

# HIGHWAY DIVIDER BASED AIR FILTRATION SYSTEM POWERED BY VERTICAL AXIS WIND TURBINE- A REVIEW

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**Abstract** - When the vehicle passes on the highways it generates a considerable amount of air due to its speed. The air tangentially strikes on the blades of the vertical axis turbine, and it makes a rotation of the rotary engine in just one direction. The generator is connected to the shaft of the vertical axis wind turbine to generate electricity. The electrical output of vertical axis turbine is stored in a battery. This stored energy which can be further used for air filtration.

The most vulnerable global challenges faced today are global warming and its effect on climate with deteriorating air quality. Air pollution is increasing inflicting heating, rise in water level, modification in seasonal patterns, downfall pattern, extreme summer and winter temperatures, droughts, and floods, etc. Along with various endemic and epidemic diseases. The condition of air quality in India is poor. As many as 54% of Indians live in cities not meeting NAAQS standard on fine particulate matter and none of the cities meeting WHO standards. The whole world, as well as Asian nation, is disturbed concerning the degradation of air quality that affects each type of life material. So, the aim is to design a system which can control the air pollution by using the energy generated by itself.

**Key Words:** Vertical Axis Wind Turbine, HEPA Filter, Renewable energy, Air Pollution

## 1. INTRODUCTION

In a daily life, the demand for the electricity is way over the assembly of power. one among the main issues ever since the natural resources are aiming to end in some unspecified time in the future. The fuel major role in production heating, a greenhouse emission, etc. Currently 68 percent of the electrical energy produced by the thermal power plant and remaining 22 percent included hydropower plant, nuclear power plant, gas power plant and as we realized the fossil fuels finished in one day. Wind energy is maximum on the highway due to the speed of the vehicle. The motivation of this project contributes to the global trend toward clean energy [1].

Air pollution is a difficult issue to deal with, which spans across multiple sources from vehicular emission,

resuspended dust, industrial plumes, construction material, waste burning, domestic heating, and cooking. In addition to these reasons, there are various seasonal sources like, burning of agricultural waste, dust storms or sandstorms and sea-salts [6]. Air pollution causes global warming and results in climate change. Climate change is one of the biggest global challenges faced by humankind and has received considerable global attention from scientists and media. The excessive dependence on fossil fuels (oil, coal, and gas) to fulfil the growing energy needs increases the emission of pollutants into the atmosphere. Approximately 1.1 billion people breathe unhealthy air and are responsible for 7 million deaths every year globally [7,8].

### 1.1 Impulse Savonius Vertical Axis Wind Turbine

The highlighting feature of this turbine is its simpler design. A Finish engineer Savonius introduced the Savonius rotor in the 1920s. He has reformed the design of Flattener's rotor by dividing a cylinder into half, along its central axis and relocating the two semi-cylindrical surfaces sideways. This shape is recognized as "S" when viewed from top. These types of rotors may be of two, three or higher bladed systems and can be used in single-or multi-staged arrangements. The rule is predicated on the distinction of the drag force between the convexo-convex and therefore the depressed components of the rotor blades after they rotate around a vertical shaft. This is chosen because of its simple construction and self-starting capacity at low wind speed [1].

Vertical axis wind turbines offer several advantages over traditional horizontal-axis wind turbines (Horizontal axis wind turbines). They can be packed nearer along in wind farms, permitting additional in a very given house. they're quiet, Omni-directional, and that they manufacture lower forces on the support structure. they are doing not need the maximum amount wind to get power, therefore permitting them to be nearer to the bottom wherever wind speed is lower. By being closer to the ground they are easily maintained and can be installed on chimneys and similar tall structures [2].

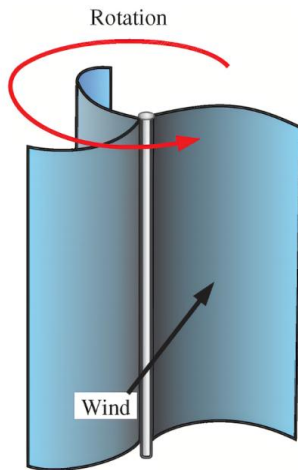


Figure 1: Vertical Axis Wind Turbine [14]

### 1.2 Air Filter

High-efficiency particulate arrestor (HEPA), originally called high-efficiency particulate absorber they can be packed nearer on in wind farms, allowing extra in a very given house. they are quiet, Omni-directional, which they manufacture lower forces on the support structure. they're doing not want the most quantity wind to urge power, thus allowing them to be nearer to rock bottom where wind speed is lower. The filter must satisfy certain standards of efficiency such as those set by the United States Department of Energy (DOE) [7].

These standards define what qualifies as a HEPA filter. The two most common standards require that an air filter must remove (from the air that passes through) 99.95% (European Standard) or 99.97% (ASME standard) of particles that have a size greater than or equal to  $0.3\mu\text{m}$  [6]. HEPA filtration works by mechanical suggests that, not like the ionic and gas filtration, that use negative ions and gas severally. So, the chances of potential pulmonary side-effects like asthma and allergies are much lower with HEPA purifiers. To ensure that a HEPA filter is working efficiently, they should be checked and changed at least every six months in commercial.



Figure 2: HEPA Air filter [16]

## 2. METHODOLOGY

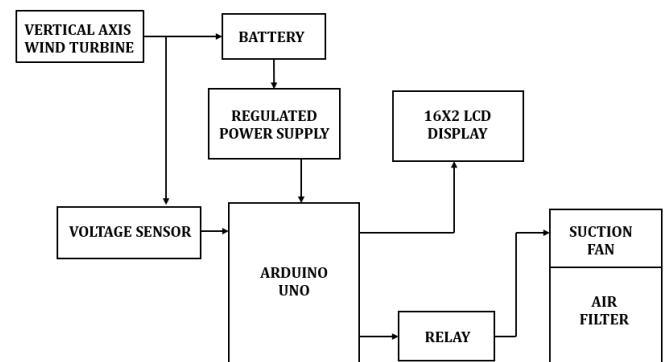


Figure 3: Block Diagram

This project mainly works in two parts. The first step is the energy generation and next is the utilization of harnessed energy.

A vertical axis wind turbine is set up on the dividers separating the roads. The turbine is driven by the turbulence of air created by the movement of vehicles on roads. Availability of air in both the directions is an added advantage in this project. The turbine blades and the shaft materials are made up of Aluminium sheets. The turbine is then coupled with a dc motor. It is a 12V brushless DC Motor which is powered by Pulse Width Modulated DC voltage. The motor is then connected to the battery to store the generated energy.

Meanwhile connections are also given to display devices. Firstly, it is connected to a voltage sensor module which measures the generated voltage. The output of the voltage sensor is coupled with a Microcontroller based Arduino UNO device. The Arduino takes the input from voltage sensor and

converts the data received. The converted data is processed in such a way to display it on the LCD display board. The display device used here is a 16x2 liquid crystal display. The system is also provided with a RPS (Regulated Power Supply)

unit. The main function of the RPS is to distribute the energy stored in the battery for different energy requirements in the circuit.

Next step is the utilization of energy in the battery to treat the polluted air. So, the main component in this step is a air filter. The most suited kind of air filter for this project is the HEPA (High Efficiency Particulate Arrestor) filter. HEPA filter is a very rare kind of filter which filters pollutants of various particle sizes including nano particles. A filter paper is wound around the air filter to eliminate solid particles in air. The filter preferred here is a cylindrical shaped filter which is hollow inside and has opening at the top.

A exhaust fan is fixed at the top of the filter. Now the exhaust fan sucks the air through the filter which means the contaminated air is passing through the layers of filter paper and HEPA filters. It indicates that majority of pollutants in the air are eliminated. The treated air is left out to the atmosphere. The energy for the exhaust fan is supplied from the battery. The current is not directly supplied to the fan but through means of a relay. The relay makes sure that the exhaust fan is switched on only when the wind turbine is rotating. It means that when there are no vehicles on roads and there no rotation of the turbine, the exhaust fan is switched off. This is very important because any kind of energy should not be wasted.

### 3.RESULTS

When the air turbulence around the turbine i.e., air started to hit the turbine blades, the turbine started to rotate. Maximum amount of wind energy is used by the turbine as the no of turbine blades are properly designed.

The motor which is coupled with the turbine starts to convert the available mechanical energy to electrical energy. The terminals of the motor are connected to battery as well as voltage sensor.

The terminals are connected to the battery through a rectifier circuit for the power conversion. The voltage sensor sends the signals to the Arduino and the result is displayed on the LCD board.

The relay which acts as switch in this model is switched on when the turbine is rotating i.e., the battery is charging. When the turbine stops to rotate the relay switches off and no supply is given out.

When the supply is switched on to the exhaust fan, the fan starts to rotate. It starts to suck the air through the filter. When the contaminated air is sucked through the filter, maximum number of pollutants are removed from the air. Therefore, the air quality is improved.

### 4.FUTURE SCOPE

As vehicles are increasing on roads daily the energy generation from wind turbine also increases.

Air pollution on Indian cities will be a major problem in the coming years. So, using techniques like these as soon as possible will ensure a better future for cities.

Even if there is revolution in electric vehicles in the future, there is no way that there is no use for this system.

With green energy being the future theme, we can use more futuristic techniques to generate energy and use it for different purposes.

If solar energy generation is coupled with this system, it will generate large amount of power which can be used for different purposes.

With research about the maximum constituents of vehicular air pollution, a different air filter could be designed with a better cycle life compared to other filters

### 5. CONCLUSIONS

This system is environmentally friendly. The working model of our project is a vertical axis wind turbine system which is a good and effective solution for power generation, Highway side application of wind turbine with improved efficiency can help us to reduce the gap between demand and supply of power. The designed air filtration system can be used to engulf all air pollutants from the vehicle discharge at all the express highways in India. For this system we don't require any extra power rather we use the power generated by the wind thrust of vehicle movement by use of vertical axis wind turbine. Thereby the design system would help to minimize air pollution at its source without any extra effort.

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