Design An Epic Magnetic levitation helped vertical axis Maglev Wind Turbine

[1]Bhuvnesh Rathor, [2]Pramit Mathur, [3]Himanshu Garg, [4], Nitish Kumar Pandey, [5]Lokesh Lakhara
[1]Assistant Professor, [2]Student, [3]Student, [4]Student, [5]Student
Global Institute of Technology, Jaipur

Abstract - **A crucial factor being created of human resource is the Energy. As ordinary vitality sources are crippling altogether, the improvement of perpetual and economic power source resources like breeze, daylight based is essential for human life. The breeze control been utilized by individual for an increasingly unmistakable day and age and today wind control is pulling in the benefits of vitality division and their application is going into speedier improvement. The standard Wind turbine requires high structures to allow space for their huge edges consequently Maglev Turbines are an impeccable plan. Maglev wind turbines have a couple focal points over common breeze turbines. For instance, they're prepared to use turns with starting paces as low as 1.5 meters for each second (m/s). In like manner, they could work in winds outperforming 40 m/s. At present the greatest normal breeze turbines on the planet make only five megawatts of vitality. Nevertheless, one broad maglev wind turbine could make one GW of clean force, enough to supply imperativeness to 750,000 homes**

keywords - **Vitality, Attractive Levitation, Force Generation, Maglev Wind Turbines, Renewable Energy.**

I. INTRODUCTION

Renewable energy is commonly electricity supplied from sources, such as wind power, solar power, geothermal energy, hydropower and various forms of biomass. These sources have been coined renewable due to their continuous replenishment and availability for use over and over again. The popularity of renewable energy has veteran a significant upsurge in recent times due to the exhaustion of conventional power generation methods and increasing realization of its adverse effects on the environment. Wind power or wind energy is the use of wind to provide the mechanical power through wind turbines to turn electric generators and traditionally to do other work, like milling or pumping. Wind power is a sustainable and renewable energy, and has a much smaller impact on the environment compared to burning fossil fuels. Wind farms consist of many individual wind turbines, which are connected to the electric power transmission network. Onshore wind farms also have an impact on the landscape, as typically they need to be spread over more land than other power stations and need to be built in wild and rural areas, which can lead to "industrialization of the countryside and habitat loss. Small onshore wind farms can feed some energy into the grid or provide electric powerto isolated off-grid locations. This project focuses on the utilization of wind energy as a renewable source. In the United States alone, wind capacity has grown about 45% to 16.7GW and it continues to grow with the simplification of new wind projects. The aim of this major qualifying project is to design and implement a magnetically levitated vertical axis wind turbine system that has the ability to operate in both high and low wind speed conditions. Our choice for this model is to showcase its efficiency in varying wind conditions as compared to the outdated horizontal axis wind turbine and contribute to its steady growing popularity for the purpose of mass utilization in the near future as a reliable source of power generation. Unlike the traditional horizontal axis wind turbine, this design is levitated via maglev (magnetic levitation) vertically on a rotor shaft.

Table 1. Installed Wind Power Capacity In World (MW)

S.no	Nation	2014	2015	2016	2017	2018
1	China	1,14,763	1,45,104	1,68,690	1,88,232	2,11,392
2	European Union	1,28,752	1,41,579	1,53,730	1,69,319	1,78,826
3	United States	65879	74472	82183	89077	96665
4	Germany	39165	44947	50019	56132	59311
5	India	22465	27151	28665	32848	35129
6	Spain	22987	23025	23075	23170	23494
7	United Kingdom	12440	13603	15030	18872	20970
8	France	9285	10358	12065	13759	15309
9	Brazil	5939	8715	10740	12763	14707

10	Canada	9694	11205	11898	12239	12816
11	Italy	8663	8958	9257	9479	9958
12	Sweden	5425	6025	6519	6691	7407
13	Turkey	3763	4718	6101	6516	7369
14	Poland	3834	5100	5782	6397	5864
15	Denmark	4845	5063	5227	5476	5758
16	Portugal	4914	5079	5316	5316	5380
17	Australia	3806	4187	4327	4557	5362

This maglev technology, which will be looked at in great detail, serves as an efficient replacement for ball bearings used on the conventional wind turbine and is usually implemented with permanent magnets. This levitation will be used between the rotating shaft of the turbine blades and the base of the whole wind turbine system. The conceptual design also entails the usage of spiral shaped blades and with continuing effective research into the functioning of sails in varying wind speeds and other factors, an efficient shape and size will be determined for a suitable turbine blade for the project.

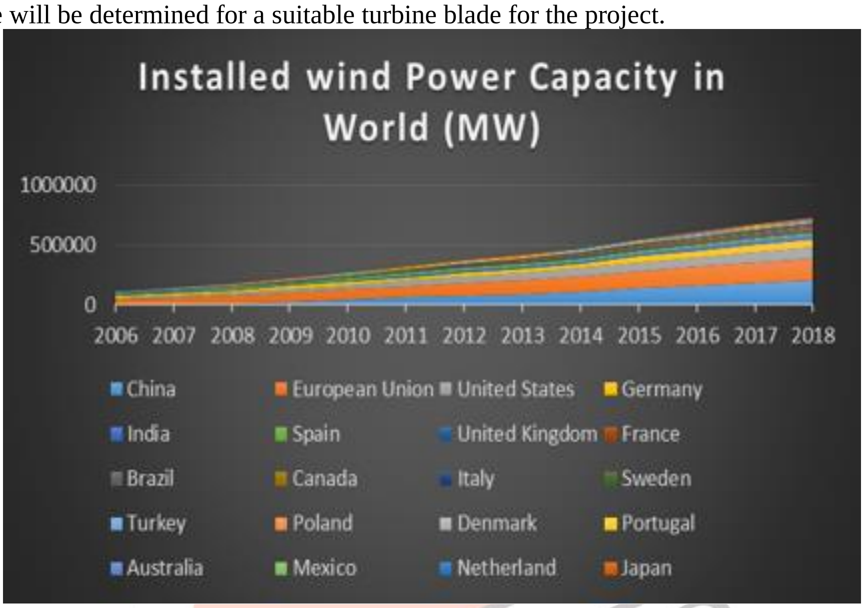

Fig. 1. Installed Wind Power Capacity In World (MW)

II. Research Of Rajasthan Installed Capacity Of Wind Power

4298 MW wind power plant has been installed Capacity in Rajasthan. The Jaisalmer Wind Park is India's 2nd largest operational onshore wind farm. This project located in Jaisalmer, Rajasthan. The project, developed by Suzlon Energy, was initiated in August 2001 and comprises Suzlon's entire wind portfolio – ranging from the earliest 350 kW model to the latest S9X – 2.1 MW series. Its installed capacity is 1,064 MW, which makes it one of world's largest operational onshore wind power plant. At the end of FY12, its combined installed capacity was 1064 MW on 1 April 2012. This achievement makes the wind park the 2nd largest of its kind in India, and one of the largest wind plants in the world.

A. Mathematical Modelling of Wind Turbine

The blades of wind turbine extract the kinetic energy from the wind and converted mechanical energy. The Kinetic energy is equal to the mass of air m and the wind speed in equation

$$E = \frac{1}{2}.m.v^2 \quad (1)$$

The moving air power is equal to

$$P_w = \frac{dE}{dt} = \frac{1}{2}.m.v^2 \quad (2)$$

Where m is the mass flow rate per second. The air passes across an Area A.
From the Equation (2)

$$P_w = \frac{1}{2} m.A.\rho.\mathrm{v}^2 \quad (3)$$

Where ρ is the air density (ρ =1.225 kg/ m^2)
The power extracted from the wind by the blades

$$P_{Blade} = C_p(\lambda,\beta).P_w = C_p(\lambda,\beta).\frac{1}{2} m.A.\rho.v^3 \quad (4)$$

Where C_p - power coefficient.

The power coefficient given two Functions. β (In degree) is the pitch angle of the rotor blades. The theoretical value of power coefficient is C_p = 0.593.

λ is defined the tip speed

$$\lambda = \frac{w_m R}{v} \tag{5}$$

Where w_m - Angular Velocity of the rotor

R -Length of the rotor Blade.

The rotor torque given the equation

$$T_w = \frac{P_{Blade}}{\omega_m} = \frac{\pi C_P(\lambda,\beta)\rho R^2 A v^3}{2\omega_m} \tag{6}$$

The power coefficient C_P is defined as a function of the blades angle and the tip speed ratio

$$C_P(\lambda,\beta) = c_1(c_2.\frac{1}{\gamma} - c_3.\beta - c_4.\beta^x - c_5)e^{-c_6\frac{1}{\gamma}} \tag{7}$$

With γ defined as

$$\frac{1}{\gamma} = \frac{1}{\lambda + 0.08\beta} - \frac{0.035}{1+\beta^3} \tag{8}$$

Where the coefficient are equal to c_1 =0.5, c_2 =116, c_3 =0.4,

c_4 =0, c_5 =5, c_6 =21 (c_4 =0 that why x is not used)

At the nominal value of wind speed (Ws), the wind turbine produces the nominal power (P_{nom}). The wind farm trips from the network when the wind speed outperforms the most wind speed values, until the control comes back to its nominal values. Wind profile data, used in this paper, appear in fig

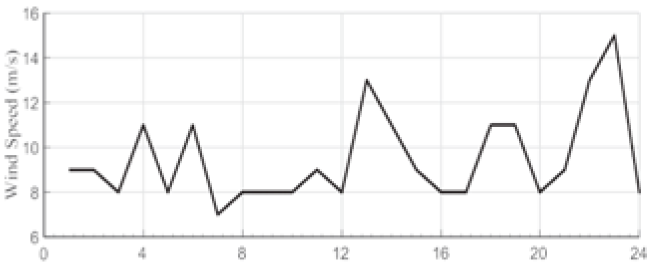

Fig. 2. Graph of Wind Speed

For Wind Generation

$$V_1 = \frac{1}{3}(V_{RY} - e^{-j\frac{2\pi}{3}}.V_{YB})$$

$$S_W = \frac{P_{nom}}{(w_s)} \times 10^6$$

$$I_1 = \frac{2}{3} \times \frac{S_W}{V_1}$$

$$I_2 = -e^{-j\frac{2\pi}{3}} \times I_1$$

III. MAGLEV WIND TURBINE

Different the conventional type, the vertically oriented blades of the wind turbine are suspended in air by using permanent magnet which produces magnetic force to lift up the blades. Since the turbine blades are suspended by magnetic force produce by the permanent magnet, there is no need of ball bearing to retain the blades. This allows the friction between the blades and ball bearing can be reduced significantly and thus, diminishes the energy loss. This also helps reduce maintenance costs and increases the lifespan of the generator. The Maglev wind turbine, which was first unveiled at the Wind Power Asia exhibition in Beijing, is expected to take wind power technology to the next level with magnetic levitation.

Magnetic levitation (maglev) is a method in which an object is suspended with no support other than magnetic fields. The magnetic force produced is used to counteract the effects of the gravitational force and lift up the object. There are many advantages for utilizing magnetic levitation that is to minimize friction, make force measurement, design, and entertaining devices. Recently, this advance technology is applied into transportation system in which non contacting automobile travel safely at very high speed while suspended, guided, and propelled above a guide way by magnetic fields. The concept of magnetically levitated vehicle stimulates the development of useful application in various fields such as the power generation.

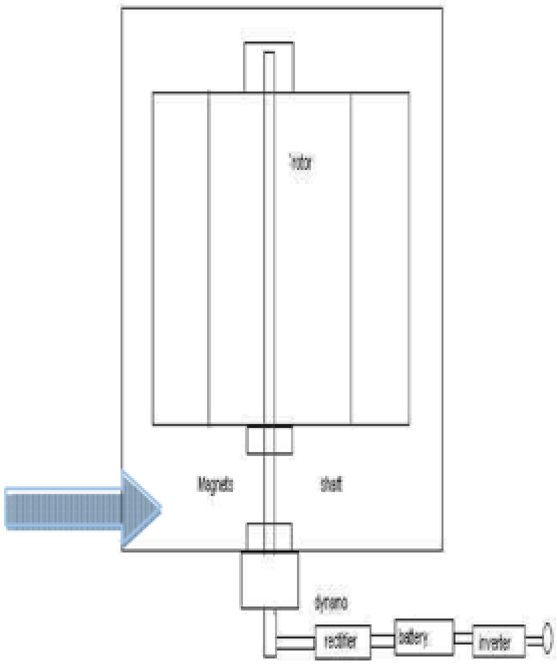

Fig. 3. Block Diagram of Maglev Wind Turbine

This phenomenon operates on the repulsion characteristics of permanent magnets. This technology has been predominantly utilized in the rail industry in the Far East to provide very fast and reliable transportation on maglev trains and with ongoing research its popularity is increasingly attaining new heights. Using a pair of permanent magnets like neodymium magnets and substantial support magnetic levitation can easily be experienced. By placing these two magnets on top of each other with like polarities facing each other, the magnetic repulsion will be strong enough to keep both magnets at a distance away from each other. The force created as a result of this repulsion can be used for suspension purposes and is strong enough to balance the weight of an object depending on the threshold of the magnets. Power will then be generated with an axial flux generator, which incorporates the use of permanent magnets and a set of coils. The generated power is in form of DC, stored in battery, this can be used to directly supply the DC loads and can also be converted to AC using inverter to supply AC loads. It can be used as OFF grid and ON grid as shown in above figures. Wind power is a proven and highly effective way to generate electricity. Maglev technology is the most efficient means of transferring kinetic energy to generate electricity. The vertical axis wind turbine platform floats on a magnetic cushion with the aid of permanent- magnet suspension and a companion linear synchronous motor. This technology eliminates nearly all friction and delivers maximum wind energy to the downstream lineargenerator.

The characteristic that set this wind generator apart from the others is that it is fully supported and rotates abouta vertical axis. This axis is vertically oriented through the centre of the wind vent which allows for a different type of rotational support rather than the conventional ball bearing system found in horizontal wind turbines. This figure shows a basic rendition of how the maglev will be integrated into the design. If the magnets where ring shaped then they could easily be slid tandem down the shaft with the like poles facing toward each other. This would enable the repelling force required to support the weight and force of the wind turbine and minimize the amount of magnets needed to complete the concept.

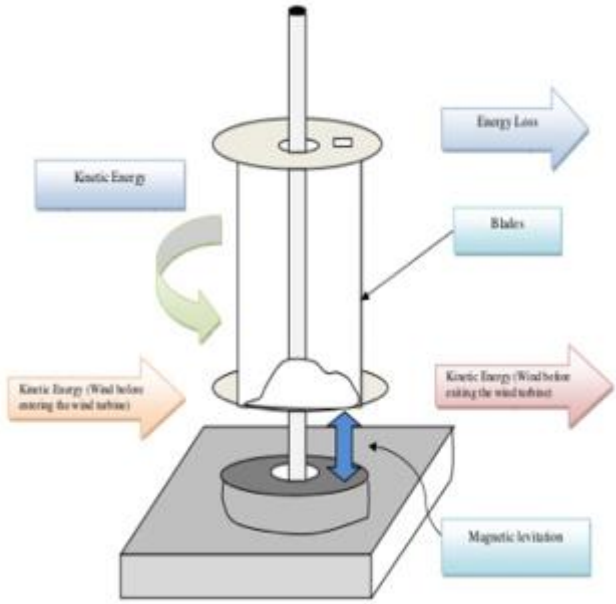

Fig. 4. Working Diagram of maglev Wind Turbine

A. Components Used To Construct Maglev Wind Turbine

- Cast Iron Frame Chassis
- Wheels
- Battery
- ACP and Wooden Sheet
- Steel Plate Fins
- Bearing
- Inverter Circuit
- Stand
- Neodymium Magnet

IV. Practical Set-up

This is an Inverter circuit use for the convert DC power to AC power

Fig. 5. Inverter Circuit

Fig. 6. Connection Setup

Fig. 7. Working Model

V. Conclusion

The Vertical Axis Wind Turbine (VAWT) with magnetic levitation performs better than theconventional wind turbine. This is because, the maglev VAWT model has lower starting wind speed(1.6 m/s) compare to conventional one (4.59m/s). The rotational speed of maglev VAWT is higher, that is 640.80rpm, and while the conventional model is 265.92rpm at constant wind speed of at 5.63m/s.The time taken for the maglev wind turbine to stop rotating is longer than that of conventionalwhich is 14.5s and 1.5s respectively. Therefore, the Maglev wind turbine is suitable for theapplication of urban areas to provide green energy.

References

[1] J. Clerk Maxwell, a Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[2] Dinesh N. Nagarkar and Dr. Z. J. Khan,"Wind Power Plant Using Magnetic Levitation Wind Turbine", International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue1, July 2013.

[3] M. Bhadu, B. Rathor and S. K. Bishnoi, "Modern control techniques of AC microgrid," *2017 International Conference on Computing and Communication Technologies for Smart Nation (IC3TSN)*, Gurgaon, 2017, pp. 1-6.

[4] Minu John, Rohit John, Syamily P.S, Vyshak P.A," MAGLEV WINDMILL",International Journal of Research in Engineering and Technology(IJRET) Volume 3,Issue 3,May 2015.

[5] Mrunal D. Palaspure, Jayant R.Mundre, SanketC.Pant ,AktarKhaA.Pathan,RoshansingR.More,"An Innovative Way Of Generation Of Power by Using Magnetic Power Based Windmill ",International Journal of Emerging Technologies in Engineering Research(IJETER) Volume 5,Issue 4,April 2017.

[6] K.D.Chaware and N.N.Wadaskar ,"Experimental Investigation of Windmill to Generate Electric Power using Magnetic Levitation : A Review", International Journal of Scientific Research in Science, Engineering and Technology(IJSRSET) Volume 2,Issue 4,July-August 2016.

[7] Roshni D. Murodiya and Dr.Hari Kumar Naidu,"Design and Development of Vertical Axis Wind Turbine Using Maglev System", International Journal of Scientific Engineering and Research(IJSER), Volume 4,Issue 7,July 2016.

[8] Bhushan Rawool, Krishna Shahu, PiyushSawant and Ravi Sahani,"GREEN E-GENERATOR", International Research Journal of Engineering and Technology(IRJET),Volume 3,Issue 4,April 2016.

[9] Amit D. Patil, Amit W. Chake, Manoj I. Helonde, Pravin M. Gupta, "Vertical Axis Wind Turbine with Maglev Technology", IJSRD -International Journal for Scientific Research &Development , Vol. 2, Issue 12, 2015

[10] Kelvin J Van Dyke, "An introduction to magnetic levitation and its application", IEEE, May-2014

[11] Minu John, Rohit John, "Maglevwindmill", International Journal of Research in Engineering and Technology, Volume: 04, Issue: 05, May-2014.

[12] B. Rathor, M. Bhadu and S. K. Bishnoi, "Modern Controller Techniques of Improve Stability of AC Microgrid," *2018 5th International Conference on Signal Processing and Integrated Networks (SPIN)*, Noida, 2018, pp. 592-596.

[13] Dinesh N Nagarkarand, Dr. Z. J. Khan, "Wind Power Plant Using Magnetic Levitation Wind Turbine", International Journal of Engineering and Innovative Technology Volume 3, Issue: 01, July 2013.

[14] Vishal Dhareppagol, MaheshwariKonagutti, "Regenedyne maglev wind power generation", International Journal of Electrical, Electronics and Data Communication, Volume- 1, Issue- 6,July 2010

[15] Mohammad M. Bashar, "Computational and Experimental Study on Vertical Axis Wind Turbine in Search for an Efficient Design", Georgia Southern University, December 2014

[16] Javier Castillo Tampere, "Small-Scale Vertical Axis Wind Turbine Design", University of Applied Sciences , December 2011.

[17] B. Rathor, N. Utreja, M. Bhadu and D. Sharma, "Role of Multi-Band Stabilizers on Grid Connected Microgrid," *2018 2nd International Conference on Micro-Electronics and Telecommunication Engineering (ICMETE)*, Ghaziabad, India, 2018, pp. 318-322.

[18] Chetan Singh Solanki, "Renewable Energy Technology", January 2008

[19] US 7,462,950 B2, (United States of America), Dec. 9, 2008, "MAGNETIC LEVITATION WEIGHT REDUCTION STRUCTURE FOR A VERTICAL WIND TURBINE GENERATOR".

[20] Thanhtoan Tran, Donghyun Kim and JinseopSong , "Computational Fluid Dynamic Analysis of a Floating Offshore Wind Turbine Experiencing Platform Pitching Motion" ,May 2014.

[21] V. Agrawal, B. Rathor, M. Bhadu and S. K. Bishnoi, "Discrete Time mode PSS Controller Techniques to Improve Stability of AC Microgrid," *2018 8th IEEE India International Conference on Power Electronics (IICPE)*, JAIPUR, India, 2018, pp. 1-5.

[22] Chris Kaminski, Austin Filush, Paul Kasprzak and Wael Mokhtar, "A CFD Study of Wind Turbine Aerodynamics", Grand Valley State University, 2012.