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RESEARCH ARTICLE

DESIGN AND FABRICATION OF MAGLEV WIND TURBINE.

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Abstract

The traditional wind turbine need very high structures to allow room for their massive blades, hence Maglev Turbines are an ideal solution. It is estimated that renewable sources might contribute about 20%-50% to energy consumption in the later part of the 21st century. Maglev wind turbines have several advantages over conventional wind turbines. For instance, they're able to use winds with starting speeds as low as 1.5 meters per second (m/s). Also, they could operate in winds exceeding 40 m/s. At present the largest conventional wind turbines in the world produce only five megawatts of power. However, one large maglev wind turbine could generate one GW of clean power, enough to supply energy to 750,000 homes. The paper aims to make a systematic analysis of design and fabrication processes to find out optimum output from the Vertical Axis Maglev Wind Turbine and by also using solar panel for using the solar energy to generate electricity.

Introduction:-

Combining latest MagLev technology with PV (Solar) panels gives the best of both worlds for greater independence from costly grid electricity bills. From apartments to street lighting, hybrid systems are starting to bring consistent power to areas worldwide, MagLev turbines are an ideal solution to the traditional wind turbine, which need very high structures to allow room for their massive blades. MagLev technology (so called due to the 'magnetic levitation' friction free drive) has been around for a while as we know from the Magnetic Levitation high speed trains.

Using MagLev technology in VAWT's (Vertical Axis Wind Turbine) means less moving parts, less maintenance, smaller profile and most importantly, very little wind to start working due to the lack of friction.

The smaller more compact design of the VAWT, makes it ideal for home use as the unit and blades stand upright. Having magnetic levitation means the turbines weight is frictionless in operation allowing even a small breeze to turn it and produce power. The Excluss MagLev uses latest NdFeB (Neodymium) rare earth magnets which are 10x stronger than others, eliminating the need for any electromagnetic drive, making them friction and virtually maintenance free. Due to air/ground temperature difference, when the sun goes in ground wind instantly increases. So the Excluss hybrid system produces power day and NIGHT.

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Objective of Maglev:-

1. Design of a new method of generation of electricity using the wind energy generated by the moving vehicles on the highways, roads, etc.
2. Incorporation of more renewable energy to the power system.
3. Development Stand-alone system for providing the power to the highways.
4. Combination of the two natural powers to make desired output.

Wind Power:-

Wind is known to be another form of solar energy because it comes about as a result of uneven heating of the atmosphere by the sun coupled with the abstract topography of the earth's surface. With wind turbines, two categories of winds are relevant to their applications, namely local winds and planetary winds.

The latter is the most dominant and it is usually a major factor in deciding sites for very effective wind turbines especially with the horizontal axis types. These winds are usually found along shore lines, mountain tops, valleys and open plains. The former is the type you will find in regular environments like the city or rural areas, basically where settlements are present. This type of wind is not conducive for effective power generation; it only has a lot of worth when it accompanies moving planetary winds.

Wind power is the use of air flow through wind turbines to mechanically power generators for electricity. Wind power, as an alternative to burning fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation, consumes no water, and uses little land.[2] The net effects on the environment are far less problematic than those of nonrenewable power sources.

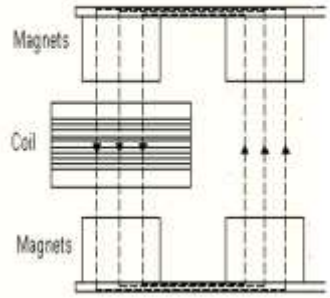
Solar power: Solar power is the conversion of sunlight into electricity, either directly using photo voltaic (PV), or indirectly using concentrated solar power. Concentrated solar power systems (Unified Solar) use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaic convert light into an electric current using the photovoltaic effect.

The International Energy Agency projected in 2014 that under its "high renewable" scenario, by 2050, solar photovoltaic and concentrated solar power would contribute about 16 and 11 percent, respectively, of the worldwide electricity consumption, and solar would be the world's largest source of electricity. Most solar installations would be in China and India.

Photo voltaic were initially solely used as a source of electricity for small and medium-sized applications, from the calculator powered by a single solar cell to remote homes powered by an off-grid rooftop PV system. As the cost of solar electricity has fallen, the number of grid-connected solar PV systems has grown into the millions and utility-scale solar power stations with hundreds of megawatts are being built. Solar PV is rapidly becoming an inexpensive, low-carbon technology to harness renewable energy from the Sun.

Maglev Turbine:-

Unlike the maglev vehicle, the vertically oriented 4 blades of the wind turbine are suspended in the air above the base of the machine by using permanent magnet. 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, minimizes the energy loss. This also helps reduce maintenance costs and increases the lifespan of the generator.

Construction:-

Neodymium Magnets:-

The Neodymium metal element is initially separated from refined Rare Earth oxides in an electrolytic furnace. The "Rare Earth" elements are lanthanides (also called lanthanides) and the term arises from the uncommon oxide minerals used to isolate the elements.

The Rare Earth elements are abundant e.g. Neodymium element is more common than gold. The Neodymium, Iron and Boron are measured out and put in a vacuum induction furnace to form alloy. Other elements are also added, as required for specific grades e.g. Cobalt, Copper, Gadolinium and Dysprosium (e.g. to assist with corrosion resistance).

The neodymium magnet is given a protective coating. It is imperative that the drying is thorough otherwise water is locked into the plated Neodymium magnet and the magnet will corrode from the inside out.

Permanent Magnets:-

Permanent magnets are magnets that are permanently charged. They are different from electro-magnets in that electro-magnets only have magnetic properties when an electrical current is flowing through them. Permanent magnets, on the other hand, are always magnetic.

Permanent magnets are made using rare earth metals. These magnets are not only very powerful but also extremely useful. While care must be taken when handling and using permanent magnets, the world would be a very different place if these magnets were not present in day to day products that are used by everyone the world over.

1. **Dimensions:** 40mm OD x 20mm ID x 10mm thick
2. **Magnetic Face;** 40mm diameter
3. **Magnets Type;** Neodymium
4. **Material:** NdFeB,
5. **Grade:** N52
6. **Plating /Coating:** Ni-Cu-Ni (Nickel)
7. **Magnetization Direction:** Axial/radial(Poles on Flat Ends)
8. **Hole type:** single hole
9. **Max Operating Temp:** 176ºF (80ºC)
10. **Quantity:** 1 pcs

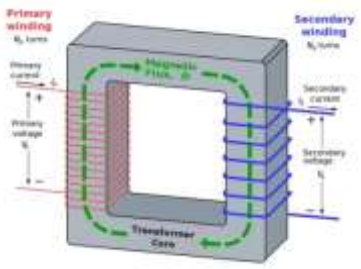
Generator:-

The basic understanding of a generator is that it converts mechanical energy to electrical energy. Generators are utilized extensively in various applications and for the most part have similarities that exist between these applications. However the few differences present is what really distinguishes a system operating on motors.

With the axial flux generator design, its operability is based on permanent magnet alternators where the concept of magnets and magnetic fields are the dominant factors in this form of generator functioning. These generators have air gap surface perpendicular to the rotating axis and the air gap generates magnetic fluxes parallel to the axis.

Coils:-

An electromagnetic coil is an electrical conductor such as a wire in the shape of a coil, spiral or helix. Either an electric current is passed through the wire of the coil to generate a magnetic field, or conversely an external time-varying magnetic field through the interior of the coil generates an EMF (voltage) in the conductor. A current through any conductor creates a circular magnetic field around the conductor due to Ampere's law. The advantage of using the coil shape is that it increases the strength of magnetic field produced by a given current. The magnetic fields generated by the separate turns of wire all pass-through the center of the coil and add (superpose) to produce a strong field there.



The direction of the magnetic field produced by a coil can be determined by the right hand grip rule. If the fingers of the right hand are wrapped around the magnetic core of a coil in the direction of conventional current through the wire, the thumb will point in the direction the magnetic field lines pass through the coil.

Medium-density fiberboard (MDF):-
MDF is generally cheaper than plywood, but it is not as hard and can sag under heavy weight. MDF doesn't handle moisture very well, either, so it is more suited for indoor use, such as in furniture. Moisture also affects the strength of plywood; exterior-glued plywood can be used outdoors, but it works best when moisture content remains low.

Magnetic Levitation:-
This phenomenon operates on the repulsion characteristics of permanent magnets. Using a pair of permanent magnets like neodymium magnets and substantial support magnetic levitation can easily be experienced. By placing 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. In this project, we expect to implement this technology for the purpose of achieving vertical orientation with our rotors. In the designed prototype, the stator and rotor are separated in the air using the principle of magnetic levitation.

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. In this project, we expect to implement this technology form the purpose of achieving vertical orientation with our rotors as well as the axial flux generator.

DC-AC CONVERSION / battery charging unit:-
Over the years, alternating current has been the common choice of power supply. AC is popular because the voltage can be easily stepped up or down using a transformer. Due to the inherent properties of a transformer, DC voltage cannot be altered using this type of equipment. Transformers operate due to a changing magnetic field in which the change in magnetic flux induces a current. Direct current cannot provide a changing magnetic field therefore a transformer with an applied DC input would only produce heat. The output from the maglev windmill will be an alternating voltage. This output can be directly connected to load or can be converted to dc and stored in a battery for later use.

Literature Review:-
R. F. Post[1] filed a Patent on Magnetic Levitation System which stated that Repelling Magnetic forces are produced by the interaction of flux- conc. Magnetic field (produced by permanent magnets or electromagnets) with an inductively loaded closed electric circuit. When one such element moves with respect to the other, a current is induced in the circuit. This current then interacts back on the field to produce a repelling force.

S. Mashyal and Dr. T. R. Anil[2] designed a portable highway wind turbine, which is to be contributing towards the global trend in wind energy production in a feasible way. Wind turbines are traditionally employed in rural areas; the main goal the work is to design a wind turbine that can be used in cities. In particular, the turbines will use the wind draft created by vehicles on the highway to generate electricity. The idea is to offset the amount of pollution created by burning fossil fuels by introducing a potential source of clean energy. As the automobiles moves from highways/expressways, there is a creation of pressure column on both the sides of the road. This pressure column is created due to imbalance of high pressure/low pressure energy band created by the automobiles. Due to this pressure

band wind flow and create pressure thrust. The pressure thrust is sufficient to generate electricity through designed wind turbine.

G.P. Ramesh and C.V. Arvind [3] studied that Due to Vertical Axis Wind Turbine low power generation capabilities, the Vertical Axis Wind Turbine is highly conducive for standalone applications. The operational range limits the power generating capability in wind turbines and is highly influenced through the blade shape and angle of attack. Recently maglev concept is introduced to increase the velocity of rotational mass and thereby the power generation capability. A maglev design incorporated with the optimized wind turbine is presented in this work. Initial investigation on three different wind profiles and the suitable airfoil provide the degree of impact at angle of 30° to have the highest lift coefficient for the chosen airfoil structure.

A.P Diaz, G. J Pajaro and K. U Salas [4] stated that Although vertical axis turbines have long existed, it was not until the beginning of the twentieth century when the Darrieus (1921) and Savonius rotors (1924) appeared; the two most used models nowadays. Savonius rotor was invented by the Finnish engineer Sigurd J Savonius with two half cylinders basic design that rotate around an axis. In this research, four different models of Savonius rotor blades are analyzed, as well as the traditional rotor and He found the best Power Coefficient (Cp) and the best torque coefficient (Cm) for different models. In order to achieve the objective, a CFD computational model was used, with 3D simulations in transient regime. A computational domain was defined as a function of the minimal longitude in the system, and meshing is performed after a mesh size independency analysis. The results show that helical Savonius rotor performs the best in the analyzed operation conditions and improves in ~20% above the other configurations. In addition, 3-blade rotor presents the lowest performance of all the models with a power coefficient Cp of 0.073.

Y. Hongxing, Z.Wei, L.[5]Chengzhi recommended an optimal design model for designing hybrid solar–wind systems employing battery banks for calculating the system optimum configurations and ensuring that the annualized cost of the systems is minimized while satisfying the custom required loss of power supply probability (LPSP). The five decision variables included in the optimization process are the PV module number, PV module slope angle, wind turbine number, wind turbine installation height and battery capacity. The proposed method has been applied to design a hybrid system to supply power for a telecommunication relay station along south-east coast of China. The research and project monitoring results of the hybrid project were reported, good complementary characteristics between the solar and wind energy were found, and the hybrid system turned out to be able to perform very well as expected throughout the year with the battery over-discharge situations seldom occurred.

W Kim and D. L. [6] Trumper presented a high-precision magnetic levitation (maglev)stage for photolithography in semiconductor manufacturing. This stage is the world's first maglev stage that provides fine six-degree-of-freedom motion controls and realizes large (50 mm 350 mm) planar motions with only a single magnetically levitated moving part. The key element of this stage is a linear motor capable of providing forces in both suspension and translation without contact. The advantage of such a stage is that the mechanical design is far simpler than competing conventional approaches and, thus, promises faster dynamic response and higher mechanical reliability. The stage operates with a positioning noise as low as 5 nm rms in x and y, and acceleration capabilities in excess of 1 g (10 m/s2). They demonstrate the utility of this stage for next-generation photolithography or in other high precision motion control applications.

Table 1:- Summary of Literature Review		
Author	**Technique**	**Remarks**
R.F. Post	Principles of Magnetic Forces.	Patent on Magnetic Levitation System.
S. Mashyal and Dr. T. R. Anil	Study of Pressure thrust & pressure energy.	Designed a portable highway wind turbine
G.P. Ramesh and C.V. Arvind	Power Generation	Study of Power generation for Vertical Axis Wind turbine.
A.P Diaz, G. J Pajaro and K. USalas	Study of power Coefficient & torque coefficient	Study of vertical axis wind turbine.
Y. Hongxing, Z.Wei, L.	An optimal design model for designing hybrid solar–wind systems	Reducing the cost of the system
W Kim and D.L. Trumper	High-precision magnetic levitation (maglev)stage for photolithography in semiconductor manufacturing.	Improved mechanical design &providing forces in both suspension and translation without contact.
S. Eriksson, H.Bernhoff, M.Leijon	Comparative study of horizontal axis Wind turbine & vertical axis Wind turbine	The blade areas for different turbines resulting that VAWT blades are better than others.
G.M. Herbert, S. Iniyan, E. Sreevalsan, S. Rajapandian	Study of wind energy and environmental aspects.	Evaluation and Analysis of models of wind turbine and its components.
M. Islam, D. S. Ting, A.Fartaj	Study of the main aerodynamic models	design of straight-bladed Darrieus-type VAWT

S. Eriksson, H.Bernhoff, M.Leijon[7] made a comparative study of the horizontal axis wind turbine and two different concepts of vertical axis wind turbines; the Darrieus turbine and the H-rotor these three different wind turbines from the most important aspects including structural dynamics, control systems, maintenance, manufacturing and electrical equipment. A case study is presented where three different turbines are compared to each other. Furthermore, a study of blade areas for different turbines is presented. The vertical axis wind turbine appears to be advantageous to the horizontal axis wind turbine in several aspects.

G.M. Herbert, S. Iniyan, E. Sreevalsan, S. Rajapandian[8] estimated that roughly 10 million MW of energy are continuously available in the earth's wind. Wind energy provides a variable and environmental friendly option and national energy security at a time when decreasing global reserves of fossil fuels threatens the long-term sustainability of global economy. This paper reviews the wind resources assessment models, site selection models and aerodynamic models including wake effect. The different existing performance and reliability evaluation models, various problems related to wind turbine components (blade, gearbox, generator and transformer) and grid for wind energy system have been discussed. They reviewed different techniques and loads for design, control systems and economics of wind energy conversion system.

M. Islam, D. S. Ting, A. Fartaj [9] attempted to compile the main aerodynamic models that have been used for performance prediction and design of straight-bladed Darrieus-type VAWT. It has been found out that at present the most widely used models are the double-multiple stream tube model, Vortex model and the Cascade model. Each of these three models has its strengths and weaknesses which are discussed by them.

Conclusion:-

MAGLEV AND SOLAR wind energy conversion systems are practical and potentially very contributive to the production of clean renewable electricity from the wind even under less than ideal sitting conditions.

It is hoped that they may be constructed used high-strength, low- weight materials for deployment in more developed nations and settings or with very low tech local materials and local skills in less developed countries.

The MAGLEV wind turbine designed is ideal to be located on top of a bridge or bridges to generate electricity, powered by wind.

The elevated altitude gives it an advantage for more wind opportunity. With the idea on top of a bridge, it will power up street lights and or commercial use.

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