Design and Manufacturing of Vertical Wind Turbine to Generate Electricity on Highway to Utilize Unused Wind Generated by Vehicles

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Abstract - The objective of the project is to design a wind turbine power generate to recapture wind energy from vehicles running on the highway. Wind energy is considered the fastest growing clean energy source however; it is limited by variable natural wind. Highways can provide a considerable amount of wind to provide torque to the turbine due to high vehicle traffic. This energy is unused. Extensive research on wind patterns is needed to determine the average velocity of the wind created by oncoming vehicles. The wind turbines will be placed on the medians therefore fluid flow from both sides of the highway will be considered in the design. Using all of the recorded data, existing streetlights on the medians can be fitted with these wind turbines. Additionally, since the wind source will fluctuate, a storage system for the power generated will be designed to distribute and maintain a constant source of power. Ideally, the turbine can be used globally as an unlimited power source for streetlights and other public amenities. Project will be setup at highways to operate street lights as well as car charging points. Hence there is constant source of wind power available due to which project helps to contribute to the global trend towards clean energy in feasible way.

Keywords: Armature Battery, Wind Speed, Dynamometer, Bearing.

I. INTRODUCTION

Wind is the flow of gases on a huge scale. On the surface of the earth, wind consists of the bulk movement of air in meteorology, winds are often referred to according to their strength, and the direction from which the wind is blowing in human civilization, wind has inspired mythology, influenced the events of history, expanded the range of transport and warfare, and provided a power source for mechanical work, electricity and recreation. Wind energy is the fastest growing source of clean energy worldwide. A major issue with the technology is fluctuation in the source of wind. There is a constant source of wind power on the highways due to rapidly moving vehicles.

The motivation for designing a “Highway Draught Power Generator” is to contribute towards the global trend in wind energy production in a feasible way. Wind turbines are traditionally employed in rural areas the goal of this project is to use the turbine in cities also. In particular, the turbine will use the wind created by vehicles on the highway to generate electricity. The idea is to offset the amount of pollution created by burning fossil fuels created by introducing a potential source of clean energy. The price of turbines is increasing in accordance with the rising cost of energy and commodities. The price of designing the turbine, calculated in energy savings must be recovered in a reasonable time period. Every vehicle on the highway offers an intermittent and uncontrolled source of wind power. The design of wind turbine must include storage of power and a system to distribute the generated power effectively. Working noise level and space are other important design considerations. The wind turbines should have as slight negative impact on the placement location as possible. Wind turbines are usually used in remote locations. This offers the supplementary challenge of having to transport the power produced to the location wherein it will be utilized. Fortunately, the wind turbine in this project is designed for use in high traffic zones where the demand for power is high. Safety is another major design consideration. The turbines must be placed in high traffic zones therefore several safety provisions are incorporated into the design. These safety measures include stationary highway guards surrounding the rotating turbine blade and warning labels.

1.1 Brief History of Existing Technology:-

The vertical axis wind turbine is used lesser than horizontal axis wind turbine. This is due to variation of wind direction and its speed. The vertical axis wind turbine is used to generate power from the wind potential which is produced at national highways by crossing fast moving of vehicles. If the wind is properly directed towards the wind turbine blades, optimum electricity could be generated. The speed of the wind stream varies with vehicle speed and shape of vehicles. The turbine only rotates when a vehicle crossed across them and it remains rest until vehicles not crossed. In this perspective, there is no incessant rotation in turbine at low headed wind.

1.2 Significance/Importance of the Project:-

Since we are depending mostly on non-renewable sources, and they are depleting in a very fast manner, currently there is a shortage of electric power in the world. Also, pollution due to conventional sources like coal, diesel etc. is also a major problem. Because of these above mentioned reasons, we are trying for incorporation of more renewable energy resources (like solar, wind etc.) into the grid to support the increasing power demand. These renewable sources are long term sources of energy and only capital cost is significant for its implementation. Nowadays, the vehicle density is increasing by a very fast rate and because of the development in road transportation facilities such as the development of express highways and national highways, where vehicles move in immense speed, large amount of wind energy will be generated by the moving vehicles on these highways.

1.3 Current Scenario

As of 31st March 2016, total installed capacity in India is 255.012 GW. Maximum energy requirement is served by the conventional sources, a main part of which is contributed by thermal power plants. In India almost 177.742 GW of energy is produced by thermal plants, 40.799 through hydroelectric power plants, 4.78 GW through Nuclear power plants and remaining 31.692 GW through additional renewable source. India's electricity division is amongst the world's most active performers in renewable energy utilization. India stands 5th in wind power generation with an installed capacity of 21.136 GW. Even though, we are facing a shortfall of electrical energy due to lack of resources and the increased power demand. Currently, we are trying to incorporate additional renewable sources into the grid to support the increased power demand. As a part of it a lot of researches are going on in the field of wind power generation and the researchers are trying to exploit the field of highway wind power generation as highway is one of the major sources of wind energy.

1.4 Important Terms

a) **Impact of Wind Energy**: - It is the wind energy which flows around the moving vehicles due to reaction of body motion; it flows towards the surrounding of highways and strikes the harnessing system, if such system is placed. Technically, study of this type of energy is called as Fluid Flow Dynamics.
b) **Anemometer**: - It is the instrument used to measure velocity of fluid flow (air) in the surroundings.

Extensive research work on wind flow patterns is required to determine the average velocity of the impact wind created by vehicles running on the highways/expressways. We have investigated the potential of Impact wind energy because much more advanced work has already been done in harnessing the natural wind energy. But little work has been done for Impact wind. As the automobiles moves on highways/expressways, there is creation of front and back pressure column on both sides of the roads. The pressure column is created due imbalance of high pressure/low pressure energy band created by the automobiles. Because of this pressure band, wind flow and create pressure thrust. This Impact pressure thrust depends on different factors as follows:-

i. The intensity/frequency of the vehicles traffic.
ii. The size of the automobiles.
iii. The speed of the automobiles.
iv. Distance between the harnessing system &vehicles.
v. Angle of Impact.
vi. Velocity of natural wind.

II. LITERATURE REVIEW

Example of Suresh Mashyal system [1] 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.

Example of Mithun Raj K K system [2] Vertical axis wind turbine can be installed on the median of the roads so that the wind from both sides of the median will act tangentially in opposite direction on both sides of the turbine thereby increasing effective wind speed acting on the turbine. This wind flow will depend on the velocity of the vehicle, size of the vehicle and intensity of the traffic. The kinetic energy of the wind is converted into rotational energy using vertical axis wind turbine which is either coupled directly or through gear. Rotational energy from the turbine is converted into electrical energy by the permanent magnet synchronous generator whose output is fed to an IGBT based chopper. Since the wind speed is not constant, the output of the generator will be varying frequently. Chopper regulates the output of the generator and charges the battery. Stored energy in the battery can be used to light LED based street lights using an LED driver circuit.

Example of Sushant N. Malave system [3] Highways can provide a required considerable amount of wind to drive a turbine due to high vehicle traffic. This energy is unused. Extensive research on wind patterns is required to determine the average velocity of the wind created by oncoming vehicles. The wind turbines will 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. Additionally, since the wind source will fluctuate, a storage system for the power generated will be designed to distribute and maintain a constant source of power.

Example of Minu John system [4] Magnetic levitation, maglev, or magnetic suspension is a method by which an object is suspended with no support other than magnetic fields. Magnetic pressure is used to counteract the effects of the gravitational and any other accelerations. The principal advantage of a maglev windmill from a conventional one is, as the rotor is floating in the air due to levitation, mechanical friction is totally eliminated. That makes the rotation possible in very low wind speeds. Maglev wind turbines have several advantages over conventional wind turbines. For instance, they're able to use winds with starting speeds as low as 1.5 meters per second (m/s). Also, they could operate in winds exceeding 40 m/s. The wind turbine rotor levitated properly using permanent magnets, which allowed for a smooth rotation with negligible friction.

2.1 Objective of the Project:-

In corporation of more renewable energy to the power system.

Design of a new method of generation of electricity using the wind energy generated by the moving vehicles on the highways.

Development Stand-alone system for providing the power to the highways.

Provide Charging Port for Electric Cars

Now days the demand on electricity is much higher than that of its production. One of the main issues ever since men realized is that natural resources are going to be finished one day and a replacement is to be found. Apart from that fossil fuels play a main role in pollution, global warming and greenhouse gas. In order to overcome problems incorporation of more renewable energy sources such as sunlight, wind and biomass is needed in the current century. Energy is much essential for growth of any nation. The global demand for energy is growing in a rapid rate due to fast rise in population and industrialization, while the energy sources are diminishing in a very fast manner. Currently, more than 68 percent of electrical energy is formed by thermal power plants where fossil fuels like coal, diesel etc. are used. As we realize that fossil fuels are going to be exhausted, we're trying to improve other means of power generation. Wind energy is measured the fastest growing source of clean energy. However, it is restricted by its variable nature. Highways can provide a substantial amount of wind to drive a turbine due to heavy vehicle traffic. Due to the pressure difference in the air adjoining the vehicle wind will be produced. The goal of this project is to extract this energy in the most efficient manner. Small vertical axis wind turbines can be installed in these zones to extract this power

III. EXPERIMENTAL SETUP

3.1 Design Objectives

The vertical blade design is to be applied in urban environments, involved to existing street lights. Their place on existing poles permits them to be easily connected to the grid, or to the LED lights, and provide 50% - 100% of the 45 W used by the street lights.

Due to competition of present turbine designs, the rated wind speed for the design is an important specification to differentiate the turbine from its competitors. Most of wind turbines work with an average wind speed of 10 -15 m/s, while the intended design is to work at an average wind speed of 5 m/s.

There are several ways to approach this particular design problem. In literature surveys, I discovered different features of wind turbines which were appealing for different reasons. For example, the gear turbines in China were very inexpensive and the modular sections could easily be snapped together to form a bigger system. That particular design did not seem as environmentally friendly as the designs with larger propellers.

3.2 Design Requirements

The turbine should have a start with wind speed of 2 m/s, and an optimal operational wind speed of 5 m/s (the average Boston wind speed). At the optimal operational wind speed, the wattage production is to be at least 25 W, about 50% of the required wattage of an LED street light. Using the general equation for calculating the theoretical power obtained from wind turbines, with a coefficient of performance of 35% and an average wind speed of 5 m/s, the required swept area of the blades was determined to be 1.5 m2 .The design should also measure no taller than 80 inch, allowing the required interstate highway vertical clearance of at least 840" above the road. Finally, it should have a lifespan of 25 years, needing minimum to no maintenance. The growth of green energy has opened a market for efficient wind turbines. The shift towards LED street lights provides a use for small scale wind turbines. The wind turbine is to power the wattage necessary by an LED street light, approximately 45 W.

Now a day the world have been industrialized by the technologies like microcomputer, 3G, 4G devices, sixth sense devices etc. By using these we can join from any corner of the world. If we consider which leads this technology development means the answer takes us to the origin and saves Energy. So without energy nobody will move in this world in this 21st century there are more systems to produce energy. Some of them are ecofriendly and some of them are palatable. Once we aim to produce energy by ecofriendly means the greatest idea is by using renewable energy. In renewable energy sector the windmill plays an important role in energy creation. The present design of windmill might not be applied in our surroundings. As it is not suitable for all wind direction and it provides fractional efficiency and also rise in cost of design, installation, and maintenance. To overcome all these problems a unique method of wind is to be introduced. This project have kept one step forward of windmill technology with use complete application. The core goal of this project is to produce energy by using renewable energy resources in that way the wind is very much eco-friendly and very compactable one. By using that energy in a valuable way we can produce a constant power This VAHW is a new method which overcomes the earlier windmill problems. By regulating the windmill blade it suit itself with efficient energy generation in all direction.

3.3 Reason behind Selection of Vertical Turbine

Sr. No.	**Performance**	**Horizontal axis wind turbine**	**Vertical axis wind turbine**
1	Power generation efficiency	50 to 60 %	Above 70 %
2	Electromagnetic Interferences	Yes	No
3	Steering mechanism of wind	Yes	No
4	Gear box Above 10 KW	Yes	No
5	Blade rotation space	Quit large	Quite small
6	Noise	5 to 60 db	0 to 10 db.
7	Wind resistance capability	Weak	Strong
8	Ground projection effect on human being	Dizziness	No effect
9	Failure rate	High	Low
10	Maintenance	Complicated	Convenient
11	Rotating speed	High	Low
12	Effect on birds	Great	Small
13	Cable standing problems	Yes	No
14	Starting wind speed	High (2.5 to 5 m/s)	Low (1.5 to 3 m/s)
15	Power curved	Depressed	Full

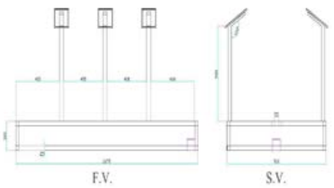


Fig. 01. Frame along with solar panels ***Fig. 02 Assembly***

The cost of turbines is increasing in accordance with the rise in cost of energy and commodities. The cost of designing the turbine, calculated in energy savings must be recovered in a reasonable time period. Each vehicle/automobile on the highway offers an intermittent and uncontrolled source of wind power. The design of the wind turbine must include storage of power and a system to distribute the generated power effectively & efficiently.

Operational noise level and space are other significant design considerations. The wind turbines should have as little negative impact on the placement location as possible. Wind turbines are usually used in remote locations. This offers the extra challenge of having to transport the power generated to the location wherein it will be used. Fortunately, the wind turbine in this project is designed for use in great traffic areas where the demand for power is high.

Safety is another major design consideration. The turbines must be placed in great traffic areas therefore several safety provisions are incorporated into design.

These safety measures include stationary highway guards surrounding the rotating turbine blades and warning labels.

3.4 Calculations

Length of blade, l =0.226 m

Breath, b = 0.077 m

Area of Blade = l x b = 0.0174 m^2

Power =0.5 x p x A x V^2

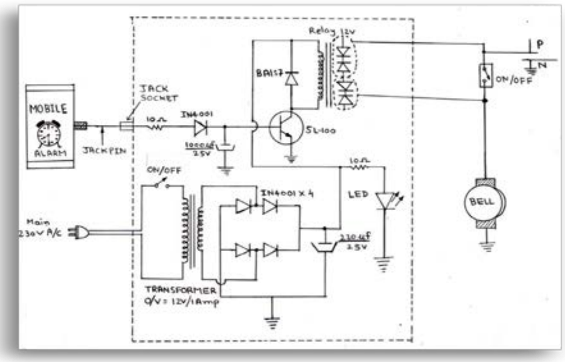
Power = P = 0.5 x 1.093 x 0.0174 x 73 = 3.26 watt **11.736 kWh**

Torque = 11.236 = (2 x 3.14 x 300 x T)/60 = **0.37 N-m**

Wind Speed (Km/hr)	Wind speed (m/sec)	Calculated mechanical power in watt	Electrical power = 0.4 * mechanical power watt
0	0	0	0
5	1.385	0.089	0.035
10	2.770	0.715	0.286
15	4.155	2.410	0.966
20	5.540	5.720	2.290
25	6.925	11.180	4.470
30	8.310	19.320	7.730
35	9.695	30.690	12.70
40	11.080	45.810	18.320
45	12.465	65.230	26.090
50	13.850	89.470	35.790
55	15.230	119.09	47.630

3.5 Material of Vertical Axis Wind Turbine

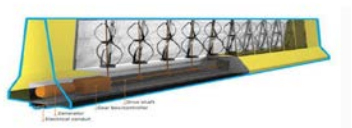
On the other hand, the fabrication of turbine blades has become an important matter as well. Composite materials start to replace the applications of metal. Glass fibers are the most widely used to reinforce plastics due to their minimum cost and fairly good mechanical properties. However, these fibers have serious drawbacks. The use of bio composites fiber as a reinforcement in Fiber-Reinforced Plastics to replace synthetic fibers such as glass is receiving serious attention. This is due to its advantages such as renewability, low density, and high specific strength. Current studies have explored the development of biodegradable composite materials using natural fibers such as flax, bamboo, pineapple, reinforcement for biodegradable plastics. These studies have examined molding conditions, and interfacial bonding and show positive result. Study on several natural fibers mechanical properties such as tensile strengths, flexural strengths and Chirpy impact also shows comparable results to glass fibers. The application of bio composites fiber is wide. Aerospace, automotive, building, construction and RE are the potential area of application. The potential in automotive industry is convincing. A few part parts can be replaced to bio composites fiber such as beam and dashboard. A study reports that hybrid fiber glass is potential to replace the existing glass mat thermoplastic product. In addition, an extensive study is needed especially on manufacturing processes and



commercialization processes.

3.6 Design Alternative

There are several ways to approach this particular design problem. In literature surveys, I discovered different features of wind turbines which is appealing for different reasons. For example, the gear turbines in China were very inexpensive and the modular sections could easily be snapped together to form a bigger system. That particular design did not seem as environmentally friendly as the designs with larger propellers. Other designs include turbines built into highway dividers or on overhead poles as seen in the design by the Arizona State Student Joe (last name not provided) (Joe, 2007). Joe calculated that with cars moving at 70 mph, 9,600 kilowatts of electricity could be produced per year using his design.



Name of Compo nent	Pictorial view	Function
PCB BOAR D		A Printed Circuit Board (PCB) mechanically supports and electrically connect electronic components using conductive tracks, pads and other features etched from copper sheet laminated onto a nonconductive substrate

Transformer		The transformer is a static device which is used to transfer the electric energy from one AC circuit to another AC circuit, with increased or decreased in voltage but without any change in frequency
Diodes		Control one electrical circuit by opening and closing contacts in another circuit
Resister		The main function of resisters in a circuit is to control the flow of current to another component
LED indicator		It is a device which emits the light when circuit is ON
Capacitor		A capacitor is a passive two terminals electrical component is used to store electrical energy temporarily in an electric field.
Soldering Gun		A soldering Gun is an electrically metals using tin based solders to achieve strong mechanical bond with good electrical contact.

Fig. 04 Circuit diagram

3.8 Working Principle

a) Capturing wind induced by moving/running vehicles

The moving vehicles may be all types of light or heavy vehicles running on road, such as two, three, four wheelers or even bigger vehicles. The moving/running vehicles could be railway train running on railway track. The vehicles could also be aircraft moving on to the runway, taking off or landing; when testing the propellers in the workshops, proceeding to or standing by in the holding area before taking off. These induces fast winds in all it direction of propagation.

b)Routing the induced wind in same direction of the wind turbine

If the wind is properly directed towards the wind turbine blades, optimum electricity may be generated. The desired direction of wind is got by a means for channeling wind, in the direction of the wind turbine. Channeling of wind in a desired direction may be obtained by, at least one truncated cone or pyramid shaped housing/casing or a pair of planar members converging towards the blades of the wind turbine. Aerodynamics is the science and study of the physical laws of the behavior of objects in an air flow and the forces that are produced by air flows. The shape of aerodynamic profile is decisive for blade performance. Even minor alterations in the shape of the profile can greatly alter the power curve and noise level. Therefore a blade designer does not simply sit down and outline the shape when designing a new blade.

The aerodynamic profile is formed with a rear/back side, is much more curved than the front side facing the wind. Two portions of air molecules side by side in the air flow moving towards the profile at point A will isolated and pass around the profile and will once again be side by side at point B after passing the profile's trailing edge. As the rear side is more curved than the front side on a wind turbine blade, this means that the air flowing over the rear/back side has to travel a longer distance from point A to B than the air flowing over the front side. Therefore this air flow over the rear side must have a higher velocity if these two dissimilar portions of air shall be reunited at point B. Greater velocity produces a pressure drop on the Rear/back side of the blade and it is this pressure drop that produces the lift. The highest speed is obtained at the rounded front edge of the blade. The blade is almost sucked forward by the pressure drop resulting from greater front edge speed. There is also a contribution resulting from a small over-pressure on the front side of the blade. Compared to an idling blade the aerodynamic forces on the blade under operational conditions are very huge. Most of the wind turbine owners have surely noticed these forces during a start-up in good wind conditions.

The wind turbine will start to rotate very slowly at first, but as it collects speed it begins to accelerate faster and faster. The change from slow to fast acceleration is a sign that the blade's aerodynamic shape comes into play, and that the lift greatly increases when blade meets the head wind of its own movement.

IV. SIMULATION AND ANALYSIS

4.1. Mathematical Model and Discussion

From the previous studies completed by eminent scientist Albert Betz in 1919 (Book Published, 1926) [1] , I come to know the well-known equation of wind energy power P, harnessed by wind turbine having blade cross-section area A due to wind velocity Vw in the air like viscous medium of density ρ is given by- $P = C_p \rho A V_w^3$

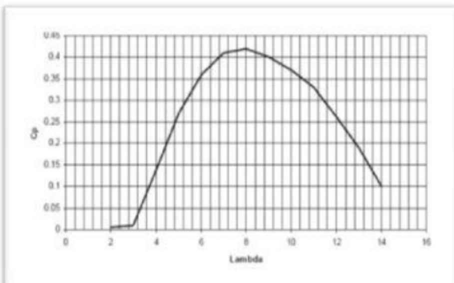


Fig. 05 Graph Cp Vs tip speed

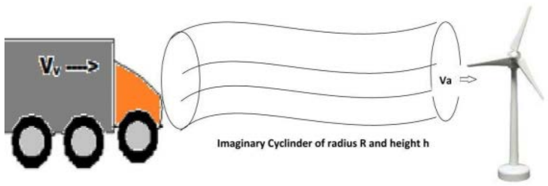


Fig. 06 Demonstration of effect of wind

Here Cp is Betz Law limit which is related to Power Coefficient and it varies with the tip speed ratio λ of the turbine in honour of scientist Albert Betz. Tip speed ratio is ratio of blade tip speed to wind speed. The variation of Cp with tip speed ratio λ is shown in fig. This law concluded that no wind turbine can convert more than 16/27 (59.3%) of the kinetic energy of the wind into mechanical energy turning a rotor. The qualitative behaviour of air fluid can be understood by using the law of conservation of energy and Bernoulli theorem. Fig. 06 Demonstration of effect of wind According to Bernoulli theorem lowering of air fluid pressure may result in increased in the velocity of air flow.

Let us consider an isolated vehicle is moving on the highway with velocity Vv in the air fluid and vehicle-air drag result in the setup of air turbulence in the surrounding air. In order to calculate real air pressure variation due to vehicle movement, let us assume a cylindrical air tube of height h and radius R around turbine (at least equal to Radius of turbine) which absorbs all the kinetic energy of wind turbulence generated.

This assumption lead to a laminar flow of velocity profile having no viscous losses and turbulence. If there is no loss of air turbulence along curved surface of a cylinder and the air turbulence can only enter or exit at the circular face of the cylinder. Thus our assumption indirectly leads to a relation between effective flow velocity and maximum velocity i.e. Effective flow velocity is one half of the maximum velocity. The velocity of air flow Va in cylindrical air tube is dependent on velocity of vehicle Vv and both may have direct variation so

Va = αVv ... (4.2)

Where α is a correlation coefficient having value from 0 to 1 depending on surrounding area and vehicle-air drag. A pressure difference is created at end of cylindrical air tube by running of vehicle, which will result in drag force on wind turbine. The net drag force can be correlated with cylinder faces pressures as

F = (P 2 − P 1) πR2

The pressure change can itself be related to medium density change Δ ρ and air profile velocity Va by ½ ΔρVa2. Therefore resultant drag force on wind turbine due to imaginary air column is

F = Δρ Va2πR2 (4.3)

This is vehicle aerodynamic drag force and this drag force will perform work in rotating wind turbine. So net power transfer by air profile will be

P = F.Va

= ΔρVa3πR2

Or P = Δρ α3Vv3πR2 (4.4)

Our calculated eq. (4.4) is similar to previous workout equation by Albert Betz in 1926 and T. Morbiato in 2014 for wind power P harnessed by wind turbine. The equation (4.4) is similar to equation (4.1) in term of variation with respect to vehicle speed but having different coefficient. The Betz law limit utilization of such wind power generated and state that maximum usable power is only about 59.3%.Therefore wind profile usable power Pu is

Pu ≤ Cp P

Or Pu= 0.29 Δρ α3Vv3πR2 (4.5)

The equation (4.5) gives power generated by a windmill due the velocity profile of a moving vehicle. This show that $Pu \propto Vv3$ $Pu \propto R2$
And$Pu \propto$ Δρ
So our mathematical calculation show that usable power is varies cubically with velocity of vehicle, but same time limited by cubical variation of constants α and density difference.
It is velocity of wind va which rotates the turbine or whose kinetic energy of wind is transferred to rotational energy of turbine. The rotational speed of turbine having radius R is given by $\omega = C\ va\ /\ R$

where C is dynamic constant which can be correlate to Betz constant having maximum value 0.59. In view of this one can easily say that rotational speed of turbine due a vehicle having speed $vv$is given by
$\omega = C\ mvmaR2 + \rho 2 - \rho 1\ \pi R4h$ 12 (4.6)
The equation (4.6) show that for some optimal R some rotation speed can induce from speedy vehicle

Sr. No.	Types Of Vehicles	Height Of Anemometer From Road Level (Cm)	Distance Between Anemometer And Vehicle (Cm)	Velocit ergy
1	6-Wheel truck	40	25	3.4
2	10-Wheel truck	40	25	4.6
3	12-Wheel truck	40	35	2.9
4	6-Wheel truck	60	30	5.7

5	10-Wheel truck	60	20	6.9
6	12-Wheel truck	60	20	5.4
7	6-Wheel truck	80	35	6
8	10-Wheel truck	80	25	6.7
9	12-Wheel truck	80	20	3.1
10	6-Wheel truck	100	20	8.7
11	10-Wheel truck	100	20	7
12	12-Wheel truck	100	20	4.8
13	6-Wheel truck	120	20	9.2
14	10-Wheel truck	120	20	9.8
15	12-Wheel truck	120	20	6.2
16	6-Wheel truck	140	20	7.9
17	10-Wheel truck	140	20	7.1
18	12-Wheel truck	140	20	4.4
19	6-Wheel truck	160	20	7.8
20	10-Wheel truck	160	20	6.5
21	12-Wheel truck	160	20	5.8
22	6-Wheel truck	180	20	4.8
23	10-Wheel truck	180	20	6
24	12-Wheel truck	180	20	6

Table no. 04. Wind Speed Analysis -

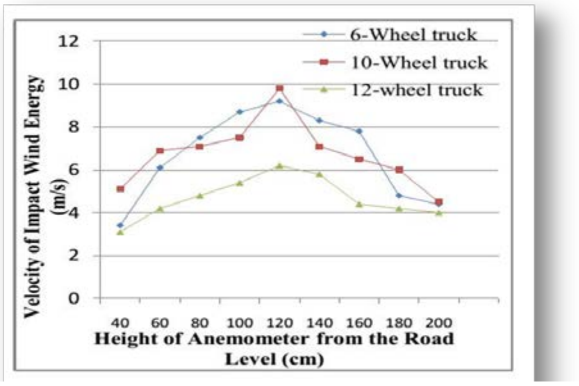


Fig. 07 Graphical Comparison between height of Anemometer and velocity of impact wind energy

The pressure thrust of wind energy can be converted into mechanical and this mechanical energy can be converted into electrical energy with the help of placing harnessing system (Vertical Axis Wind Turbine) just nearby these highways sides and centre. The energy generated depends on different factors as mentioned before and can be stored in batteries simultaneously. The energy stored can be utilized at different application point in the form of clean energy. A major hindrance in the growth of wind energy is fluctuation in the sources of wind energy. This problem of variability can't be omitted as it is happening naturally. So, one has to think how to extract constant source of energy from the variability, that is what we can called as innovative idea.

V. RESULT AND DISCUSSION

5.1. Result and Discussion

From my observations and mathematical calculations it turn out that vehicle motion through its velocity Vv induced some velocity to air-mass which can rotate wind turbine of radius R. The maximum usable power in view of Betz limit is $Pusable$=0.29$\Delta\rho\alpha 3Vv3\pi R3$ (5.1) Above equation shows that wind power generated varies cubically with the velocity of vehicle but limited by the value of Betz limit Cp , correlation coefficient, α and density of air, ρ.

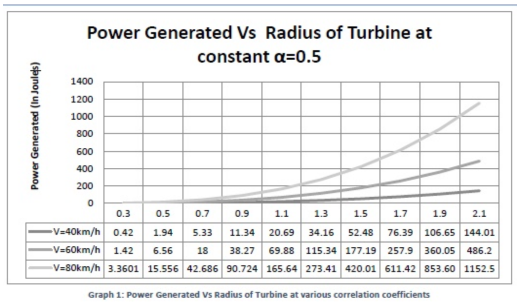


Fig08. Characteristic of power generation with radius of turbine:

Above Graph 1 clearly states that with the increasing radius of the wind turbine, the ability of turbine to capture the aerodynamic drag increases increasing the power generating ability of system. The power generated ranges between 0.42 Joules at radius of turbine at 0.3 metres to 0.1kJoules with radii of turbine at 2.1 metres, for velocity of vehicle at 40km/h under most appropriate conditions. When the vehicles run via speed of 60km/h, the range substantially increases from 1.43Joule to 0.2kJoules with the same range of radii of turbine as stated. The power generated seems to be feasible at vehicles speed 80km/h. The range shifts as high to 1.42 joules to 0.5kJoules with the same described limits of radii.

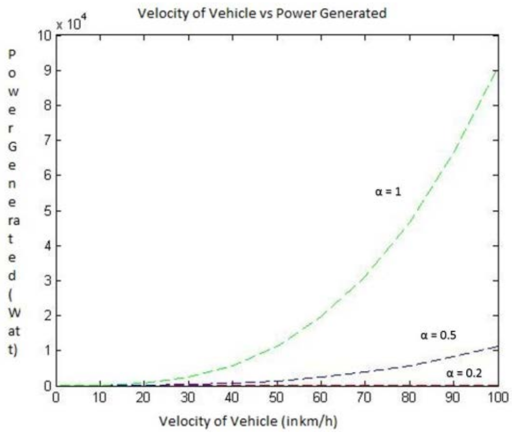


Fig.09 Power Generated Vs Radius of Turbine at various correlation

The useful power generated with Δρ = 0.1 Kg/m3 and R= 1 m for vehicle's velocity in the range 0 to 100 Km/h is shown in graph 2 having correlation coefficient 0.1, 0.5 and 1. The useful power generated is found of few KW order. For example useful power generated is 0.5kW for Vv = 60 km/h, $\Delta\rho$ = 0.1 Kg/m3, R= 1 m and α = 0.5.

5.2. Feasibility of Model:

The era of 21st century is switching from private use to corporate use. So, the question of feasibility is a common one. Even it will be right to state that a model is not being graded if the cost is more than the output. From above study, it is clear that though the efficiency of my model is less, but it is sufficient enough to produce an adequate amount of Energy if rented a favourable condition. If we include energy loss factors like air resistance, friction factor etc. then still we can use a minimum of 10% of maximum value, available for power generation then still some significance value can be generated as shown in graph 2. We can also place the small circular turbine or series of small circular turbines at regular intervals, then these combined groups of turbines will certainly show a rise in the efficiency by capturing the wind at larger scale.

5.3 Conceptual Advantages

1. The energy create is environmental pollution free and does not cause any harm to environment.
2. Can be used to produce energy free electricity.
3. Can be used to develop nearby villages and make it prosperous.
4. Till now the energy which is waste can be utilized in developmental work.
5. Wind energy is pollution free and eco-friendly.
6. There is no damage to birds.
7. Wind energy has very good potential and it is fastest growing energy source.

5.4. Limitations

1. Being free, the wind energy is fluctuating and variable source of energy.
2. Flow of vehicles is also not constant with respect to time so there is no generation when there is traffic jam or no vehicles on road (which is overcome by solar panels and 10%backup feedback plan).
3. Various control circuits, microcontrollers and high grade of security is required.

VI. CONCLUSION

The need of Renewable Energy becomes more significant nowadays due to several issues such as global environment problem, the depleting of fossil fuel thus raise the oil price as well and economic concern. In Developing Nations, the growth of heavy industry have promote to pollution rise. Besides that, the demand on electricity for industry and the community will increase as well. In this situation, government already takes smart action in promoting, enforcing and enhancing the RE by the policy or act that already launched. However, sufficient amount of funding should be allocated to improve the technology in solving fundamental problems as well as product design and development. The funding system have to be integrated with proper implementation and monitoring system. In some areas, wind resources are sufficient. Even the technologies of various types of VAWT are already established and commercially available in the market. The discussion on aerodynamic design of VAWT which can operate at any weather condition is very crucial. It must be commercially ready and tested for the user as well. Conclusively, extensive data is collected on wind patterns formed by vehicles on both sides of the highway. Although 3 turbines 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, can be used to power street lights. Hence this design concept is meant to be sustainable and environmentally friendly. It also gives clear idea about smart highways which makes the use of renewable energies and makes use of smart technology.

VII. FUTURE SCOPE

Future Scope

1) To modify the design of turbine for better efficiency.
2) To increase the power generation, implementation of solar panels.
3) To increase the effectiveness, implementation of speedboater generators.
4) Implementation of piezoelectric footpath.
5) Use of closed loop traffic signalling.
6) To convert it in Smart Highway

Star Ideas

1) Currently we have designed a timer circuit which will control the street light with the use of mobile phones in cheapest cost of RS 200/- only.

We are in try to take approvals and to present MY project in front of NHAI, to help our nation to become economically strong

Fig. 10 Star Ideas

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