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# Design and Development of Wind Energy Harvesting Equipment using Savonius Turbines

Mr. Samarth G. Gaikwad[1], Mr. Virendra P.Patil[2]
[1]B.E Student, Department of Mechanical Engineering,DKTE Society's Textile & Engineering Institute Ichalkaranji, Maharashtra, India
[2]B.E Student, Department of Mechanical Engineering, Padmabhooshan Vasantraodada Patil Institute of Technology, Budhgaon, Maharashtra, India

***Abstract: This research work present energy harvesting methods and the use of wind energy using VAWT (Vertical Axis Wind Turbine). .Energy harvesting is the technique of utilizing the energy which is going to be waste. There is lot of techniques to utilize this energy. Wind energy is the great source of the renewable source of the energy. In this project we are going to harvest the energy of wind by using savonius wind turbines of small size. The energy from wind is converting into mechanical energy by rotor or turbine and this transfer to small dc motor cum generator. This energy is then directly converted into electricity by generator. If this can be implemented in wide range then it can be a great source of energy.***
***Keyword: Energy harvesting, Wind energy, VAWT, Savonius turbine, Mechanical energy.***

## I. INTRODUCTION

With populations increasing exponentially and our natural resources being exhausted by increases in demand, it is more important to invest in renewable energy. Our consumption of fossil fuels as energy has been traced to be a leading cause in environmental issues. The by-product of fossil fuel consumption is carbon dioxide, which has been named to be a primary constituent leading to Global Warming. The amount of carbon dioxide that someone or something produces is known as its "carbon footprint." The media has been focusing on this issue and many green movements have started to try and reduce our "carbon footprint." There are only a few types of energy that do not produce carbon dioxide. These are nuclear power and renewable energy sources such as wind, solar and hydro power. Renewable energy sources are the cleanest from of these sources, because there is no waste formed as by-product of these sources. Nuclear energy produces nuclear waste which could take up to but not limited to 100 years until it can be disposed of properly. Wind turbines have been used throughout the world to generate electricity from off shore wind farms to residential smaller scale wind turbines.

### *A. Wind Energy- Renewable Energy Source*

Wind results from air in motion. Air in motion arises from a pressure gradient. On a global basis one primary forcing function causing surface winds from the poles towards the equator is convective circulation. Solar radiations heats the air near equator, and this low density heated air is buoyed up. At the surface it is displaced by cooler more dense higher pressure air flowing from the poles. In the upper atmosphere near the equator the air thus tends to flow back towards the pole and away from the equator. The net result is global convective circulation with surface winds from north to south in northern hemisphere.

Any device capable of slowing down the mass of moving air, like a sail or propeller can exert a part of energy and convert it into useful work. There are three factors determine the output from the wind energy converter:

*1)* The wind speed.
*2)* The cross section of wind swept by rotor.
*3)* The overall conversion efficiency of the rotor, transmission system and generator.

The amount of energy that captured from the wind is exponentially proportional to the speed of the wind. If a wind were perfectly efficient, the power generated is approximately equal to:

$$P \text{ (watts)} = 1/2 \times p \times A \times V^3$$

p = density of air (kg/m3)

A = Area of blade (m2)

V = velocity of wind (m/s)

Air density at sea level and 14 degrees p = 1.225 Kg/m3.

Therefore, if wind speed is doubled, the power in the wind increases by a factor of eight, i.e. 2 x 2 x 2. In reality, because wind turbines are not perfectly efficient, changes in wind velocity do not have such a dramatic effect on wind power. Betz' Law states that you can only convert approximately 59 % of the wind energy to mechanical energy using a wind turbine. However, small changes in velocity do impact on available energy, making wind speed an important factor to consider in the placement of a wind turbine.

*B. Wind Turbines*

Conversion of the kinetic energy if the wind into mechanical energy that can be Utilized to perform work or to generate electricity. Most machines for converting wind energy into mechanical energy consist basically a number of sails, vanes or blades radiating from hub or central axis. The axis may be horizontal or vertical. Based on the axis of rotation wind turbine has mainly two types that is:

1) *Horizontal axis wind turbine (HAWT):* Horizontal-axis wind turbines **(**HAWT**)** have the main rotor shaft and electrical generator at the top of a tower, and may be pointed into or out of the wind. Small turbines are pointed by a simple wind vane, while large turbines generally use a wind sensor coupled with a servo motor. Most have a gearbox, which turns the slow rotation of the blades into a quicker rotation that is more suitable to drive an electrical generator.

Fig no 1: Horizontal axis wind mill

2) *Vertical axis Wind Turbine (VAWT):* A vertical-axis wind turbine (VAWT) is a type of wind turbine where the main rotor shaft is set transverse to the wind (but not necessarily vertically) while the main components are located at the base of the turbine. This arrangement allows the generator and gearbox to be located close to the ground, facilitating service and repair. VAWTs do not need to be pointed into the wind, which removes the need for wind-sensing and orientation mechanisms.

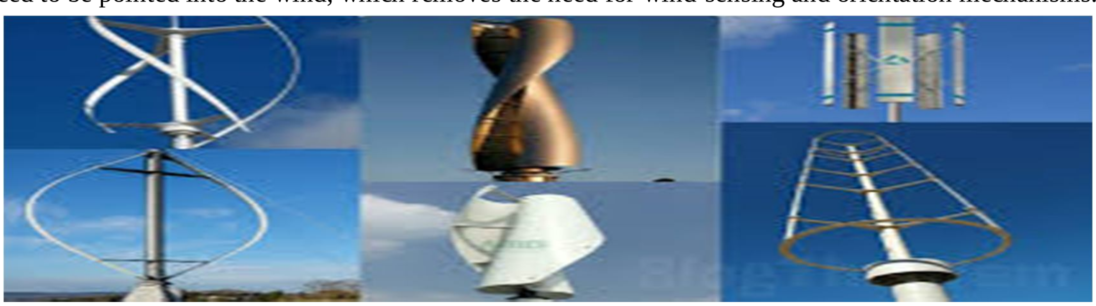

Fig no 2: Vertical Axis Wind mill

## II. PROBLEM DEFINITION

India and rest of the world mostly depends on non-renewable sources of energy to meet the energy requirements. While considering the renewable energy sources, it contributes below 20 percent in global production of power, rest energy is generated by conventional sources which causes to pollution and many environmental problems. Still there is lack of power generation than the requirement and is very vital problem in the country. In this project we are going to deal with this problem by utilizing the wind energy of small speeds through a vertical axis wind turbine. We use the Savonius type turbine with some modification in conventional design to get improved performance. Its working principle is similar to conventional turbine. If we use it in bulk quantity we can get more output. These turbines can be located in any place where small amount of wind flow is available say in floor of houses in urban as well as rural areas, on open grounds and near the high ways, roads etc. For better space utilization we can arrange on a tree like shape bases.

## III. CURRENT SCENARIO

The current population of India is 1.28 billion people accounting for more than 17.5% of world's population. Out of which, 32% is urban and rest is rural. It faces a formidable challenge in providing adequate energy supplies to users at a reasonable cost. India's energy challenge is of fundamental importance. In the last six decades, energy use has increased 16 times and the installed electricity capacity by 84 times. Overall generation in the country has been increased from 967.150 BU during 2013-14 to 1048.673 BU during the year 2014-15.Nevertheless, India as a country suffers from significant energy poverty and pervasive electricity deficits. In recent years, India's energy consumption has been increasing at a relatively fast rate due to population growth and economic development, even though the base rate may be somewhat low. With an economy projected to grow at 8-9% per annum, rapid urbanization and improving standards of living for households, the demand is likely to grow significantly. The broad vision behind India's integrated energy policy is to reliably meet the demand for energy services of all sectors including the lifeline energy needs of vulnerable households in all parts of the country with safe, clean and convenient energy at the least-cost. This must be done in a technically efficient, economically viable and environmentally sustainable manner using different fuels and forms of energy, conventional and non-conventional, as well as new and emerging energy sources to ensure supply at all times with a prescribed confidence. While considering current wind energy generation status of the India. More than 95 percent of total nation's wind energy generates from just five states located in southern and western India i.e. Gujarat, Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh. These five states are also accounted for approximately 85 percent of total installed capacity before the end of 11 th five yearly plans. It clearly indicates that these five states have been leaders in wind energy generation while other states like Madhya Pradesh, Rajasthan and Kerala are also quickly increasing their capacity.

## IV. ENERGY HARVESTING

Energy harvesting or energy scavenging is the process of extracting small amount of ambient environment through various sources of energy. The available energy' from energy for harvesting is mainly provided by ambient light (artificial and natural lighting), ambient radio frequency, thermal sources and mechanical sources. Reduction in size and energetic demands of sensors, and the low power consume circuitry opened trend in CMOS electronic opened novel research lines on battery recharge via available power sources. Harvesters can be employed as battery rechargers in various environments, such as industries, houses, the military (as for unmanned aerial vehicles) and handheld or wearable devices. The possibility to avoid replacing exhausted batteries is highly attractive for wireless networks (Wireless Sensor Networks), in which the maintenance costs due to battery check and replacement are relevant. Another emerging field of application is biomedical systems, where the energy could be harvested from an off-the-shelf piezoelectric unit and used to implement drug delivery systems or tactile sensors. Recent research also includes energy conversion from the occlusal contact during chewing by means of a piezoelectric layer and from heart beats. We can classify the main energy harvesting technologies by the hierarchy. Motion harvester systems can be structured as follows: the harvester collects inputs through its frame, directly connected to the hosting structure and to the transducer, at the end of the system chain; a conditioning circuit manipulates the electrical signals. This project specifically focuses on piezoelectric motion harvesting techniques. The possibility and the effectiveness of extracting energy from human activities have been under study for years. As a matter of fact, continuous and uninterrupted power can potentially be available: from typing (—mW), motion of upper limbs (-10 mW). And air exhalation while breathing (— 100 mW), walking (—W) and in this work we review state of the art of motion based energy harvesting. Among available motion based harvesting techniques, piezoelectric transduction offers higher power densities in comparison to electrostatic transduction (which also needs an initial polarization).

## V. LITERATURE VIEW

Wenlong Tian at al. Investigated in his paper named "Computational Fluid Dynamics Prediction of a Modified Savonius Wind Turbine with Novel Blade Shapes" that the effect of blade fullness, which is a main shape parameter of the blade, on the power production of a two-bladed Savonius wind turbine is investigated using transient computational fluid dynamics (CFD). Simulations are based on the Reynolds Averaged Naiver-Stokes (RANS) equations with a renormalization group turbulent model.

B. A. Bhayo et al. presents and discusses in their paper named "Optimization of Savonius rotor for wind turbine" the results from an experimental investigation of three models of wind S-rotors. Models I is modified from conventional Savonius rotor with a single stage and zero offsets zero overlaps; model 2 is three blade single stage wind rotor and model 3 is double stage conventional Savonius rotor. The three models were designed. Fabricated and characterized in terms of their coefficient of performance and dynamic torque coefficient. A special open wind simulator was designed for the test.The optimum parameters for the models were based on previous studies.

Mohammed Hadi Ali et.al. Compares and investigates in his paper named "Experimental Comparison Study for Savonius Wind Turbine of Two & Three Blades at Low Wind Speed." For that purpose he were designed two models of two and three blades and fabricated from Aluminium sheet, each of them has an aspect ratio of ( As = WI) =l), the dimension is ( H = 200 mm height and diameter D 200 mm) and the blades were made Of semi — cylindrical half of diameter (d = 100 mm). The two models were assembled to have (overlap e = 0 and a separation gap e = O).It was observed from the measured and calculated results that the two blades savonius wind turbine is more efficient, it has higher power coefficient under the same test condition than that of three blades savonius wind turbine. The reason is that increasing the number of blades will increase the drag surfaces against the wind air now and causes to increase the reverse torque and leads to decrease the net torque working on the blades of savonius wind turbine.
Albani, M.Z. Ibrahim et.al Suggested in their paper named "Preliminary Development Of Prototype Of Savonius Wind Turbine for Application in Low Wind speed in Kuala Terengganu, Malaysia" that, at some location the lower average wind speed become one of the factors wind turbines has not been used widely as an alternative method for generating the electric power. Thereby, small scale wind turbine which can generate electric power in low Wind speed must be designed. In this study, a Savonius Of vertical axis wind turbine (VAWT) has been designed fabricated and its performances were tested. A simulate calculation also has been made to expect the power output generated by designed prototype. From the study, found that although low wind speed, small scale wind turbine still can perform its function and generate electric power.

## VI. DESIGN OF TREE STRUCTURE:

In the project the tree shaped structure is just for supporting the turbine as a single unit. It may not be necessary to design the all tree structure as per the standard procedure.
So we shape the structure by considering the following points.

1) *Wind Flow:* Wind flow effects on the rotation of the turbine. When wind flows it strikes on the turbine which also comes out from the other turbine through eccentricity. While wind strikes on the turbine it may create eddies which may be effect on wind that going to flow on other turbine. But for smooth flow of the turbine this must not occur in actual practice. Therefore, Design Of that structure is done mainly by considering the resistance of wind flow of the flowing Wind and the Wind come out from the other turbine. As per this consideration turbine must be suitably placed on the tree structure. For that purpose we place the each turbine 500 mm apart from each other.
2) *Load Carrying by the Tree Structure:* The tree is taking load to the dc motors and the self-weight of the structure. The static dynamic turbines, while the turbines are rotating is little bit higher due to requires loading I with more strength. If we use the PVC for the support as well as for the limbs, it may get break at the joints of the limb. Also it may not get more rigid support in dynamic loading condition. By considering this point we used the MS bar for the supporting which has more strength than PVC material. The PVC limb structure apply less self-weight than that of metal so it we prefer PVC material for the limb structure. Due to this it may sustain with more load in conditions.
3) *Easy Assembly and Wiring:* To get and summation of all outputs of turbine motors we need to connect all the motors in series connection. But the series connection may create more wiring part in the project and it also look so critical if it keep open. Also the main purpose to use hollow PVC pipes is that it can be easily assemble and disassemble, and fixing of motor on the structure is simple. We can do the wiring internally and can be put it into the inside of the pipes. This can make the assembly more simple and easy to handle.
4) *Aesthetic Consideration:* To get more attractive look of the tree shape we use PVC material. It has more smooth surface finish than that of the metal pipes. So it creates a pleasant look of the turbine. The height of the support pole and the limb structured is maintained in specific level so that it may get sufficient height from the ground. This may offers more wind flow for the turbines to rotate. The height also provides safe operation. To look the more tree like structure we put the limbs at specific angle. This also reduces the load on the pole. Due to this entire considerations tree structure looks more aesthetic and attractive in design.

## VII. DESIGN OF BLADE

Design of the turbine is very critical problem as we start to design from of the initial stage. Most of the turbine design is based on the trial and error basis.in that the turbine is designed by considering the wind parameter and aerodynamic parameters, then one of the design is tested in the wind tunnel. On the basis of the results from the wind tunnel the required changes in initial design in done and the final design is made. But this process of designing turbine requires more cost and all that accessories like wind tunnel and testing equipment's which are very costly and time consuming. so by considering that, we design the turbine based on previous research and We also implement some of the engineering principles which may be cause Generally the savonius turbine is made by simply cutting its performance Ives and fixes them to a rotor with defined eccentricity from the cylinder in two ha We consider the following factors while designing the turbine:

1) *Geometric Dimensions:* As mentioned in previous point we initially considered the surface area that exposed to the wind flow and is given by 'h×D'. on the basis or that we consider the height 'h' of the turbine as 200 mm and the diameter as 150 mm. Deciding these dimensions is in the hand of designer and he decide these dimensions on the basis of size limitation, cost effectiveness, overall performance, output power, design feasibility. If all these parameters are satisfies the requirements then the decided dimensions can be finalised.
2) *Shape Design and Modification:* The simple shape of the savonius turbine blade is half cut cylinder. But by investigating research papers it is found that this is not a well design of blade. In that design the wind flow and resistance are not considered. Also the whole cylindrical shape is not necessary as we consider the wind flow and the seismic load of the wind of vertical entity.

## VIII. DESIGN AND CALCULATION

### A. Power and Torque Calculation

Designing Of any of the wind turbine and getting exactly ideal geometrical as well performance parameter is the most critical part. It is also very time Consuming and required high tools and software with expert personnel in that tools. So for simplification as in designing of the savonius turbine, assuming some parameter as per manufacturing constraints is done. In that assumption of turbine's diameter’s’ and height 'h' of the can be considered. Follow to that and basic design papers of savonius turbine, turbine can be co following calculation for power, torque and some parameters is done.

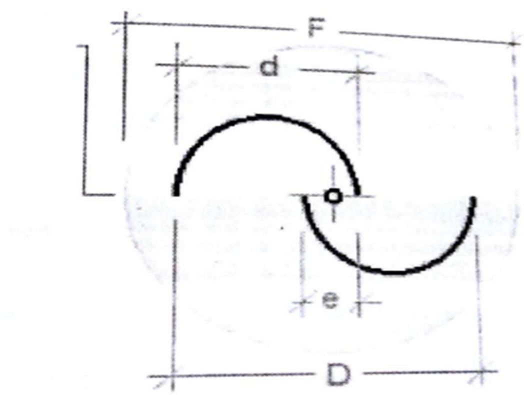


Fig no 3: Design parameter

Assumed parameter

d=90mm=0.09m
h=200mm=0.2m

Parameters:

d= diameter of plastic blade (m)
D=swept diameter (m)
e = eccentricity between blade
h= height of blade (m)
Cp= betz coefficient
V= wind speed (m/s)

- d= consider the diameter of the blade is 0.90m

1) Eccentricity (e) $=\frac{d}{3}$

$=\frac{0.09}{3}$

e= 0.03m

2) Swept diameter (D) = $2\times(d-\frac{e}{2})$

$= 2\times(0.09-\frac{0.03}{2})$

D = 0.15 m

3) Density of air $=\rho= \frac{P}{R\times T}$

$= \frac{1.01325\times 10^5}{287(26+273)}$

$\rho = 1.1807$ kg/m$^3$

Where

P= atmospheric pressure (1.01325 bar)

R= value of gas constant 287 j/kgk

T= atmospheric Temp. 26©

4) Area = hx D (h =0.2)

= 0.2X0.15

A= 0.03 m$^2$

5) Power =1/2xpxAx V$^3$ x Cp (v =6m/s, Cp = 0.593 as per the standards)

=1/2 x 1.1807 x 0.03 x 63 x 0.593

=2.268 watt

6) Rotational speed (n) $= \frac{60}{2\pi}\times w$

$w= \lambda\times\frac{v}{r}$

λ = tip speed ratio= velocity of rotor/ actual velocity of air

λ = 1 (reference from 6)

$r =\frac{D}{2} =\frac{15}{2} = 0.075$m

$w=1\times\frac{6}{0.075}$

=80 rad/s

$n =\frac{60}{2\pi}\times 80$

=763.94

n =765rpm

7) Torque of rotor shaft (Ts)

$Ts= \frac{P}{w}$

$=\frac{2.268}{80}$

=0.02835 N-M

*B. Construction*

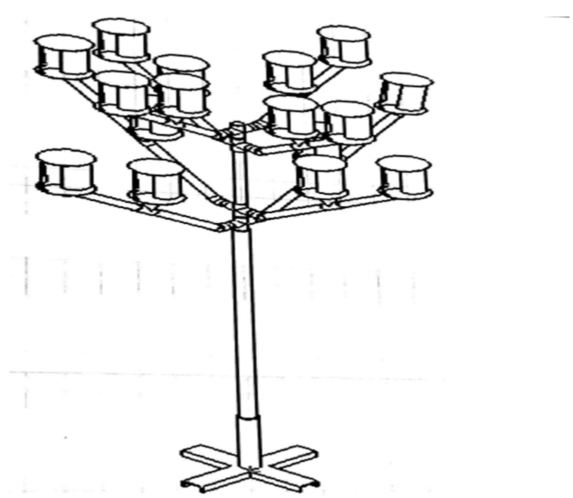

Fig no 4: Drawing of equipment

The Construction of the project structure is as shown in the base of the fracture is made up of metallic C shaped channel and a pole is fixing in it. The support pole is of mild steel material to provide strength to the top part. The top assembly of the tree and limb is attached to the pole by simple mounting& Top assembly is made of PVC material for light weight and easy assembly. All the turbines are mounted on the limbs on which the generators cum motors are fixed. The generators are permanently fixed imp the limbs of the tree by Teflon tapes and glue. Output of the turbine is collected in battery.

Fig no 5: Actual View of Equipment

TO get overall sum of output of all the motor, each motor is connected in series. Output wires are brought out from the hole drilled on the pole. To measure the output from the turbine multi-meter is used.

*C. Working*

Below Fig. Shows the general block diagram of power generation through working of the turbines. The vertical axis wind turbine mainly operates on principle of drag force of wind acted on the blade of turbine. When the wind now. The turbines also start rotating with it. Due to the rotation of the turbine the kinetic energy of the wind is energy. The turbines are further to which it converts into the electrical Into ICal to the

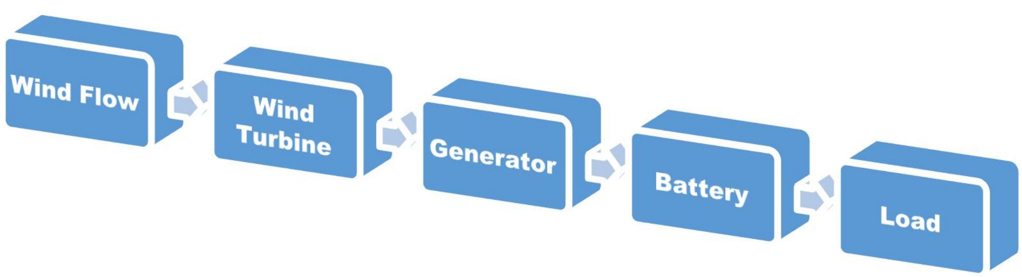


Fig no 6. Working of the turbine.

In our project the individual output of the turbine is very less, so, we use large amount of turbines to get more Output. To collect output of all the turbines in a battery series connection is done for all generators.

Due to which when all turbine gets rotated the output will get as a summation of all individual output. The output of the turbine is stored in the battery. As the wind flow varies the poweroutput from the turbine is also varies but this can be tolerable while charging the batteries. So electrical charge controller is used which can supply the constant output voltage from taking the variable input.

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## IX. ADVANTAGES

1) *Wind Energy:* Free source of the energy: As we all know wind energy is a renewable source of the energy. It is naturally available in nature, so there is no cost of the input energy which is a great advantage of the project.
2) *Utilization of Energy:* As we know the Wind energy with low speeds is difficult to utilize. Also the sources for the utilization of the energy are costlier than the output. Our work can to utilize that that actually it quantity the he can utilize amount of that can be sufficient home lighting
3) *Cost Effectiveness:* AS we consider the output of the system, the initial cost may as per the long-time output consideration it will supply almost free energy
4) *Negligible Maintenance:* Most of the equipment's utilize for renewable energy sources having very low or zero maintenance. Same as that, there is no any heavy maintenance of the system. So, there is no cost of the maintenance.
5) *Silent Operation:* If the turbines are design and manufacturing is accurate then the system is silent. There is very little sound of the wind flow may be created else all the system work silently.
6) *Pollution Free:* As We use the wind energy for power generation there is no factor in system which causing to pollution. So the system is not harmful to environment.

## X. FUTURE SCOPE.

Although we successfully implement the project at this stage but still we can do some modification in future so that its output can be improved. As per our best of the knowledge, we suggested some modification that can be possible in future. These are as follows:

1) *Increasing the Size of Turbine:* As we know the power output of the turbine is based on the frontal area of the blade. In this stage we consider a small size of the turbine just to show the demonstration of the system and cost limitation, but the power output of the turbine is based on the frontal area of the blades. So, we can increase the power output in future by designing of the blade of large size.
2) *Use of Advanced Tools:* At this stage we modify the turbine profile based on the theoretical basis only. But there is many ways to design the modified profiles of the turbine. The designed profile and also be tested and verified by some tools and software such as wind tunnel, CFD analysis. If we can use it at design stage we can design the turbine with better performance and power output which can be a great tool in the project.
3) *Use of Solar Panel:* The main purpose of the project is to get an output as energy in the form of voltage. In current stage we just use the wind energy. In future we can use the solar panel on the same structure to get more output from the system. We also can motivate to society for using the renewable sources of energy to satisfy our needs which are the harmless sources to environment.
4) *Better Design and Selection of the Generator:* At this stage we select the standard set of generator for the power generation by simply matching the power output of turbine and the generator. But it is possible to design the generator which can exactly meet the requirements of the turbine generator with small size. If we can do it then the net output in all conditions of wind now will definitely increase. If our turbine power and other parameters can match with standard generator set available in market the by critically analysing its performance in our use. We can use it in the system for power generation.
5) *Use Or Piezoelectric Material Achieves Get More Harvesting Of Energy:* We also can use of the piezoelectric material in the project to harvest the energy. As we know the piezoelectric material can produce small amount of energy when it gets mechanical motion. So by connecting it to the moving part of the turbine blades we can get output in case of very low wind speed. It will generate very low electricity but that is also one great way to harvest wind energy.

## XI. IMPACT OF THE PROJECT ON THE SOCIETY

The wind power business in India as well as the interest for sustainable electricity generation is working. Small wind energy system suitable to use at home and colleges, at social places with variable size as per power requirement which can produce power output below 1KW. So this small system can be used to supply low power equipment at home and colleges such as Tube, fans, Computer etc. The Indian government is also positive to and has high goals with great vision to increase the future energy supply with a great amount of renewable energy sources. Asper the current energy requirements the suggested small energy output units in the project can be great sources of energy.

This source can take a major load of power generation from current generation sources. Also Wind power is clean source of energy it does not create any of carbon prints and pollution contents. So this can be an important and coffined source of energy in future when all conventional sources will be finished. To establish large wind power projects today arc time consuming, Costly and complex. The general condition for small scale electricity generation has to be improved in order to enable a market development

for small scale wind turbines. It must be a reasonable combination been the economical investment and pa) back true. It is not enough to use the environmental arguments. First the marketing has to be trustworthily.
A conclusion is that we must be aware of our own energy consumption. We cannot just go on using energy without thinking. We need to use the energy) in a smart Way. There is a lot of small changes in our day to day life that see can be done in order to reduce the energy utilization.

## XII. RESULT AND DISCUSSION

After successfully running the project we took the results at different intervals in a day. For more details we took the result of the three different days. Based on the output we get the results as mentioned in the following three columns:

*1) Day 1*

Table no 1.

| Time | Wind Speed (M/S) | Output Voltage (Volts) |
|---|---|---|
| 7 AM | 3 | 1.60 |
| 9 AM | 3 | 1.52 |
| 11 AM | 4 | 2.30 |
| 1 PM | 2.5 | 1.90 |
| 3 PM | 4.5 | 3.50 |
| 5 PM | 5 | 4.50 |
| 6 PM | 4 | 3.80 |
| 7 PM | 6 | 4.85 |
| 9 PM | 3 | 2.70 |

*2) Day 2*

Table no 2

| Time | Wind Speed (M/S) | Output Voltage (Volts) |
|---|---|---|
| 7 AM | 2.5 | 1.20 |
| 9 AM | 2.5 | 1.85 |
| 11 AM | 2 | 1.30 |
| 1 PM | 3 | 2.20 |
| 3 PM | 3.5 | 3.60 |
| 5 PM | 5.6 | 5.60 |
| 6 PM | 6 | 6.20 |
| 7 PM | 5 | 4.20 |
| 9 PM | 3 | 2.60 |

*3) Day 3*

Table no 3

| Time | Wind Speed (M/S) | Output Voltage (Volts) |
|---|---|---|
| 7 AM | 3.5 | 0.9 |
| 9 AM | 3.2 | 1.60 |
| 11 AM | 3 | 2.80 |
| 1 PM | 4 | 4.20 |
| 3 PM | 5 | 6.30 |
| 5 PM | 4 | 4.85 |
| 6 PM | 6 | 5.20 |
| 7 PM | 3.5 | 3.20 |
| 9 PM | 4 | 2.30 |

As we know that the flow of the wind is fluctuating in whole day. So to get a final average output we took the results at the different intervals of time. In the results voltage is an output of the testing and wind velocity which is varying with time. From the results we can see that the voltage output is proportional to the wind velocity. In morning the wind velocity is quite low, so the overall output of the system is also low, which is fluctuating below 4 volts. In the afternoon period, the wind velocity is bit higher than the morning. So the output voltage just crosses the limit of 4 volts.In evening period of the day say after 3 pm, the wind velocity start increasing. Due to this the output also goes above 6-7 volts.

The maximum output of the day is up to6-8 volts which may be obtained at 5-6 pm. After that Same as of afternoon, the wind vary within 2.105 volts.velocity is at moderated level due to which the output is one more point to note that the above mentioned results are in the summer season. In other season or at any time in the whole year the behaviour of the wind is not constant, it's fluctuating continuously. The output results are based on the wind velocity.so, the results may be varying from above mentioned results. It is depends on the wind velocity not on the period of the day.

## XIII. CONCLUSION

From this project we successfully deal with problem of energy need of the society by utilizing the wind energy of small speeds through a vertical axis savonius turbine. In the project, we do some modifications in the design of savonius turbine than previous model of Savonius type turbine. The profile of is cut at its bottom side so that its weight is get reduced which will help to lower speed of wind. These turbines Can be located in any place where least amount of wind flow with low speed is available say at the floor of houses in urban as well as rural areas, on open grounds and near the high ways, roads etc. For better space utilization we can arrange on a tree like shape bases. If we use it in bulk quantity we can get more output and can contribute in satisfying the energy needs of the society.

## REFERENCES

[1] Wenlong Tian ,Baowei Song ,James H. VanZwieten and Parakram Pyakure"Computational Fluid Dynamics Prediction of a Modified Savonius Wind Turbine with Novel Blade Shapes" Energies, 2015.
[2] B. A.Bhayo,H H Al kayiem and N Z Yahaya. "Performance investigation of S-Rotors", 3rd International Conference of Mechanical Engineering Research (ICMER), 2015.
[3] MhoammedHadi Ali "Experimental Comparison Study for Savonius Wind Turbine of Two & Three Blades at Low Wind Speed", International Journal of Modem Engineering Research (IJMER), Oct.-2013.
[4] A. Albani, M.Z. Ibrahim "Preliminary Development of Prototype of Savonius Wind Turbine for Application in Low Wind Speed", International Journal Of Scientific & Technology Research Volume 2, Issue 3, MAY-2013.
[5] "Non- conventional energy sources", G. D. Rai, Khanna publisher. 4th edition