

A Comparative Overview on the Horizontal Axis and the Vertical Axis wind Turbines

Naveen kumar¹, Syed Fozail Ahmad²

¹Assistant professor, ²Student

^{1,2}Department of Mechanical Engineering, ABES Engineering College, Ghaziabad, Uttar Pradesh, India

ABSTRACT

Wind energy is a renewable and non-conventional source of power generation. It is a clean source of energy with a minimum to zero pollution and thus prevents the environment from deteriorating. The wind energy generation is a giant step towards sustainable development and its usage increases day by day due to lack of fossil fuels. Since India is among the fastest growing country in terms of wind energy generation, it is planning for the installation of 175 GW power capacity by financial year 2022. Wind vitality is produced through wind turbines, wind turbines are likewise called as wind vitality convertors and they convert the dynamic vitality of wind into the mechanical vitality that can be utilized for crushing grains, siphoning water, and so forth on this active vitality can be changed over into electrical vitality by means of generator. Wind turbines are of two types- Vertical axis wind turbines (VAWTs) and Horizontal axis wind turbines (HAWTs). VAWTs are mostly used domestically where power consumption is low and the requirement is of economic rate. HAWTs are more preferably used where power requirement is high and requires high output efficiency. Thus this paper contains a comparison between VAWTs and HAWTs in terms of efficiency, the gearbox mechanism, blade rotation speed, noise, blade rotating space, etc.

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1. WIND TURBINE

1.1. INTRODUCTION

Wind is a type of sunlight based vitality. Winds are brought about by the uneven warming of the air by the sun, the abnormalities of the world's surface, and turn of the earth. Wind energy is portrayed as the way toward utilizing the breeze speed to produce power through a wind turbine. Wind turbines are only the advancement of the exemplary windmills that can be seen in a significant number of the rustic zones of the world. The primary motivation behind the development and wide utilization of wind turbines are to decrease the dependence on petroleum derivatives for making energy and furthermore to make a spotless energy asset.

A wind turbine converts the kinetic energy of wind into mechanical energy and a generator further converts that mechanical energy into electricity. The transformation of wind energy into electrical energy is finished by pivoting propeller like edges around a rotor. The drive shaft is then turned by the rotor, that further turns an electric generator and along these lines electricity is created.

The mechanism of a wind turbine can be further understood through a schematic diagram as of fig.2.

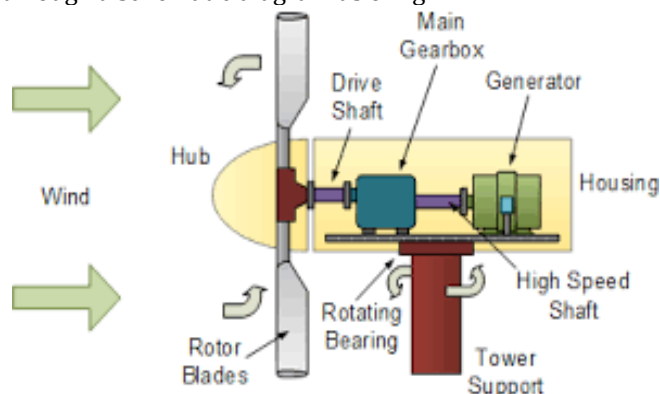


Fig.2- Working mechanism of a wind turbine



Fig.1-A typical wind farm

Two prime wind turbines that are currently available in the global market are the horizontal axis wind turbines and vertical axis wind turbines. Small wind turbines has an

electricity production capacity of about 10 kW, whereas large scale wind turbines generate electricity of capacity of about 5000-8000 KW. In terms of efficiency the wind energy varies greatly due to the wide variation in geographical locations that affects the wind quality at the location where it is being installed, the efficiency could be more than 40% if the location is selected carefully.

1.2. NEED FOR WIND TURBINE

Energy has a great input in all sectors of any country's economy. Till late 1980's energy has been produced largely through the burning of coals, hydrocarbon oils and natural gases that ultimately leads to high carbon emissions causing the greenhouse effect that results into global warming. Hence, environmental deterioration has become a great concern in the world's current scenario. With the increasing emission of greenhouse gases, depletion of natural resources like coals, natural gases and other fossil fuels have created hindrance in prolongation of these resources. Thus, the need for an alternate source of energy comes into existence that are called non-conventional sources of energy. These renewable or non-conventional sources and wind energy specifically, doesn't affect the environment as conventional sources do.

Due to the geographical conditions of India, many renewable resources such as wind, solar, biomass, hydro and tidal are

available. India is among the largest growing country in terms of wind energy since the 1970's. In the fiscal year 2018-19 India produced 64.03 Terrawatt hour (TWh) energy through the wind energy source that is 4% of the total energy generated.

Our energy needs are changing, and so is the way we are meeting them. In today's time of the depleting natural resources need for the increased use of renewable energy sources has increased, due to this all the developed and developing countries are concerned to meet their power requirements through renewable sources that are clean and doesn't harm the environment.

Some of the leading countries in renewable energy production specifically wind energy are shown in the table 1.

With the aggregate information of installed power capacity through wind energy. The cumulative installed capacity of India as of 2013 was 20,150 MWs mainly escalate over Tamil Nadu, Madhya Pradesh, Maharashtra, Kerala, Gujarat, West Bengal, Rajasthan, Andhra Pradesh, Karnataka and other states. Their share of distribution in wind energy production is shown with the help of a chart in fig.2. Till the financial year of 2018-19 the installed wind power capacity and generation was recorded as 36,625 MWs and 62,036 GWs respectively.

Table1. Top 10 Cumulative installed capacity 2009-2013 (in MW)

Country	2009	2010	2011	2012	2013
CHINA	25,805	44,733	62,364	75,324	91,424
UNITED STATES	35,086	40,298	46,919	60,007	61,091
GERMANY	25,777	27,191	29,060	31,270	34,250
SPAIN	19,160	20,623	21,674	22,784	22,959
INDIA	10,926	13,065	16,084	18,421	20,150
UNITED KINGDOM	4,245	5,248	6,540	8,649	10,531
ITALY	4,849	5,797	6,737	8,118	8,552
FRANCE	4,574	5,970	6,800	7,623	8,254
CANADA	3,319	4,008	5,265	6,204	7,803
DENMARK	3,465	3,749	3,871	4,162	4,772

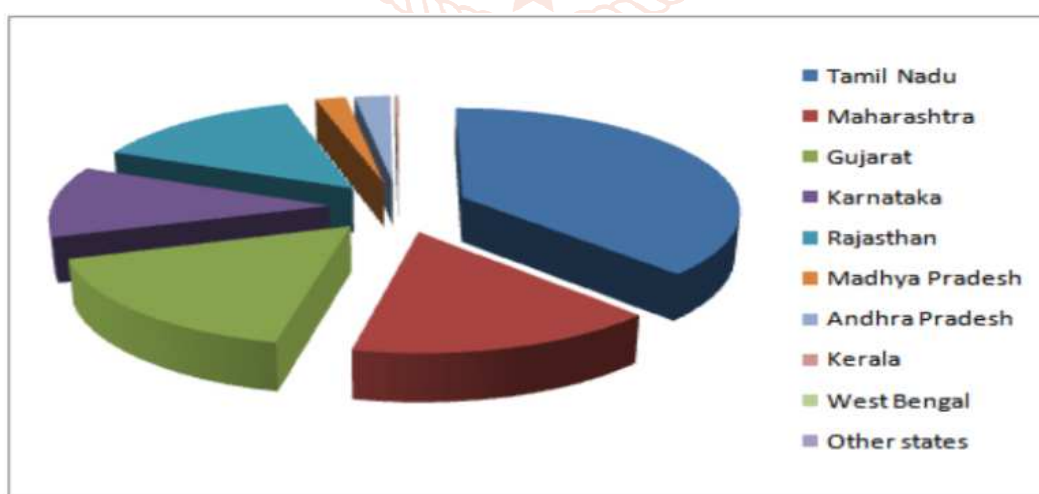


Fig. 2-distribution of wind energy production among different states of INDIA in MWs

2. HORIZONTAL AXIS WIND TURBINES (HAWTs)

The concept of HAWTs as depicted in fig.3 were used in the early 5000 B.C, where the villagers near the Nile River extracts the strength from the wind to transport their boats alongside the river. Since then the wind turbines had passed through numerous adjustments and innovations for higher

overall performance and higher performance fee in power technology. Horizontal axis wind turbine is a broadly used source of renewable energy, apart from the fact that it requires heavy mechanism for operation. HAWTs contain blades in aerodynamic shape and requires torque for the

electrical power generation through rotation of blades. The rotational axis for a horizontal axis wind turbine should be parallel to the wind's route as a way to generate energy at most efficient rate. There is a wide range of commercially available designs for HAWTs ranging from 50 W to 4.5 MW. The production cost is low when it generates high volume of electrical energy.

However, there is one major disadvantage that is HAWTs must be structured always pointing in the direction of flowing wind for efficient working. In addition it also requires a yaw mechanism for the blade rotation with additional gear system which makes it more complex and costly if it doesn't produce energy efficiently.



Fig.3- ancient horizontal axis wind turbine

2.1. VERTICAL AXIS WIND TURBINE (VAWT)

In comparison to the above discussed Horizontal axis wind turbines, the vertical axis wind turbines as shown in fig.4, shows that the blades of VAWTs rotate perpendicular to the earth and on a prescribed vertical axis. The mechanisms used for these types of turbines are either drag or lift mechanism and sometimes the both to operate. The two most common and popular designs of VAWT are the Savonius type and the Darrius type and both of the above functions on two distinct principles. The initial one that is savonius type uses drag forces to work in analogy with the water wheel and the other one that is Darrius uses aerodynamic blades to turn the turbine by generating lift.

In the field of wind energy research, vertical axis wind turbine had developed over recent years where a large number of Darrius type turbines are being structured in America and the Musgrove turbines being experimented in England.

For domestic purposes and low volume production vertical axis wind turbines are most preferred one as it is economical and also occupies less area for the set up motive when compared with the horizontal axis wind turbines. It can easily generate electricity even at low wind speed. The way of electricity generation at ground level and its easy installation due to less height from the ground and light weight as compared to HAWTs makes it preferable to use for domestic purposes.



Fig.4- Vertical axis wind turbine

Along these lines both the kinds of wind turbines are utilized commercially and domestically by picking the one that fits the necessities of intensity age. Following is a schematic diagram of horizontal axis wind turbine (HAWT) and vertical axis wind turbine (VAWT) in fig.5.

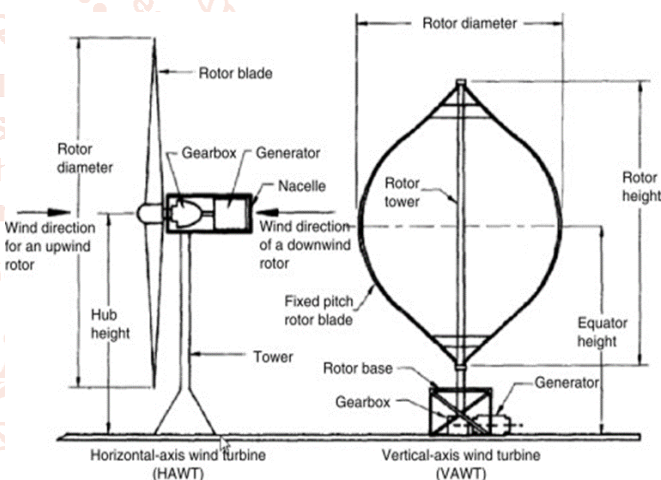


Fig.5-schematic diagram of the types of wind turbine

3. BENEFITS OF VAWT OVER HAWT

From the above discussion we understood that both types of turbines have their advantages and disadvantages according to the type of power requirement through electricity generation. But when concerned for domestic purpose usage vertical axis wind turbines have an edge over horizontal axis wind turbine.

Since horizontal axis wind turbines (HAWTs) are the most conventional way to harness wind energy but VAWTs has an edge in terms of advantages when compared to the regularly and widely used horizontal-axis wind turbines (HAWTs) in sync with the use in domestic works.

Benefit of using a VAWT over the traditional HAWT is that it does not need a yaw mechanism, because it can channel the energy of wind from all directions. Unlike HAWTs, VAWTs may be packed in close proximity inside wind farms as they are compact in size. In our routine life examples we can easily notice that the wind blades of a horizontal axis wind

turbine make noises when they are in motion and also the turbine rotates in single fixed direction when the wind is favorable for rotation of blades due to which the blades exerts high force on the installed structure. In opposition to the HAWTs the blades of VAWTs are quite less noisy, they are omnidirectional and they additionally create lower load on the support of the installed structures. VAWTs blade can

operate on low speed winds and due to that they can be structured near to ground level and can be easily controlled and implemented on tall structures.

To further compare the performances of both the turbines a table is given which provides the efficiency comparison of both along with following parameters.

Table2. Comparison in terms of different performance criteria between vertical and horizontal axis wind turbines

Performance	Vertical axis turbine	Horizontal axis turbine
Generated power efficiency (%)	70	50-60
Electromagnetic interference	No	Yes
Mechanism of the wind steering	No	Yes
Gearbox mechanism	No	Yes
Blade rotation space	Quite small	Quite large
Wind confrontation capability	Strong	Weak
Noise (dB)	0-10	5-60
Cut in wind speed (m/s)	1.5-3	2.5-5
Failure rate of system	Low	High
Operation and maintenance	Convenient	Complicated
Revolving speed	Low	High
Cable position problem	No	Yes

CONCLUSION

In today's era of degrading aspiration for a healthy life due to pollution caused by burning coals, fossil fuels, natural gases etc. and rapid rate of increment in the greenhouse gases, makes one to think about the alternate ways for meeting daily energy requirements if not fully through renewable energy sources then it could be maximum when asked for power generation for consumption. The most common and widely used renewable energy sources are wind energy, solar energy, hydro energy etc. out of which this paper contains a comparison based overview on using either horizontal axis or vertical axis wind turbines. The paper discusses about the history of wind turbine, need for its emergence and wide popularity for its usage. Wind energy is a clean form of energy producing method with minimum pollution possible. The installation of wind turbines require a big landmass in area for the establishment of wind farms containing hundreds of wind turbines. The paper also discusses about the two types of wind turbines that are the horizontal axis and vertical axis wind turbines, as HAWTs has an edge over VAWTs in commercial use as HAWT can generate more electricity in steady wind conditions than VAWT but in terms of domestic usage in rural areas VAWT generates more efficiency in electricity generation when compared to HAWT. VAWT's compact size and easy working mechanism make it more suitable for domestic use than the HAWT.

REFERENCES-

- [1] The development of straight bladed vertical axis wind turbine, W.S BANNISTER, S.GAIR in *Energy for Rural and Island Communities: Proceedings of the Conference*,

Held at Inverness, Scotland, 22-24 September 1980, 1981.

- [2] Power Electronics for Renewable Energy Sources, Syed M. Islam, Md. Mubashwar Hasan, in *Power Electronics Handbook (Fourth Edition)*, 2018.
- [3] Development of Wind Energy in India Deepak Sangroya, Dr. Jogendra Kumar, Nayak** Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand-247667, India.
- [4] Future Scope of Wind Energy in India, Vishal Maurya1, Sushant Khare1, Shrish Bajpai (Undergraduate Student, Electronics & Communication Engineering Department, Faculty of Engineering, Integral University, U.P., India).
- [5] Energy: Current Approach Cheng Siew Goh Department of Quantity Surveying and Construction Project Management, Heriot-Watt University Malaysia, Putrajaya, Malaysia.
- [6] Comparison of horizontal axis wind turbine (HAWT) and vertical axis wind turbine (VAWT) Muhd Khudri Johari*, Muhammad Azim A Jalil, Mohammad Faizal Mohd Shariff University Kuala Lumpur -Malaysian Institute of Aviation Technology, Dengkil, Selangor, Malaysia.
- [7] REVIEW ON VERTICAL AND HORIZONTAL AXIS WIND TURBINE, C. M. Vivek, P. Gopikrishnan, R. Muruges, R. Raja Mohamed, 2017.
- [8] Khare, V., Khare, C., Nema, S., & Baredar, P. (2019). *Introduction to Energy Sources. Tidal Energy Systems*, 1-39.