A Novel Design for Highway Windmill through Re-engineering

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Abstract: The purpose of this project is to design a wind turbine which recaptures wind energy from vehicles on the highway. Wind energy is considered as the fastest growing clean energy source; although it is limited by variable natural wind. Highways are good source of wind which left behind wind by the fast-moving vehicle traffic. This wind is useless till it can be used to drive the fan of the wind turbine. This energy is not only unmeasured in potential but also being witnessed going to waste. This energy is unused and could prove to be a boon for power related problems. A preliminary investigation of the characteristics of this VAWT has been done, and a data set has been collected. The objective to design this prototype wind turbine through the re-engineering is to generate power from the wind of the moving vehicle which remains unused. The design of the wind turbine is simple, and it is a low-cost wind turbine. Previously, these wind mills were established in rural areas. The main motive of this project is to install this wind mill in cities for better production of electricity. The wind draft behind the turbine is used as a source, which rotates the blades of wind turbine. This project idea is going to supersede the profanation in atmosphere which was indicted due to scalded fossil fuel.

Keywords: Wind Power, Re-engineering, Highway, Windmill Component.

1. Introduction:

From the advent of 21st century, the need of power rose to levels like never before. As much as new ways were developed still billions of people are living without electricity. According
to estimates that number is about a quarter of total population living on the planet which is both shocking and disturbing. In India only 78.7% of population has access to electricity which translates to thousands of villages still living without even a bulb [1]. With ever increasing population and depleting natural resources it is an alarming situation especially for country likes ours, India and other developing nations as well. The reason being our primary sources for generating electricity are fossil fuels [2]. This project or design started as an exploration about ten months back. Here the authors would like to stress on the word – ‘reengineering’, by reengineering they targeted to make a model which was unlike any made before, using materials which were usable and lying in machines that were not usable. The authors later realized how useful such small wind turbine could be in rural coastal areas.

2. WHY WIND ENERGY AS A SOURCE OF ENERGY:

Wind is a source of energy which is extracted from the blowing wind and is then converted into electricity. This conversion is carried out with the help of wind turbines, wind pumps etc. which are connected with blades which rotates when moving air applies a force on it. The main cause of taking wind as a source for power production is the rapid consumption as well as less availability of the non-renewable resources in present days [3]. This kind of natural fuel has come out to be an excellent alternative fuel and is considered to be extremely beneficial with its super merits which include:

- Wind energy is naturally available and can be easily used at a huge demand with negligible human effort.
- It doesn’t pollute nature at all due to zero greenhouse gas emission.
- Round the clock availability everywhere on earth’s surface.
- It can be used in large as well as small scale power production.
- As per return of interest (ROI) the best renewable resource.

Wind is among the best possible source which can be utilized anywhere, anytime and places from high attitude areas to coastal areas through wind turbines. It can be used again and again as many times needed. Wind energy has even helped for employment for the people in manufacturing sector from the constructions, development, installations of the wind turbines to the maintenance criterion [4].

Wind energy has also overtaken many power generation systems like solar panels, gas products etc. with its higher availability, low maintenance and it has even stood high on the scale where the need of petroleum and diesel has been in so much need. Today wind energy is
answered, emphasized and recommend as the first option in any kind of power generation system by every developed and developing countries.

According to the latest study it’s been observed that the wind power generation has increased by 2.5% of the world’s electricity in 2011, before it was 0.5% in 1997 which jumped up to 1.5% in the year 2008. The wind energy usage is continuously increased by the new techniques and modern engineering ideas. Many countries like Denmark and Portugal, wind power has contributed around 20% of the total electricity production and it is even increasing with every day [5,6].

The only demerit faced while using wind as a source is the speed at which it blows. The lesser speed of the flowing wind the lesser it the power production or may even pause the production work.

Hence, with the fastest growing mode of power/electricity production and helping to lighting up so many houses and streets, wind is chosen to be the best source in every possible case.

3. DESIGN OF BLADES OF OUR DESIGN:

Modified standard Savonius type blades have been used; the blades have been curved at the bottom and twisted at certain angles. These blades are cut out of used buckets of paint. So, essentially it was a HDPE grade plastic from a raw material perspective. This not only keeps it lightweight but also aligns with the goal of keeping this project green as much as possible. This new modification contributes in getting more drag force.

Fig. 1: Blades of wind mill made by plastic paint cans.
4. ELECTRICAL GENERATOR USED: DYNAMO

A dynamo is used in this assembly for conversion of mechanical energy to electrical energy. Its rating is 12 V. Dynamos basically are DC generators. Staying committed to making this a reengineering project; the dynamo has been procured from an old model lying dusted. Any alternator, permanent magnet generator with low rpm could have solved this purpose.

![Gear mechanism used in wind mill.](image)

5. GEAR MECHANISM:

Teeth ratio of the VAWT design is set to 3:1. The driving gear has double the number of teeth compared to that of driven gear. The driven gear is then connected to the shaft of dynamo. Gears have been sourced from building block games used for making robots or cars. A higher teeth ratio was intended to be implemented in this VAWT Turbine but due to unavailability of parts the idea was dropped.
6. THE COMPLETE MODEL

In this design, a shaft has been used to support the blades on top. Two bearings are there to rectify any changes in moment of inertia as speed of rotation increases. A custom tripod stand design has been welded to support the complete structure. Cost of the project has been minimized to the highest extent possible by using reusable parts.

7. EXPERIMENTAL ANALYSIS:

This data has been generated by simulating the wind sources. Cars and two-wheelers were used to create a substantial flow of wind. In further testing other artificial sources of wind were used. The results are encouraging. Digital tachometer has been made use for RPM measurement and Digital Multimeter has been used for volts measurement. Results have been shown in the Graph 1 & Table 1.
8. CONCLUSIONS:

The concerned VAWT model has produced quite satisfactory results. On seeing positive early stage results, attempts were made to enhance those results and fortunately those attempts were successful. At the completion of this project, the authors have learnt something new and are ready to apply this knowledge in future engineering projects as well as in various challenging aspects of life. Similar designs are already being used for testing purposes in many nations around the world. Arizona State University also conducted research in this direction. In Germany too, such designs are seen. They also found a way to look up for maintenance in future by giving it such a design that advertisement hoardings could also be put up on the structure. So, it is safe to say that future looks promising for such designs.

The presented VAWT has yielded quite good results in highway applications. It will be quite successful in areas which are naturally windy such as coastal areas. The model itself can be designed in some modified ways. The authors had a limited knowledge of aerodynamics and blades design. So, may be with more knowledge in future a better design could be come up with. On the applications prospective, wind energy generation is getting much traction in recent times. After solar energy it has the highest throughput among other non-conventional energy resources [7]. The presented wind turbine can also be used in conjunction with solar energy to make it perform better giving it an autonomy period in case wind energy is not available. This model could also be used in metro subways. This was a potential that will be explored since wind generated by metros is quite high compared to other.

| S. No. | RPM | Volt generated (V) |
|-------|-----|--------------------|
| 1     | 10  | 0.07               |
| 2     | 20  | 0.15               |
| 3     | 45  | 0.23               |
| 4     | 55  | 0.36               |
| 5     | 60  | 0.4                |
| 6     | 80  | 0.46               |
| 7     | 90  | 0.51               |
| 8     | 100 | 0.54               |
| 9     | 120 | 0.63               |
| 10    | 140 | 0.74               |
| 11    | 160 | 0.85               |
| 12    | 180 | 1.1                |

Table 1: RPM Vs. Volt Generated.
References

[1] Pereira, Marcio Giannini, et al. "Evaluation of the impact of access to electricity: A comparative analysis of South Africa, China, India and Brazil." Renewable and Sustainable Energy Reviews 15.3 (2011): 1427-1441.

[2] Abbasi, T., & Abbasi, S. A. (2010). Biomass energy and the environmental impacts associated with its production and utilization. Renewable and Sustainable Energy Reviews, 14(3), 919-937.

[3] Ahmed, S. (2015). Wind energy: theory and practice. PHI Learning Pvt. Ltd.

[4] Abdullah, M. A., Yatim, A. H. M., Tan, C. W., & Saidur, R. (2012). A review of maximum power point tracking algorithms for wind energy systems. Renewable and sustainable energy reviews, 16(5), 3220-3227.

[5] Liu, Yijin, et al. "Comparison study of tidal stream and wave energy technology development between China and some Western Countries." Renewable and Sustainable Energy Reviews 76 (2017): 701-716.

[6] Bajpai, Shrish, and Naimur Rahman Kidwai. "Renewable Energy Education in India." Comparative Professional Pedagogy 7.4 (2017): 103-113.

[7] Mohammed, Y. S., Mustafa, M. W., & Bashir, N. (2014). Hybrid renewable energy systems for off-grid electric power: Review of substantial issues. Renewable and Sustainable Energy Reviews, 35, 527-539.
