Assesment Of Wind Energy Potential From Highways

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Abstract- *On keeping prime focus on the heavy duty automobiles on highways/expressway, I find out that there is large amount of wind pressure generated on these roads due to wind disturbance/ wind turbulence created by these automobiles. As any automobile passes along the path, it creates a very huge air pressure on the nearby surrounding areas.*

This high pressure of wind is till now of no use. Till now there is no as such technology developed to utilize this high pressure column of wind so generated. With concern to this, I had tried to develop a wind mill which work on the principle of these highway wind energy.

Keyword- cm-centimeter**,** rpm-revolution per minutes

I. INTRODUCTION

As the automobiles moves from highways/expressways, there is a creation of pressure column on both the sides of the road. This pressure column is created due to imbalance of high pressure/low pressure energy band created by the automobiles. Due to this pressure band wind flow and create pressure thrust.

This wind Pressure thrust depends upon the:-

a) The intensity of the traffic.
b) The size of the automobile.
c) The speed of the automobiles.

This Pressure thrust of wind energy can be converted into mechanical energy with the help of small turbines placing them just nearby these highways sides and centre.

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Fig1: sample picture of wind turbines installed near side highway.

These small turbines installed on road side by getting high pressure from winds starts rotating. This rotational energy of turbine can be stored in batteries and can be utilized in any work in the form of electricity.

These are vertical axis turbines which can be installed nearby highways. These turbine rotates on the energy pressure created by the nearby moving automobile. These moving turbines produces mechanical energy in the form of rotation which can further be used to produce electricity with the help of generator. These turbines can be installed just near by the highways as well as railway tracks which can useful to rotate these turbines.

All these turbines can be connected through each other with the help of a common shaft can be called as drive shaft. This drive shaft can be connected to generator with the help of gear drive system (which can increase the speed of the drive shaft further). Through this generator we can connect to a battery which can store that energy for temporary basis

Fig 2: The model of lights glowing from the energy generated through highways

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The wings of the turbine can be installed in between the two paths that is on the divider or on the opposite side of the highways. These turbine are vertical axis curved shaped covering as large surface area as possible. This system is used to produce electricity and use it at that place only or can be transferred to nearby village or can be use to develop and maintain a bio diversity or wild life sanctuary nearby.

II. COMPONENT DESCRIPTION

S.No.	Name of Components	Material	Dimensions In cm
1).	Base	Wood	65 x 65
2).	Rotor	Steel	L= 22.6, D=7.7
3).	Shaft	Aluminium	D=1.2, L=40
4).	Bearing	High-Carbon Steel	Ball bearing
5).	Gearing Arrangement	Dagchun	Spur gear

Speed-- The shaft speed is a very crucial factor in all types of alternator and generator. The unit needs to make higher voltages at lower rpms, otherwise it is not suited for wind power use. This goes for all power units...even motors used as generators and alternators should be rated for low rpms.

Start-Up Speed- This is the wind speed at which the rotor starts turning. It should spin smoothly and easily when you turn it by hand, and keep spinning for a few seconds. Designs that 'cog' from magnetic force or that use gears or pulleys to increase shaft speed will be poor at start up. A good design can start spinning in 5 mph winds and cut in at 7 mph.

Cut-In Speed- A wind generator does not start pushing power into the battery bank until the generator or alternator voltage gets higher than the battery bank voltage. Higher shaft speed means higher voltage in all generators and alternators, and you want to try and get the highest shaft speed possible in low winds--without sacrificing high-wind performance. Most commercial wind generators cut in at 8-12 mph. The generator's low-speed voltage performance, the design of the rotor (the blades and hub), and the wind behavior all factor into where cut-in will occur.

Voltage Regulation-- With battery-charging windmills, voltage control is not generally needed--until the batteries fill up. Even if your alternator is producing an open-circuit voltage of 90 volts, the battery bank will hold the system voltage down to its own level. Once the batteries are full, you'll need to send the windmill's output to a 'dump load' such as a heating element. This regulation can be done manually by simple turning on an electric heater, stereo, or lights. Automatic systems can be built or purchased too.

Battery Bank Voltage-- In addition to having less line loss, 24v and 48v power systems give other significant advantages in wind alternator systems. The primary consideration for the wind turbine builder or buyer, however, is that the alternator must be wound differently for different system voltages.

Inefficiency-- Every generator has a certain speed at which it runs most efficiently. But since the wind is not constant, we must try to design to a happy medium. As the wind speed rises, the raw power coming into the generator from the wind becomes more than the generator can effectively use, and it gets more and more inefficient. This power is wasted as heat in the stator coils. Alternators with wound fields can adjust the magnetic flux inside to run most efficiently, but PM alternators cannot. An alternator that uses many windings of thin wire will have better low-speed performance than one that uses fewer windings of thicker wire, but higher internal resistance. This means it will become inefficient more quickly when producing higher amperage as wind speeds and power output rise.
The formula used to calculate power wasted from inefficiency is:
AMPS^2 * RESISTANCE = Power wasted as heat in the alternator windings (in watts).

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Rotor/Turbine-A wind generator gets its power from slowing down the wind. The blades slow it down, and the alternator collects the power. BOTH must be correctly designed to work together and do this efficiently. We are not experts at blade design...we sort of started in the middle with a functioning design, and made changes from there. Really, you could make a simple set of blades with a straight 5 degree pitch down the entire length and they would work JUST FINE! But to really tune in the performance of your wind generator, it's important to pay attention to a few factors. ALSO--please forgive us when we slip up and refer to the rotor as a "prop" or "propeller"--it doesn't propel anything! Rotor is the proper term, not to be confused with the rotor of an armature.

Blade Material- Wood is really an ideal material for blades. It is very strong for its weight, easy to carve, inexpensive, and is resistant to fatigue cracking. Choose the best, straightest, most knot-free lumber you can find; pine and spruce are excellent. Hardwoods are generally too heavy. Steel and aluminum blades are much too heavy and prone to fatigue cracking; sheet metal would be a poor choice, and extremely dangerous...check out the photo of fatigue cracks on a sheet metal windmill TAIL in Ward's Prop Gallery and imagine what the vibration would do to sheet metal blades! Cast reinforced Fiberglas blades are very strong, and are common on commercial windmills--but the mold making process would take longer than carving a complete set of blades from wood, and there would be little or no gain in strength.

Diameter- Blades that are too short attached to a large alternator will not be able to get it moving fast enough to make good power. Blades that are too large for a small alternator will overpower and burn it up, or over speed to the point of destruction in high winds--there's not enough of an alternator available to collect the energy coming in from the wind.
Number of Blades -The ideal wind generator has an infinite number of infinitely thin blades. In the real world,

more blades give more torque, but slower speed, and most alternators need fairly good speed to cut in. 2 bladed designs are very fast (and therefore perform very well) and easy to build, but can suffer from a chattering phenomenon while yawing due to imbalanced forces on the blades. 3 bladed designs are very common and are usually a very good choice, but are harder to build than 2-bladed designs. Going to more than 3 blades results in many complications, such as material strength problems with very thin blades. Even one-bladed designs with a counterweight are possible.

Tip Speed Ratio (TSR)-This number defines how much faster than the wind speed the tips of your blades are designed to travel. Your blades will perform best at this speed, but will actually work well over a range of speeds. The ideal tip speed ratio depends on rotor diameter, blade width, blade pitch, RPM needed by the alternator, and wind speed. Higher TSRs are better for alternators and generators that require high rpms--but the wind speed characteristics at your particular site will make a big difference also. If in doubt, start in the middle and change your blade design depending on measured performance.

Taper- Generally, wind generator blades are wider at the base and narrower at the tips, since the area swept by the inner portion of blades is relatively small. The taper also adds strength to the blade root where stress is highest, gives an added boost in startup from the wider root, and is slightly more efficient. The ideal taper can be calculated, and it varies depending on the number of blades and the tip speed ratio desired. Hugh Piggott's Wind power Workshop book and his free Blade Design Notes contain the relevant formulas. Honestly, though...if you simply take a look at a picture of a functioning small-scale wind generator's blades and estimate the taper by the eyeball method, you will come very close to meeting the criteria and have a very functional blade. Our Basic Blades page gives a basic introduction to blade design and carving.

Pitch and Twist- As we've said before, a simple wind generator blade with a straight 5 degree pitch down the whole length would give adequate performance. There are advantages to having a twist, though--like with taper, having more pitch at the blade root improves startup and efficiency, and less pitch at the tips improves high-speed performance. The wind hits different parts of the moving blade 's leading edge at different angles, hence designing in some twist. One of our common blade designs that's right in the middle for design parameters is to build an even twist of 10 degrees at the root and 5 degrees at the tip--but the ideal solution will also depend on your alternator cut-in speed, efficiency and local wind patterns.

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Carving- Our layout and carving process is very simple after marking the cut depth at the trailing edge at both the root and tip, the two depths are connected with a pencil line. Dan likes to use a hand saw to make layout cuts into the blade every couple inches along the length before firing up the electric planer.when the saw kerfs disappear, the pitch is correct. DanB prefers to hack into it with a planer right from the start. In case you are fuzzy about how this all goes together, the drawings below might help.

Bearings-A bearing is a device to allow constrained relative motion between two or more parts, typically rotation or linear movement. Bearings may be classified broadly according to the motions they allow and according to their principle of operation as well as by the directions of applied loads they can handle.

III. WORKING PRINCIPLE

DESCRIPTION OF WORKING PRINCIPLE

A. Capturing wind induced by moving 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 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 the direction of the wind turbine.

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If the wind is properly directed towards the wind turbine blades, optimum electricity may be generated. The desired direction of wind is obtained 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 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 the 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 merely sit down and outline the shape when designing a new blade.

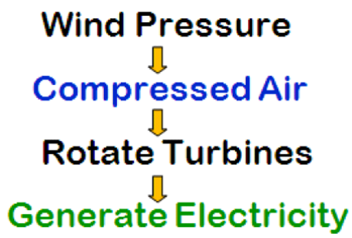

Fig 3. Process Involved

The aerodynamic profile is formed with a rear 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 separate 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 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 different portions of air shall be reunited at point B. Greater velocity produces a pressure drop on the rear 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 this 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 large. Most 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 gathers 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 the blade meets the head wind of its own movement.

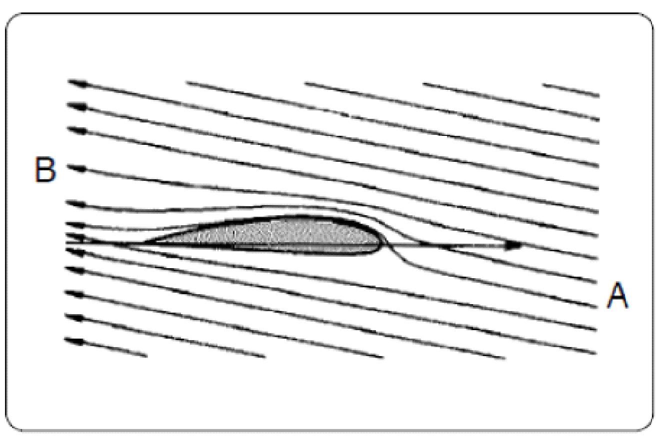

Fig 4. Aerodynamic Profile of Blade

The fast acceleration, near the wind turbines operational rotational speed, places great demands on the electrical cut-in system that must capture and engage the wind turbine without releasing excessive peak electrical loads to the grid. The desired direction may be transverse or parallel to the direction of plane of rotation of blades depending upon the type of wind turbine used or the direction of wind, or it the design of the wind turbines. The turbines are connected

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to electricity generator to generate electricity. The generated electricity may be used directly or stored in batteries which can be used at the time of need.

C. Converting the energy of the wind into mechanical energy by using wind turbine.

There are two primary physical principles by which energy can be extracted from the wind. These are through the creation of either lift or drag force (or through a combination of the two). Drag forces provide the most obvious means of propulsion, these being the forces felt by a person (or object) exposed to the wind. Lift forces are the most efficient means of propulsion but being more subtle than drag forces are not so well understood.

Lift is primary due to the physical phenomena known as Bernoulli's Law. This physical law states that when the speed of an air flow over a surface is increased the pressure will then drop. This law is counter to what most people experience from walking or cycling in a head wind, where normally one feels that the pressure increases when the wind also increases. This is also true when one sees an air flow blowing directly against a surface, but it is not the case when air is flowing over a surface.

D. Converting that mechanical energy into electrical energy by using a generating device.

The generator is the unit of the wind turbine that transforms mechanical energy into electrical energy. The blades transfer the kinetic energy from the wind into rotational energy in the transmission system, and the generator is the next step in the supply of energy from the wind turbine to the electrical grid.

The wind turbine may be connected to an electricity generator. The generated electricity may to be stored in pluralities of batteries from which energy may be used as per the need.

These turbines have been designed to power small units like compartments of train, recharging batteries, although we should mention that it is also quite easy to imagine how a specially designed wind turbine like this could sit on top of the train or at front and power its engine as you cruise along on the rail/road. This wind turbine was developed to be used as an alternative means to recharge communications equipment too.

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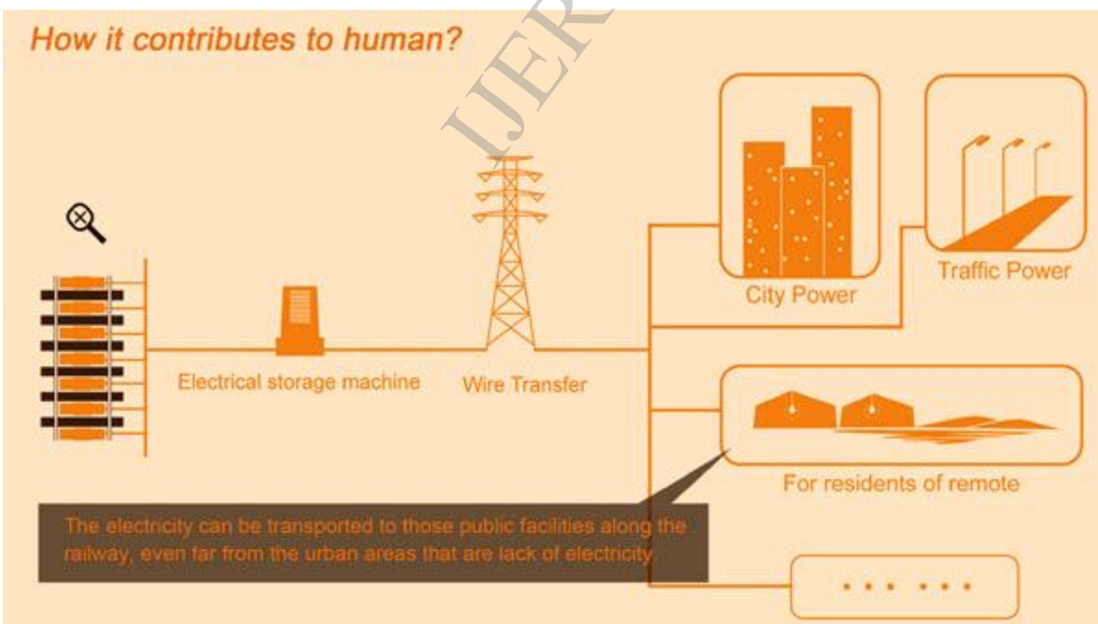

Fig 5. Developed power distribution

IV. DESIGN CALCULATIONS ASSUMPTIONS

1. Neglecting friction losses in all sections.

2. Vehicle moving with 93 kmh.
3. Velocity of wind is 7 m/sec.

Area of Blade

Discharge =2.5 m^3/min
Velocity of Wind, V = 7 m/s
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 7^3
P = 3.26 watt
P = 11.736 kWh

Torque

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

Calculation for Gears

N_1 = rpm of driving Gear= 300 rpm
N_2 = rpm of driven Gear300 x (37/19) = 584 rpm
T_1 = Number of teeth on = 37
T_2 = Number of teeth on= 19

Velocity Ratio = T_2/T_1
= 1.95
Power on D.C motor = 3.26 x 1.95
= 6.357 watt

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V. ECONOMICS AND FEASIBILITY

The cost of wind-generated electric power has dropped substantially. Since 2004, according to some sources, the price in the United States is now lower than the cost of fuel-generated electric power. In 2005, wind energy cost one-fifth as much as it did in the late 1990s, and that downward trend is expected to continue, as larger multi-megawatt turbines are mass-produced. A British Wind Energy Association report gives an average generation cost of onshore wind power of around £0.032 per kWh. Most major forms of electric generation are capital intensive, meaning that they require substantial investments at project inception, and low ongoing costs. This is particularly true for wind power, which have fuel costs close to zero and relatively low maintenance costs. Wind energy benefits from subsidies of various kinds in many jurisdictions, either to increase its attractiveness, or to compensate for subsidies received by other forms of production or which have significant negative externalities. It is possible to produce electricity from wind for as little as £0.02 per kWh, comparing with the cost of electricity from conventional sources. However, low cost generation is only possible on the windiest sites. Typically, electricity from wind will cost around £0.02-0.10 per kWh depending on scale and location.

VI. ADVANTAGES

a. The energy produce is environmental pollution free and does not cause any harm to

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environment.

b. Till now the energy which is waste can be utilized in developmental work.
c. Installation and maintenance charge is no to much high.
d. There is no damage to birds and animals.
e. Can be use to produce energy free electricity.
f. Can be use to pump water and develop a well maintained irrigation system.
g. Can be use to develop nearby villages and make it prosperous..
h. Can be use to maintain a biodiversity, wild life sanctuary or national park.

VII. CONCLUSION:

Wind has a lot of potential in it and if properly harnessed then it can help solve the energy crises in the world. The study of wind turbine and its characteristics showed that how it can be properly designed and used to get the maximum output. The power electronic circuitries have helped the concept of wind power a lot. Without them this concept would have been too expensive and farfetched. With the thyristors and converters being used not only the operations have been smoothened but also the efficiency has been increased to a great extent. From the voltage stability analysis it was showed that how a doubly fed induction generator has superior characteristics than a simple induction generator. This report also showed the integration of wind farms with the transmission grid and the problems associated with it and the probable solutions that can be applied to solve them and have a better performance

VIII. ACKNOWLEDGEMENT

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