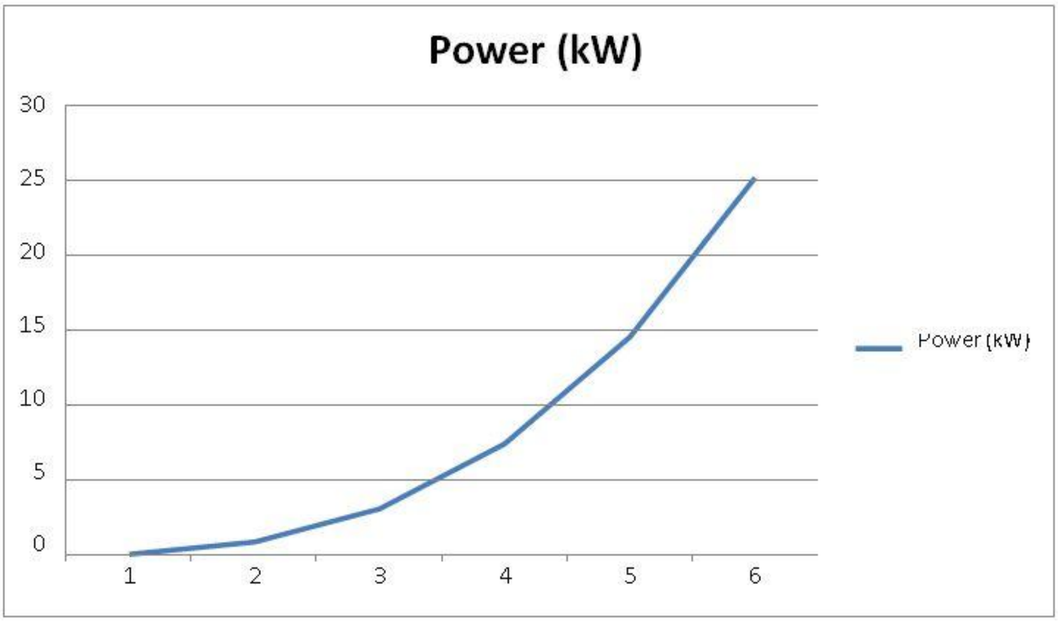

Chart 3. Speed to Power

Figure 10. Working Model of Hybrid Energy System

VIII. CONCLUSION

Conclusively, extensive data is collected on wind patterns produced by vehicles on both sides of the highway. Using the collected data, a wind turbine is designed to be placed on the medians of the highway. Although one turbine may not provide adequate power generation, a collective of turbines on a long strip of highway has potential to generate a large amount of energy that can be used to power streetlights, other public amenities or even generate profits by selling the power back to the grid. This design concept is meant to be sustainable and environmentally friendly. Additionally, a wind turbine powered by artificial wind has a myriad of applications. Parallel uses of Solar Panels are highly efficient way to charge the batteries. Solar panels works when there is full day light. So solar panels works approximately 8 hours of day light time with continues and efficient work output ,whereas Savonius turbine works continuously for 24 hours ; but not continuously. Theoretically any moving vehicle can power the turbine. The highway wind turbine can be used to provide power and solar panel also provides power in any city around the globe where there is high vehicle traffic and sunny weather.

IX. ADVANTAGES

- No yaw mechanism required.
- It can be located nearer to the ground, making it easier to maintain the moving parts of the turbine.
- VAWT have lower wind start up speed than the typically HAWTs.
- VAWTs may be built at locations where taller structures are prohibited.
- VAWTs situated close to the ground can take advantages of locations where rooftops, mesas, hilltops, ridgelines, passes funnel the wind and increases wind velocity.
- It is a renewable source of energy.
- Wind power systems are non-polluting so it has no adverse influence on the environment.
- Wind energy systems avoid 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.

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