International Journal of Engineering Research and Development
***e**-ISSN: 2278-067X, **p**-ISSN: 2278-800X, www.ijerd.com*
Volume 3, Issue 12 (September 2012), PP. 04-09

Harnessing Electrical Energy in Highways by Smart Wind Mill

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Abstract—In this paper my effective approach is to harness electrical energy from the highways by means of Vertical axis wind turbine. The smart wind mill consists of a stationary shaft which is mounted on the ball bearing on the top and bottom end of the shaft. The curvy darrieus blades are connected to the two ends of the bearing which is able to rotate on its own axis. In highways the vehicles moving on two different directions makes the wind turbine to rotate more effectively on its own axis in only one direction i.e. clockwise direction. The dynamo is connected to the either upper part or lower part of the wind turbine which works on Fleming's left hand rule of electromagnetic induction. The smart wind turbine is able to rotate more effectively as a result large amount of electricity is generated by more number of Vehicles passing by. In highways both at day as well as at night times vehicles will be moving at very high speed. So it is possible to get good efficiency as output. When the wind power gets increased certainly the number of rotations gets increased and we can get high output as electricity. Wind power is an alternate to fossil fuel which is plentiful, renewable widely distributed resource .Clean energy produces no greenhouse gases during its operation and requires little land. By this method the overall cost per unit of energy produced is less than the cost of new coal, natural gas and its installation. So the implementation can be made easier than any other methods.

Keywords—Blade design, Darrieus Blade, Green energy, Vertical Axis wind Turbine and Wind power.

I. GREEN TECHNOLOGY

Energy is the Fuel for development: The global demand for energy is rising rapidly due to massive urbanization of huge developing countries like China and India. As we realize that fossil fuels are going to run out, we're trying harder to develop other means of generating the electricity on which we depend. Renewable resources, such as solar, hydro-electric, tidal powers are particularly attractive, although they do have drawbacks.

II. DEMAND FOR ELECTRICITY

India has vast supply of renewable energy resources, even though **energy crisis** has become a great bottleneck in our sophisticated life. The total demand for electricity is expected to cross 2550,000 MW by 2030. The electrical sector have an installed capacity of 185.5 GW as of November 2011. The thermal power plant constitutes 65% , hydroelectricity has 25% and the rest is the combination of wind and solar power. In January 2012, over 700 million citizens had no access to electricity, and many people get electricity intermittently. Electrical consumption as per 2012 was 130 KWh in rural areas and 300 KWh in urban areas. India is currently suffering from major shortage for electricity. India should become one of the leading power producers in the world, but the current technologies are not sufficient to achieve our goal.

III. MY GREEN IDEA FOR POWER GENERATION!

To overcome the above problem, we need to implement the new technologies in production of energy. Smart Wind power is the conversion of wind energy into useful form of energy such as electric energy by using wind turbines in the middle or either sides of the highways to generate electricity. Wind power is an alternate to fossil fuels which is plentiful, renewable widely distributed .clean energy produces no green house gases during its operation and requires little land. So, we suggest that the energy can be harnessed in highways or roadways by placing the smart wind turbine in the middle of the highways. The smart wind turbine rotates more effectively because of the wind power generated in the roadways due to large number of vehicles passing at very high speed. The smart wind turbine consists of the shaft which is mounted on the blades and the bottom end is connected to the generator. When the wind power increases certainly the number of rotations gets increased. So we can get large *a*mount of electricity for domestic purposes. In this overall cost per unit of energy produced is less than the cost of new coal, natural gas and its installation. So the implementation can be made easier than any other methods.

IV. INNOVATION INVOLVED IN SMART WIND MILL

My effective innovative approach is a smart windmill which can overcome the problems in the present wind mill and finds a new way to make use of the wasted wind power in the roadways and highways. The smart wind mill does not occupy large acres or area to install the plant and we need not find any new place to install the plant. And It will not affect any birds and other creatures. Which have a main impact of not produce any unwanted noises.

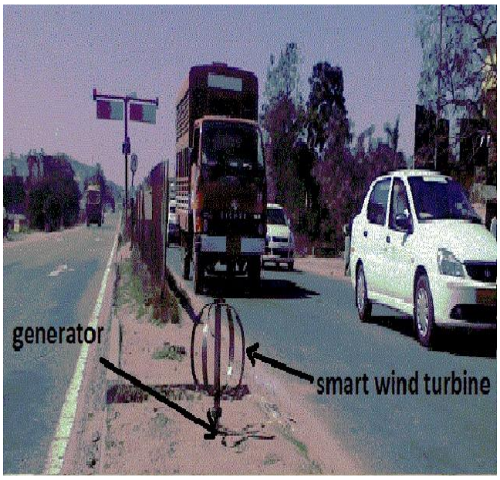

Figure No.2

The figure given above is my practical implementation of the smart wind mill in the middle of the highways.

V. GENERATOR

An **electric generator** is a device that converts mechanical energy to electrical energy. The reverse conversion of electrical energy into mechanical energy is done by a motor; motors and generators have many similarities. A generator forces electrons in the windings to flow through the external electrical circuit. It is somewhat analogous to a water pump, which creates a flow of water but does not create the water inside.

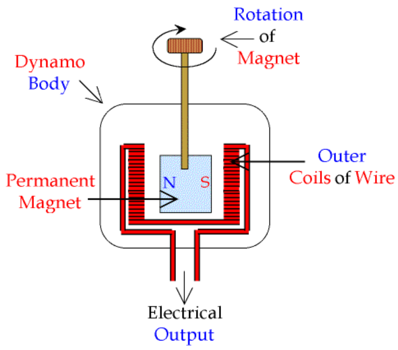

Fig No. 3: Generator

The source of mechanical energy may be a reciprocating or turbine steam engine, water falling through a turbine or waterwheel, an internal combustion engine, a wind turbine, a hand crank, compressed air or any other source of mechanical energy.

VI. THE POWER OF WIND

Wind is made up of moving air molecules which have mass - though not a lot. Any moving object with mass carries **kinetic energy** in an amount which is given by the equation:

$$\textbf{Kinetic Energy} = 0.5 \times \textbf{Mass} \times \textbf{Velocity}^2$$

where the mass is measured in **kg**, the velocity in **m/s**, and the energy is given in **joules**.

Air has a known density (around 1.23 kg/m^3 at sea level), so the mass of air hitting our wind turbine (which sweeps a known area) each second is given by the following equation:

$$\textbf{Mass/sec (kg/s)} = \textbf{Velocity (m/s)} \times \textbf{Area (m}^2\textbf{)} \times \textbf{Density (kg/m}^3\textbf{)}$$

And therefore, the **power** (i.e. energy per second) in the wind hitting a **wind turbine** with a certain swept area is given by simply inserting the *mass per second*calculation into the standard kinetic energy equation given above resulting in the following **vital** equation:

$$\textbf{Power} = 0.5 \times \textbf{Swept Area} \times \textbf{Air Density} \times \textbf{Velocity}^3$$

where **Power** is given in Watts (i.e. joules/second), the **Swept area** in square metres, the **Air density** in kilograms per cubic metre, and the **Velocity** in metres per second.

VII. EFFICIENCY OF SMART WIND MILL

The efficiency of the smart wind mill mainly depends on the size of the wind blade and nature of the environment such as velocity of the wind. The efficiency of the smart wind turbine can produce minimum of 32% of output where the threshold amount of the wind is 5 mps. And this produces a maximum output efficiency of 92% when wind velocity is more than 11mps.Small wind turbines are generally considered to be those with generation capacities of less than 100 kW. These smaller turbines can be used to power remote or off-grid applications such as homes, farms, refuges or beacons. Intermediate-sized wind power systems (100 kW to 250 kW) can power a village or a cluster of small enterprises and can be grid-connected or off-grid. These turbines can be coupled with diesel generators, batteries and other distributed energy sources for remote use where there is no access to the grid. Small-scale wind systems remain a niche application, but it is a market segment that is growing quickly.9 They are emerging as an important component of renewable electrification schemes for rural communities in hybrid off-grid and mini-grid systems

VIII. THE WIND SPEED AND ELECTRICITY PRODUCTION

As wind speed increases, the amount of available energy increases, following a cubic function. Therefore, capacity factors rise rapidly as the average mean wind speed increases. A doubling of wind speed increases power output of wind turbine by a factor of eight (EWEA, 2009). There is, therefore, a significant incentive to site. wind farms in areas with high average wind speeds. In addition, the wind generally blows more consistently at higher speeds at greater heights. For instance, a fivefold increase in the height of a wind turbine above the prevailing terrain can result in twice as much wind power. Air temperature also has an effect, as denser (colder) air provides more energy. The smoothness" of the air is also important. Turbulent air reduces output and can increase the loads on the structure and equipment, ncreasing materials fatigue, and hence O&M costs for turbines. The maximum energy than can be harnessed by a wind turbine is roughly proportionally to the swept area of the rotor. Blade design and technology developments are one of the keys to increasing wind turbine capacity and output. By doubling the rotor diameter, the swept area and therefore power output is increased by a factor of four.

Tabulation for Output Efficiency for the above model:

S.N	Velocity of wind	Efficiency
1	5 mps	32%
2	8 mps	65%
3	11 mps	92%

IX. INSTALLATION AND MAINTENANCE COST OF DARRIEUS- VAWT

- **The levelised cost of electricity** from wind varies depending on the wind resource and project costs, but at good wind sites can be very competitive. The LCOE of typical new onshore wind farms in 2010 assuming a cost of capital of 10% was between USD 0.06 to USD 0.14/kWh. The higher capital costs o.shore are somewhat o.set by the higher capacity factors achieved, resulting in the LCOE of an o.shore wind farm being between USD 0.13 and USD 0.19/kWh assuming a 10% cost of capital.
- **The potential for renewed cost reductions is good**, as supply bottlenecks have been removed and increased competition among suppliers will put downward pressure on prices in the next few years.

  Assuming that capital costs onshore decline by 7% to 10% by 2015, and O&M costs trend towards best practice, the LCOE of onshore wind could decline by 6% to 9%. The short-term cost reduction potential for wind is more uncertain, but the LCOE of o.shore wind could decline by between 8% and 10% by 2015.
- **In the medium-to long-term**, reductions in capital costs in the order of 10% to 30% could be achievable from learning-by-doing, improvements in the supply chain, increased manufacturing economies of scale, competition and more investment in R&D.

X. DIFFEERENT MEASURES OF COST AND DATA LIMITATIONS

Cost can be measured in a number of different ways, and each way of accounting for the cost of power generation brings its own insights. The costs that can be examined include equipment costs (e.g. wind turbines, PV modules, solar reflectors, etc.), financing costs, total installed cost, fixed and variable operating and maintenance costs (O&M), fuel costs, and the levelised cost of energy (LCOE). The analysis of costs can be very detailed, but for comparison purposes and transparency, the approach used here is a simplified version. This allows greater scrutiny of the underlying data and assumptions, improving transparency and the confidence in the analysis, as well as facilitating the comparison of costs by country or region for the same technologies in order to identify what are the key drivers in any differences. The three indicators that have been selected are:

- Equipment cost (factory gate FOB and delivered at site CIF);
- Total installed project cost, include fixed financing costs
- The levelised cost of electricity LCOE

XI. LEVELISED COST OF ELECTRICITY GENERATION

The LCOE is the price of electricity required for a project where revenues would equal costs, including making a return on the capital invested equal to the discount rate. An electricity price above this would yield a greater return on capital, while a price below it would yielder a lower return on capital, or even a loss. The LCOE of renewable energy technologies varies by technology, country and project, based on the renewable energy resource, capital and operating costs, and the efficiency/performance of the technology. The approach used in the analysis presented here is based on a simple discounted cash flow (DCF) analysis. This method of calculating the cost of renewable energy technologies is based on discounting financial flows (annual, quarterly or monthly) to a common basis, taking into consideration the time value of money. Given the capital intensive nature of most renewable power generation technologies and the fact that fuel costs are low, or often zero, the weighted average cost of capital (WACC), also referred to as the discount rate in this report, used to evaluate the project has a critical impact on the LCOE. There are many potential trade-offs to be considered when developing an LCOE modeling approach. The approach taken here is relatively simple, given the fact that the model needs to be applied to a wide range of technologies in different countries and regions. However, this has the additional advantage of making the analysis transparent, easy to understand and allows clear comparisons of the LCOE of individual technologies across countries and regions, and between technologies. The differences in LCOE can be attributed to project and technology performance, not differing methodologies. More detailed LCOE analysis may result in more "accurate" absolute values, but results in a significantly higher overhead in terms of the granularity of assumptions required and risks reducing transparency. More detailed methodologies can often give the impression of greater accuracy, but when it is not possible to robustly populate the model with assumptions, or to differentiate assumptions based on real world data, then the supposed "accuracy" of the approach can be misleading. The formula used for calculating the LCOE of renewable energy technologies is:

$$\text{LCOE} = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Where:
LCOE = the average lifetime levelised cost of electricity generation;
It = investment expenditures in the year t;
Mt = operations and maintenance expenditures in the year t;
Ft = fuel expenditures in the year t;
Et = electricity generation in the year t;
r = discount rate; and
n = economic life of the system.

XII. ADVANTAGES OF DARRIEUS-VAWT

A key challenge for Darrieus-VAWT is that they are generally located close to settlements where wind speeds are often low and turbulent as a result of surrounding trees, buildings and other infrastructure. Designing reliable small wind turbines to perform in these conditions where noise levels must be very low is a challenge. As a result, there is increased interest in vertical-axis technologies given that:

1. They are less affected by turbulent air than standard horizontal-axis wind turbines.
2. Have lower installation costs for the same height as horizontal-axis wind turbines.
3. They require lower wind speeds to generate, which increases their capacity to serve areas with lower than average wind speeds.
4. They rotate at one-third to onequarter the speed of horizontal-axis turbines, reducing noise and vibration levels, but at the expense of lower efficiency.

XIII. TOTAL INSTALLED CAPACITY

The wind power industry has experienced an average growth rate of 27% per year between 2000 and 2011, and wind power capacity has doubled on average every three years. A total of 83 countries now use wind power on a commercial basis and 52 countries increased their total wind power capacity in 2010 (REN21, 2011). The new capacity added in 2011 totalled 41 GW, more than any other renewable technology (GWEC, 2012). This meant total wind power capacity at the end of 2011 was 20% higher than at the end of 2010 and reached 238 GW by the end of 2011

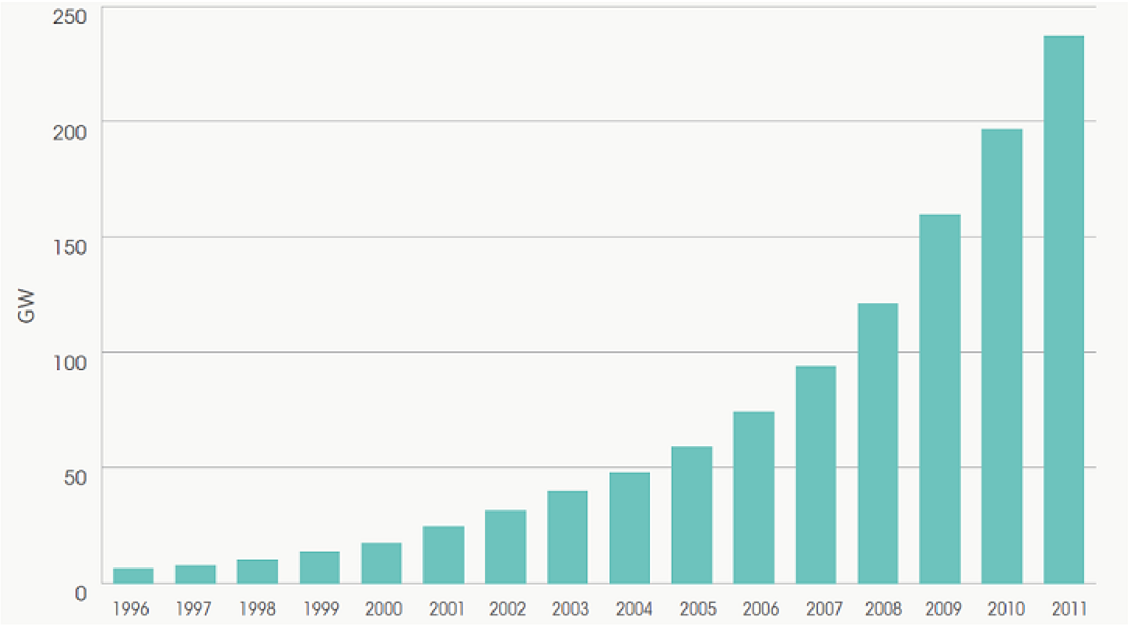

Fig. No. 4

Europe accounted for 41% of the global installed wind power capacity at the end of 2011, Asia for 35% and North America for 22%. The top ten countries by installed capacity accounted for 86% of total installed wind power capacity worldwide at the end of 2011 (Figure 3.2). China now has an installed capacity of 62 GW, 24 times the capacity they had in 2006. China now accounts for 26% of global installed capacity, up from just 3% in 2006. Total installed capacity at the end of 2011 in the United States was 47 GW (20% of the global total), in Germany it was 29 GW (12%), in Spain it was 22 GW (9%) and in India it was 16 GW (7%).

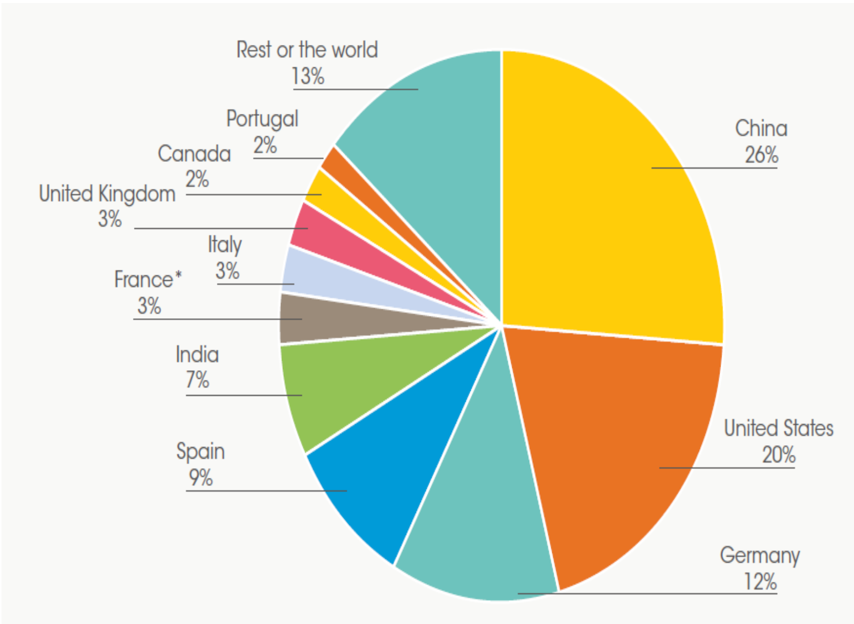

Fig.No. 5

XIV. CONCLUSION

If we implement this method surely we can shift our country into a new dimension that is we need not depend upon any other country for electricity. Energy independence is the ability of a country or region to meet all its own energy needs. An energy dependent country is a country that has to import energy to meet its energy needs energy needs. Whereas a country which has achieved energy independence can produce, transform and transport the energy that it consumes by itself.

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