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Tree Wind Turbine

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Abstract : This project (Design of Aero leaf Wind Turbine) is about designing and manufacturing a Vertical Axis Wind Turbines VAWT to transfer the wind speed to a rotational motion using these turbines. These turbines will be attached to a manufactured tree that will look like a modern design, which can be installed in and around any public area such as parks, roads, public facilities, or business offices. Aero leaf Wind Turbines are designed to produce power up to 300 watts for each turbine. This project presents a review on the performance of Savories wind turbines. This type of turbine is not commonly use and its applications for obtaining useful energy from air stream is still considered as an alternative source. Low wind speed start-up, working with any wind direction, and the less noise are some advantages of VAWT- Savories model. This project consists of three phases; designing, fabrication, and evaluating. An actual of gained power is reported to be 31~35% relative to the theoretical gained power due to the instability and inefficient of the wind speed

***IndexTerms* – Aero Leaf Wind Turbine, Vertical Axis Wind Turbine, Savories Wind Turbine**

I. Introduction

This project is about designing and manufacturing an Aero leaf Wind Turbine that can convert wind by using Vertical Axis Wind Turbines (VAWT) to a useful energy. The current power demanding in India is very high compared to power consumption world average, as reported by Arab news; Saudis consume three times more electricity than the world average [1]. This high demanding should take the focus of attention in thinking in different sources of energy. One of the best sources of energy that can apply the concept of sustainability is renewable energy such as sun, wind, and rivers. The positive point of wind energy is that unlike solar energy that only used with sunlight, wind turbine can be useful all the 24 hours all the year. Another concept of sustainability is the way that we should use in utilizing this renewable energy efficiently, and environmentally friendly. This, in turn will eliminate the environment hazard and improve India communities' health and life style. Streets, public parks, schools, and public facilities are consider as main power consumers, these consumers should be vulnerable to wind from time to time. The idea of this project is to convert this wind by using Vertical Axis Wind Turbines (VAWT) to a useful energy by using it as a power source that can serve these consumers.

1.1. PROJECT OBJECTIVES

The main objective of this project is gaining power from wind. Therefore, this project is green source of energy and has no effect on the life of earth. These wind energy turbines are small and can produce up to 300 watts for each turbine. Another objective of this project is gaining and exercising some engineering concepts such as:

- Learn about wind energy and different ways of convert it to a useful power.
- Learn the different between Vertical Axis Wind Turbines (VAWT) & Horizontal Axis Wind Turbines (HAWT).
- Learn the impact of energy & our rules as engineering students to provide alternatives.

1.2. Project Specifications

This project is 2.8 meter high (tree & turbine), it is expected to produce total of up to 600 watts. The material that the tree is made of is galvanized carbon steel and the turbine blades are made of aluminum alloy. The turbines can start working under low wind speed and can cut-off if the speed is too high.

1.3. PRODUCT ARCHITECTURE AND COMPONENTS

The project main components are tow turbines which include (blades, shaft bearings) for each turbine, electrical generator attached to the end of the shaft for each generator. The generators are connecting through wires to the control banal, which include (converter, controller and battery connected from and to the banal for the popups of changing from and to DC & AC). Below figure1.1, identifying the initial functional diagram that shows the expected project outlook. And initial real photo of the project is in the below figure 1.1.

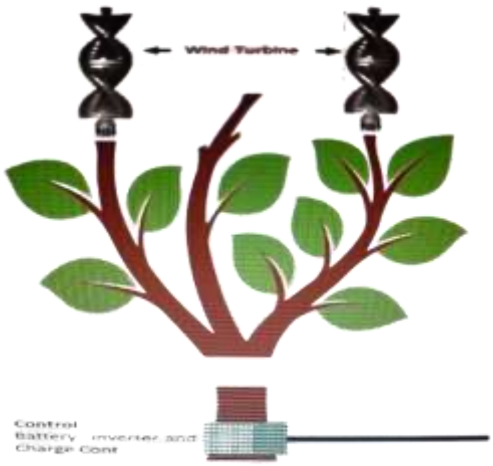

Fig.No.1. Expected Project Outlook

1.4. APPLICATION

This project idea is very simple, where it focuses on utilizing the wind energy by designing and manufacturing two VAWT and attach them to a manufactured tree. This tree can be installed across the public facilities. Facilities such as public parks, in the top of the stadiums where wind is very high and around the stadiums, services' buildings, and over the roads and streets. It can also install in a simulated tree.

II. SCOPE OF PROJECT

India is the home of 1.25 billion people i.e. 17.5% of the total world population, which makes it second most populous country in world. India has the second fastest growing economy of the world. India's substantial and sustained economic growth over the years is placing enormous demand on its energy resources. The electricity sector in India had an installed capacity of 253.389 GW as of August 2014.

India became the world's third largest producer of electricity in the year 2013 with 4.8% global share in electricity generation surpassing Japan and Russia. Power development in India was first started in 1897 in Darjeeling, followed by commissioning of a hydro-power station at Sivasamudram in Karnataka during 1902. Thermal power stations which generate electricity more than 1000 MW are referred as Super Thermal Power Stations. India's electricity generation capacity additions from 1950 to 1985 were very low when compared to developed nations. Since 1990, India has been one of the fastest growing markets for new electricity generation capacity.

India's electricity generation capacity has increased from 179 TW-h in 1985 to 1053 TW-h in 2012. Wind energy is indigenous and helps in reducing the dependency on fossil fuels. Wind occurrence is due to the differential heating of the earth's crust by the sun. Approximately 10 million MW of wind energy is continuously available to India. India's Power Finance Corporation Limited projects that current and approved electricity capacity addition projects in India are expected to add about 100 GW of installed capacity between 2012 and 2017.

This growth makes India one of the fastest growing markets for electricity infrastructure equipment. Of the 1.4 billion people of the world who have no access to electricity in the world, India accounts for over 300 million. The International Energy Agency estimates India will add between 600 GW to 1,200 GW of additional new power generation capacity before 2050 . To fill the needs of the energy of this population, India have to look towards non conventional energy resource which can fill a huge demand of energy generated by the population of India.

India is fulfilling its 85% of energy demand from the conventional recourses such as coal, nuclear energy, natural gas and petroleum which generate many greenhouse gases. Green houses gases- carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrous oxide (N_2O) etc. are produced in the energy generation process are not only harmful for people's health but it also deteriorates the environment vis-a-vis global warming and 14 hole in the ozone layer. Thus it is the need of time that country should look towards the green & renewable methods for the generation of energy so that environment can be saved from those harmful effects. Wind energy, solar energy, biomass & other renewable methods can be used for the generation of energy to fulfill the energy demands of the country

III. PROJECT DESIGN AND CODE

3.1.1 GENERAL SPECIFICATION

Aero leaf wind turbine is new way of producing energy form Vertical-axis method. This new energy source is useful in the modern cities because of it is nice design and free noise. These wind energy generators are. The Aero leaf tree is designed hold two wind Savories turbine, which are small in size and can produce up to 300 watts. The positive point of wind energy is that unlike solar energy that only can be used with sunlight only. Wind energy can be useful all the 24 hours all the year. This project is green source of energy and has no effect on the life of earth. There are no effects on the environment at all. Moreover, it is reducing the CO_2 and CO gases that effect the environment in the earth. One of the biggest challenges is the social accept of Aero leaf Wind turbine.

3.1.2 CONSTRAINTS AND REQUIREMENTS

One of the most difficultly problem is the lack of necessary equipment needed for the analysis and selection of materials accurately in the university. Also, in the market, I was really difficult to find some of the needed materials. These problems make the function of this project relying for some parts in design of previous studies mentioned in chapter 2 by doing the reverse engineering. Getting a sufficient wind, to analyze and test work. It was also the one of the berries that we have encountered, because of the lack of wind in the area at that time, and the lack of experience in aerodynamic science. Beside the Lack of important resources, the lack of financial support was a major obstacle in our way even though the budget was estimate. 18 Although the existence of moral support from our professors, Lack of sufficient time was a real challenge to show up the work as long as there was only one semester to complete the senior project.

3.1.3 DESIGN METHODOLOGY

The methodology applied to this project can be divided into six phases. These phases are information gathering, concept generation, model generation, model analysis and refinement, concept selection, and verification, these phases are shown in figure 1.2

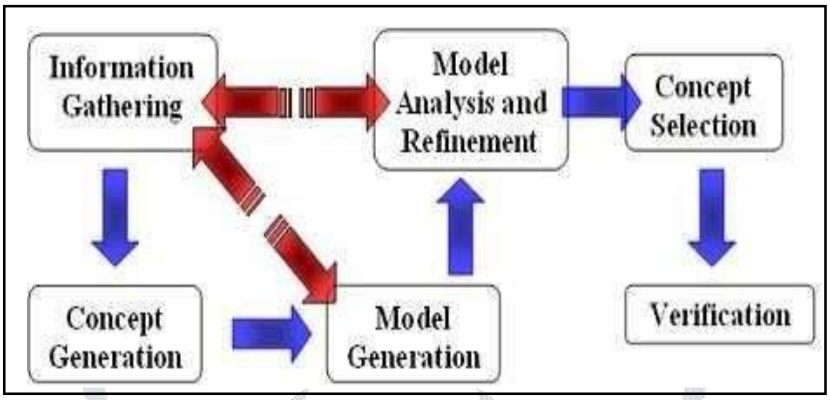

Fig.No.2 Applied Phases of used Methodology

Prior any appropriate solution can be developed, a thorough investigation has to be conducted in order to find out what solutions have already been proposed (information gathering).

Once these solutions have been analyzed and the team has an understanding of why the respective solutions are not currently being implemented, a solution generation phase is taking place. Here various solutions are presented and evaluated against criteriaand constraints (concept generation). Solution concepts are then modeling The results of the models are then analyzed and the model, as well as solution parameters, may be tweaked (model analysis and refinement).The objective of this project is to design a vertical axis wind turbine (VAWT) that could generate power under relatively low wind velocities. To accomplish this goal, the objectives are to:

- Analyze how different geometry of the wind turbineswould affect the output power of the wind turbine.
- Vibrations analysis by testing how the vibrations caused from the rotations of the wind turbines affect the structuralintegrity of various aspects buildings structures.
- Compare the operation of turbines with respect to the numbers ofattached blades.

To meet the above objectives, the tasks were to:

- Conduct background research and analysis on wind turbinetechnology.
- Design initially turbine blade for testing.
- Design tree to hold these turbines.
- Looking for power generator that has good efficiency with lowstartup speed.
- Create experimental set up.
- Manufacture parts and build model tree
- Develop future design recommendations

3.2 Product Subsystems & Components

Vertical axis wind turbine VAWT are one whose axis of rotation is vertical with respect to ground. Generally as shownin figure 3.3, the main components of this turbine are:

- Blades
- Shafts

- Generators

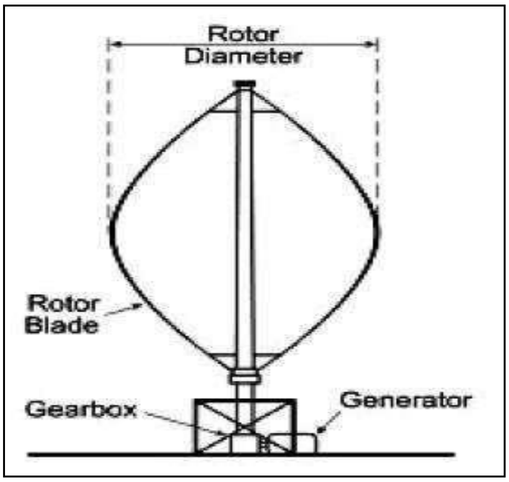

Fig.No.3. Components Of VAWT

3.2.1 ROTOR BLADES

savories blades are a crucial and basic part of a wind turbine figure 3.4. They are mainly made of aluminum, fiber glass or carbon fiber. We selected the aluminum alloy as recommended inthe study mentioned in chapter because they provide batter strength to weight ratio. The design of the individual blades also affects the overall designof the rotor. Rotor blades take the energy out of the wind; they capture the wind and convert its kinetic energy into the rotation ofthe hub. The arc angle was selected based on the pervious study mentioned in chapter , which recommended an angle of 160°.

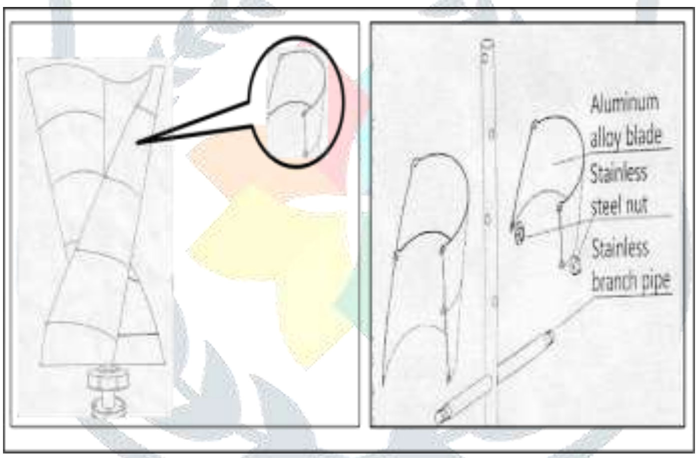

Fig.No.4. Turbine Blades Design

3.2.2 12 VOLTS 1000 RPM DC MOTOR

Fig.No.5. DC Motor

SPESIFICATION	RATING
Rated RPM	1000RPM
Base Motor RPM	3000RPM
Weight	125gm
Torque	0.15Kgc

3.2.3 12 VOLT RELAY

Fig.No.6. Relay

SPECIFICATION	RATING
Rated voltage	12VDC
Coil resistance	62.5,360,1440,5358
Rated current	33.3mA

3.2.4. TOY MOTOR

Fig.No.7. Toy Motor

SPECIFICATION	RATING
Operating voltage	4.5V TO 9V
Current at no load	70mA(max)
No-load speed	9000rpm
Loaded current	250Ma(approx)

Rated load	10g*cm
Motor size	27.5mm, 20mm, 5mm
Rated voltage	6V

3.2.5. 12 Volt Battery

Fig.No.8. Battery

SPECIFICATION	**RATING**
Battery Type	12V
Capacity	1.2Ah
Terminal Type	F1

3.2.6. SPDT 3 WAY SWITCH

Fig.No.9. SPDT 3 WAY SWITCH

SPECIFICATION	**RATING**
Manufacturer	INVENTO
Dimensions	5,5,5CM; 99.8g
Current	2A,250AC,5A,125VAC

- MODULE DESIGNE AND DETAIL IMPLIMENTATION

    i. MODULE TITLE/NAME:

    ii. POUS OF MODULE

Using the data received we made recommendations for future studies regardingthe potential of commercial tree wind turbines. These recommendations will hopefully aid in the development of a technology that would allow green energyto reduce energy costs in the average household and better the environment. Future tests could help determine the feasibility of houses, neighborhoods, or cities powered by wind turbines and being able to run off of renewable energy. The turbine performance testing and results from the research in this venture demonstrated that the split savories is the best plan that has been tried to this point at WPI. The reason is because of the expansive surface range of the split savories which empowers it to catch most maximum amounts of wind. We trustthat further research bought to be finished with different savories 50 plans in view of this reality. The savories turbine outlines are basic and modest to make,and are additionally not incredibly influenced by turbulence in the wind.Another suggestion to improve the savories design in our opinion would be tocreate a more aerodynamic backing to the savories cusp. This design would reduce the energy it requires to spin with the wind. this will allow the savoriesto rotate into the wind more efficiently, thus increasing the rate of revolution. While we do not expect this to make a significant difference, our testing demonstrates that even small differences in wind speeds lead to significantly improved power output.

IV. RESULTS AND DISCUSSION

Total installed capacity:

- For one turbine =12v* 300MA(0.3A)=3.6W
- For four turbine=3.6w* 4=14.4w

Sr.no	WIND SPEED (m/s)	RPM of turbine blade (rpm)	Output voltage (V)	Current (mA)	Wattage (of one turbine) (W1)	Wattage (of four turbine) (w1*4)
1.	10 m/s	300 rpm	3.6 V	90 mA	0.34 w	1.38 w
2.	12.6 m/s	344 rpm	4.128 V	103.2 mA	0.42 w	1.71 w
3.	13.9 m/s	391 rpm	4.7 V	117.3 mA	0.549 w	2.1 w
4.	16.4 m/s	458 rpm	5.5 V	137.4 mA	0.7535 w	3.1 w

V. TESTING

THEORETICAL WIND TURBINE POWER CALCULATION

Wind Power depends on:

- amount of air (volume)
- speed of air (velocity)
- mass of air (density) Kinetic Energy

definition:

$KE = 1/2*m*v^2$Where:

M = Mass v = velocity

Since Power is Energy per time, we can formulate equation$P = 1/2*m*v2$ m =dm/dt

Fluid mechanics gives mass flow rate (density * volume flux): dm/dt = p * A * vThus, power of the wind is P = ½ * p * A * v^3

Taking in consideration the turbine Power coefficient, power in the wind iscalculated using this formula: P = ½ * p * A * v3 *CpWhere:

P = Power in watts

P = Air density "At sea level 'air density' is approximately 1.2 kg/m^3

A = Turbine Area in m^2, which can be calculated from the length of turbine blades.

A = Turbine height *Turbine width

v = wind speed, which is the velocity of the wind in m/s

Cp = Power coefficient, usually varies according to wind turbine design,ranging between 0.05 and 0.45

The only variable in this equation is the wind speed.

VI. EXPIREMENTAL READINGS

After designing the components and structures desired for testing power output forwind turbine designs and the structures desired to be tested, we created the experimentalset-ups required to test the prototypes and structures.

In order to determine the effectiveness of the products that were manufactured, weperformed tests to evaluate them. The test set up was in Half Moon (open area). We also tested the power output of the turbine blades and evaluated how the vibrations fromthe turbine affect the stress and strain on a tree structure.

Two experiments have been conducted; the procedure of calculating the power is counting the voltage & current that feeding the battery. The power gained can be calculated using the below equation.

P = V * I

Where:

I = Current in Ampere, V = voltage

VII. CONCLUSION

From our research we were able to come up with many important conclusions and suggestions which will profit the future advancement of individual vertical pivot wind turbines. We could outline a VAWT framework that enhanced power yield when contrasted with the past projects. From our results we were able to recommend new design aspects to improve the system and efficiency.

Inefficient wind speed was the huge impact getting the required power output, minimum speed of 12 m/s is required to have acceptable output power taking in consideration 31~35% of efficiency between theoretical and experimental results.

Even though we were able to make this design of Vertical Axis WindTurbine but there is a never-ending process to always improve uponinventions and new designs. Wind turbines are a start for society to lessen the damage done to the earth by not using energy sources thatproduces pollution. Hopefully the project could propel research and testing on VAWT frameworks and give knowledge for different gatherings to finish additionally testing and enhance productivity andexecution of vertical pivot wind turbines.