HELICAL BLADE ON VERTICAL AXIS WIND TURBINE - A REVIEW

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***Abstract*: Vertical axis wind turbines are notable for their ability to capture the most wind from both directions. This ignores the need for a yawing system and rudders. One of the groundbreaking ideas that could be important in the implementation of Helical or Helix Vertical Wind Turbines in urban or city environments. Because of their safer use, low chance of blade ejection, and ability to absorb power in all wind directions. This paper presents a literature review on the implementation of an empirical estimate of a helical wind turbine power output that influenced the rotor blade design and construction. Specifically designed to provide energy to private properties or areas with less-than-ideal economic conditions**.

Keywords: Vertical axis Wind Turbine , analysis , blade design , electricity supply.

INTRODUCTION:

Wind energy is a renewable energy supply that is commonly used as a working fluid in wind turbines. However, owing to increasing environmental problems and fuel resource issues, it ceased to be used as a source of energy in the modern age. The global need for clean and green energy has necessitated advanced technological research and development. As a result, wind energy has become the industry's priority, and its usage has increased significantly, but only on a wide scale. In recent years, a growth in the number of more powerful, bigger, and more costly horizontal axis wind turbines (HAWT) has emerged, resulting in onshore and offshore wind-turbine fields. This research aims to produce energy on a smaller scale by using a small wind turbine to generate a household power supply and to create a cost-effective and affordable turbine for people who need an option to satisfy their own electricity demand. The rotor blade configuration, turbine structure, and experimental results of a helical vertical axis wind turbine are presented in this article (VAWT). This turbines have a few distinct advantages over horizontal turbines, and these advantages make them a safer choice for cities and more difficult areas.

J. Vignesh et al. (**1**) Wind has established itself as one of the most effective non-conventional methods for generating electricity. The vertical axis windmill will be effective for power generation given the geographical characteristics of our area. The main goal of this paper is to design and construct a vertical axis wind mill that can run at low wind speeds. Seralathan, Sivamani, et al. (**2**) Additive manufacturing is quickly becoming a popular method for producing complicated three-dimensional materials in a limited amount of time. Cross axis wind turbine blades and their components are developed in this analysis using fusion deposition simulation with Acrylonitrile Butadiene Styrene (ABS). The 3D CAD models are translated to.STL images, which can then be printed.

Hussain, M. Zahir, et al. (**3**) Despite the fact that high-capacity batteries are used, they appear to discharge at a much quicker rate and require regular charging. To charge these batteries, a very high-power input is needed, as well as a longer charging time (3 to 4 hours for a full charge). People do not like EVs because of this drawback. As a result, the idea is to add a device that will charge the battery while the car is in motion, rather than slowing it to charge. To make this possible, the most renewable source of electricity, Wind Energy, is being used. The Vertical Axis Wind Turbine (VAWT) is used to capture this wind energy. Dathu, K. P. M. Y. V., et al. (**4**) Polyester, glass fibre, carbon fibre, combinations of fibre with other components, and strengthening the epoxy material on the blade are some of the materials used in windmill blades. To improve reliability, the blade's weight can be reduced by replacing the blade material with lightweight materials and inserting different materials such as Nickel-Titanium (Ni-Ti), Copper-Aluminium-Nickel,(Cu-Al-Ni), Copper-Zinc-Aluminium (Cu-Zn-Ai) is used to improve the performance and power of wind turbines. The example of a modern material that is compared to traditional materials and the quality is checked. The application of quality by the combining of new materials is examined in this article.

Morales-Ruvalcaba, Carlos F, et al. (**5**) To estimate power generation, high-quality wind speed measurements are expected at the beginning of the resource evaluation process. The determination was made using the Pearson correlation coefficient between the measured time series and the wind speed calculated by interpolating bias-corrected reanalysis-estimated wind speed to all positions over different time-averaging periods. Camffo, D. et al.(**6**) The methods for calculating wind and indoor air motions are listed in this chapter. The anemometer and the wind vane are used to calculate the wind speed and direction for meteorological purposes. An anemometer calculates the total volume of air mass that passes through the instrument's sensible component in a given amount of time, contributing some of its kinetic energy to the cups or propellers that weigh it are compelled to rotate Anemometers are dependent on one or more wind properties, such as wind kinetic energy, wind pressure, wind cooling capacity, sound transmission property, or light transmission property. There are many sources of error in wind speed and path calculations, but the presence of a transducer that perturbs the wind field produces the most errors or the presence of eddies caused by structures, branches, or other obstructions.

Dan Zhao et al.(**7**) The Savonius wind turbine is a vertical-axis wind turbine that turns wind energy into torque on a spinning shaft. The turbine is made up of a series of aerofoils that are positioned vertically on a revolving shaft or structure, either on the ground or in airborne structures. One of the most basic turbines is the Savonius turbine. In terms of aerodynamics, it's a drag system with

two to three scoops. A two-scoop machine will seem to have a "S" shape in cross section as seen from above. When going against the wind, the scoops feel less drag than when moving with the wind due to the curvature. The Savonius turbine spins due to the differential drag. Savonius turbines extract much less wind power than similar-sized lift-type turbines because they are drag-type systems. Allouhi, A. et al.(**8**) This paper introduces a new systematic method for evaluating wind power generation that is based on a multidimensional approach that considers energetic, exergetic, fiscal, and environmental factors. The wind power plant is examined for two Moroccan coastal areas with significantly different outdoor meteorological parameters for comparative purposes. In the study, the three-bladed horizontal axis commercialised wind turbine Enercon-48 with a rated capacity of 800 kW is used.
Dawn, Subhojit, et al. (**9**) This paper illustrates the important aspects, as well as the promotion strategies, that the Indian government has adopted in order to improve the country's own energy security by maximising the use of available renewable energy sources. Wind power is not only used to produce electricity in India, but it is also used to provide energy at a low cost. Hoerner, Stefan, et al. (**10**) When used in arrays, vertical-axis water turbines (VAWT) have a higher area-based power density, making them a promising alternative to horizontal-axis hydro-kinetic turbines (HAWT). A surrogate model consisting of an oscillating NACA0018 hydrofoil in a closed water channel is used to research the process, following a motion rule that is similar to the true angle of incidence of a Darrieus turbine blade as it rotates. The oscillation frequency and tip speed ratio for one rigid as well as three flexible hydrofoils of various stiffnesses are investigated. As a result, the coupling mechanism is studied for a variety of system designs and working points. Measurements of lift and drag were taken in a systematic manner.
Salah, Mukhtar M. et al. (**11**) Wind data from 12 meteorological stations across the Kingdom of Saudi Arabia (KSA) was used to look into the potential of wind power generation in different parts of the world. The basic wind power equation is then used to measure the power density for all places.In addition, the monthly and annual mean wind energy is calculated to assess the suitability of each sites for the installation of different types of wind turbines. In addition, the monthly and annual mean wind energy is determined to decide if each site is appropriate for the installation of various types of wind turbines. Kaffine, Daniel T. et al. (**12**) This paper looks at a new form of wind farm spillover effect: microclimate impacts on nearby crop yields. I analyse the effects of wind energy production on crop yields using US county-level crop and wind capacity data, controlling for time-invariant county characteristics and state-level annual shocks.
García-Seoane, R., et al. (**13**) The aim of this methodological analysis was to see if the best placement of flat moss bags in relation to a contamination source increases the efficiency of contaminant interception and retention (Al, As, Cd, Cr, Cu, Fe, Hg, Ni, Pb, V and Zn). Mesh bags containing the moss Sphagnum palustre were exposed for 14 weeks in two different forms (3 replicates each) in industrial environments (two ferrous smelters, a ceramics factory, a paper and wood factory with cogeneration production, and a coal-fired power plant). Brintha, N. C., et al. (**14**) Manufacturing industries have recently undergone many long-term transformations in their production processes. In this report, scheduling was done using a workflow analysis on ceiling fan SMEs as a case study, and the workflow's efficiency was tested. The main aim of this project is to enhance workflow and incorporate SMEs in the ceiling fan industry into production lines.
Mamanpush, Seyed Hossein, et al. (**15**) Wind turbine blades that have reached the end of their useful life are mechanically recycled. Second generation composites manufactured with recycled wind turbine material and a polyurethane adhesive were first comminuted via a hammer-mill via a variety of varying screen sizes, resinated, and compressed to a final thickness. Physical properties (absorption of water) (WA), A dataset of composites made from recycled wind turbine blades with thickness swelling (TS) is provided. The effect of resin level, moisture content, mill screen size, and density on the physical properties of composites was also presented in the data collection. Jensen, Cathrine Ulla, et al. (**16**) We present the findings of a large-scale study in Denmark that looked at how on-shore and off-shore wind turbines impact the prices of nearby single-family homes and holiday homes. We discovered that on-shore wind turbines have a detrimental effect on the price of nearby assets up to three kilometres away. The negative impact grows at a decreasing marginal rate with the number of wind turbines, but decreases with distance. We see no major impact of having an off-shore wind farm in view from a property or from the nearest beach in the case of off-shore wind turbine farms, possibly because the closest off-shore turbine is 9 km from the closest traded house. We include maps that demonstrate how the marginal effect of a wind turbine differs across the landscape, demonstrating the policy importance of our results.
Stathopoulos, Ted, et al. (**17**) The paper offers some perspectives on recent development in the areas of wind resource assessment in urban habitats, the use of appropriate wind turbines for maximising the exploitation of these resources, and the importance of building and urban aerodynamics expertise for an optimum arrangement of interfacing augmented wind with its extraction mechanisms. Lee, Ka Lok, et al. (**18**) The effects of wind speed (0–12 m/s) and yaw angle (0°–90°) on convective heat losses from a cylindrical cavity heated to a uniform wall temperature was investigated experimentally. In the open section of a wind tunnel, the cavity is heated with 16 individually operated copper surface components, allowing both heat losses and heat flux distribution to be measured and subjected to a controlled convective environment.
Simiu, Emil, and Robert H. Scanlan. et al. (**19**) In ecology, there are two types of wind effects: the impact of vegetation on the wind, such as how it reduces wind speed near the ground and creates niches for small animals and plants to build and survive, and the effect that wind and turbulence have on many aspects of animal behaviour, plant growth and survival, and organism metabolisms. This article reflects on the very general physical interaction between wind (and hence turbulence) and other environmental variables such as thermal heat loss and species metabolic rates, as well as the exchange of trace gases such as CO2, and then concludes with an analysis of the most important specific aspects of wind effects in the ecological literature. Thapar, Sapan, et al. (**20**) Existing wind capacity, as well as its share of total generation capacity, were identified as important drivers. Other determinants included commercial factors such as industrial tariffs and utility efficiency. In a state-by-state study, stark differences were found, with wind growth in some states responding to infrastructure factors such as the road network.
Imholte, D. D., et al. (**21**) Clean energy technologies, such as wind energy, are being deployed globally to reduce greenhouse gas emissions. Onshore and offshore wind targets in the United States have been especially ambitious. Dilimulati, Aierken. et al. (**22**) This paper discusses the different types of urban wind turbine designs in order to better understand their efficiency and the synergy

between the turbines and the urban environments. It also takes into account a flanged diffuser shroud mechanism, which is a fluid system mounted on the roofs of buildings and used as a casing for small wind turbines to increase performance using primarily CFD. The diffuser shroud system uses special features including cycloidal curve geometry at the inlet and a vortex generating flange at the outlet to direct and accelerate airflow inside buildings. The output of the fluid machine is parametrically optimised.
Lamy, Julian, et al. (**23**) A study used 15 semi-structured interviews with residents of two coastal Massachusetts counties, one of which recently installed an onshore wind project, to determine the basic characteristics that influence expectations about the current project as well as hypothetical new onshore or offshore projects. Noise, environmental benefits, wildlife danger, and safety issues were found to be the most significant to participants, followed by economic benefits and visual aspects of the project. Mühle, et al. (**24**) The effect of an upwind turbine's rotor rotational direction on the output of another wind turbine operating in its wake was investigated in this report. For this analysis, two model wind turbines of the same rotor diameter are used in a parallel configuration. The distance between the turbines was varied between 2.0D and 5.15D, and the upstream wind turbine was either co-rotating or counter-rotating with respect to the downstream wind turbine (where D is the rotor diameter). Both computational and experimental methods were used to investigate the turbine arrays' output and wake measurements.

Viba, Janis, et al. (**25**) New wind energy devices with regulated flat blade orientation to air flow are being created. The interaction of the blade with the air flow is studied experimentally. In the ARMFIELD wind tunnel, aerodynamic coefficients for blade drag and lifting forces are calculated experimentally. The programmes Excel and MathCad are used to optimise function parameters**.** To improve the efficiency of energy transformation, it is suggested that the angular location of the flat blade during rotation of the central wheel be changed by a special law. Blade axles are kinematically attached to the central wheel for this reason**.** Stefan junk , et al. (**26**) This paper demonstrates the use of two critical additive processes in the fabrication of wind tunnel versions of an unmanned aerial vehicle (UAV) for wind tunnel measurements. The binder jetting process is used to create the UAV components. The use of multiple post-processing steps resulted in models with a high level of surface quality. In the wind tunnel, these models were tested at various flow velocities and orientations. An adjustable measuring stand made of standard profiles was designed and built to conduct measurements. Devices and fixtures made with the aid of the FDM process were used in this way.

Matha, Denis, et al. (**27**) For potential cost reductions to become competitive, floating wind technology must be industrialised. As part of the LIFES50+ H2020 research study, the floating-specific production, assembly, and construction constraints for various floating substructure concepts are explored for large potential 10MW floating wind turbines and 500MW wind farms. Hangan, Horia, et al. (**28**) Wind-structure interaction methods and research strategies These methods allow us to examine a broader range of wind events, including non-stationary and non-synoptic winds, as well as their effects on buildings and structures. One critical aspect is to assess the possible effect of wind power production on local economies quantitatively. Using a national county-level dataset from 2005 to 2011, this study conducts an ex post econometric assessment of the impact of wind power installation on local economies in China.

Ambach, Daniel, et al. (**29**) Many different approaches to predicting wind speed have been suggested in the literature. A new mathematical method for forecasting wind speed, wind direction, and air pressure is presented in this paper. The direction of the wind and the air pressure are essential factors in improving the accuracy of wind speed forecasts. A good wind forecast aids in placing the turbine in the prevailing wind direction. A threshold seasonal autoregressive conditional heteroscedastic (TARCHX) model is combined with a multivariate seasonal time varying threshold autoregressive model with interactions (TVARX). Periodicity, conditional heteroscedasticity, interactions among dependent variables, and a complex autoregressive structure with non-linear impacts are all included in the model. In comparison to traditional probability estimation methods, we use a high-dimensional shrinkage technique to estimate the dependent variables rather than relying on a distributional assumption. Schleich, et al. (**30**) Over the course of two decades, this paper discusses the impact of policies and other factors driving growth in wind power technology in twelve OECd countries. The number of patents issued is seen as a measure of progress. The considerations taken into account are also taken from the literature on innovation structures. The estimations were made using a count data econometric model. According to the findings, patenting in wind power technology is linked to public R&D in the field (reflecting supply-side policy), the stock of wind energy (reflecting learning effects), the number of patents per capita (reflecting a country's creative capacity), and the percentage of Green party voters (reflecting the legitimacy of the technology).

Wong, Kok Hoe, et al. (**31**) When opposed to horizontal axis wind turbines, vertical axis wind turbines (VAWTs) have many benefits (HAWTs). According to research, VAWTs are well suited to turbulent wind flow and urban applications. The efficiency and low self-start capacity of VAWTs, especially lift-type VAWTs, are often the key disadvantages. This paper discusses a number of flow augmentation systems in detail and aims to provide researchers with knowledge on emerging augmentation strategies as well as other related studies. Brian Hand ,et al.(**32**) Using an established aerodynamic modelling technique, this paper introduces the computational design of a VAWT for this use. The turbine solidity, blade number, blade aspect ratio, and non-prismatic structure geometry were all subjected to a through inspection.

Masoud Ghasemian , et al.(**33**) This paper summarises recent research on Darrieus VAWT simulations using CFD (computational fluid dynamics). Turbulence simulation, spatial and temporal discretization, numerical schemes and algorithms, and computational domain size are all given guidance and guidelines. Operating and geometrical parameters such as tip speed ratio, wind speed, solidity, blade number, and blade shapes are all closely studied. J.D.M.Bothaa, et al.(**34**) This paper provides an improved method for forecasting broadband noise produced by a Vertical Axis Wind Turbine due to aerodynamics (VAWT). The approach integrates newly developed airfoil noise prediction models and builds on previous studies for VAWT noise prediction. The dynamics of inflow

vibration and airfoil self-noise are both considered. Junk, et al.(**35**) The future uses of additive manufacturing have greatly grown in recent years. The use of two important additive processes in the production of wind tunnel versions of an unmanned aerial vehicle (UAV) for wind tunnel measurements is illustrated in this article. The binder jetting procedure is used to make the UAV components. The use of multiple post-processing measures resulted in models with a high level of surface consistency.

Min-HsiungYang , et al. (**36**) the output of a cutting-edge vertical axis turbine with blade self-deflection for ocean current and tidal energy applications. The interaction of blades and associated processes causes the blades to deflect as the turbine rotates. To improve turbine efficiency, the blade deflection is designed to increase not only the power output for a downstream blade, but also the power output for all downstream blades. To improve turbine efficiency, the blade deflection is designed to increase the power output for a downstream blade while lowering the resistance for an upstream blade. Mojtaba Ahmadi-Baloutaki , et al.(**37**) A series of wind tunnel experiments were used to investigate the aerodynamic interaction of vertical axis wind turbines in various array configurations. Four two- and three-turbine array setups were checked, and the findings were compared to the isolated comparison example. The free-stream wind was perpendicular to the two side-by-side turbines, so two sets of counter-rotating and co-rotating vertical axis wind turbines were measured. Almost all arrays and most measured wind speeds showed an improvement in the downstream turbine's aerodynamic efficiency.

Qing'anLi , et al.(**38**) In wind tunnel studies, this paper focused on testing the aerodynamic forces acting on a single blade based on the number of blades. The number of blades in this analysis ranged from two to five, with the cross-sectional outline of the tested airfoil being a NACA0021. The results of the six-component balance and torque metre is lower than the pressure distributions' calculations. Baloch, et al. (**39**) Electricity is vital to every country's social economic progress and social stability. It should be regarded as a necessary requirement for human growth. In today's Pakistan, low electricity production is a serious problem that directly impedes the country's growth. One-third of Pakistan's population does not have any electricity in the rural areas and about 10–12 hours load shedding in urban areas and is quite common. Although, the state of Pakistan always shows a deficit in the conventional resources, but no progress was also being made in the renewable resources such as the wind and solar energy. In rural areas, one-third of Pakistan's population is without power, and load shedding of 10–12 hours is normal in urban areas. While Pakistan has always had a deficit in traditional resources, it has made little progress in renewable resources such as wind and solar energy.

Lion Hirth et al. (**40**) This paper examines the market importance of wind power in power systems with massive reservoirs, such as those found in Sweden. Hydropower compensates for wind power output fluctuations and thereby mitigates the wind power value decrease due to its dispatch stability. The market value of wind-generated energy decreases as usage increases in all forms of power systems, but it falls at a slower pace where hydropower is present. This paper uses industry data and computational model findings to provide analytical support for the validity of this effect.

Tummala, Abhishiktha, et al. (**41**) Meeting future global energy demands and tackling climate change has put a burden on traditional power sources. Wind is one of the feasible renewable energy sources. However, since large-scale wind farms have the ability to alter climate conditions, localised small-scale wind turbines are a more sustainable choice. The different types of small-scale wind turbines, including horizontal axis and vertical axis wind turbines, are discussed in this article. The stability, blade design, power, and manufacturing of horizontal axis wind turbines were investigated. sunny, et al. (**42**) The aerodynamic simulation, design, and performance assessment of vertical axis wind turbines are discussed in this article (VAWT). Using software methods, the aerodynamic simulation of VAWT is created using the NACA0012 airfoil with a chord length of 0.12 m. Lightweight 3 bladed functional concept model of VAWT made of aluminium with rotor diameter and height of 0.36 m and 0.40 m, respectively is fabricated. In a subsonic wind tunnel, this realistic prototype model is evaluated to evaluate output parameters such as wind strength, mechanical power at the turbine shaft, tip speed ratio (TSR), and power coefficient.

García, Jorge H., et al. (**43**) This thesis explores the relative capacity of private and public compensation to answer this issue. We run a Choice Experiment (CE) to look at household compensation expectations for the local siting of a potential wind farm. Households were offered three choices to choose from, each of which had three distinct characteristics: the number of generators, the private compensation level, and the public compensation level According to the findings, the wind farm causes health losses to both local residents and non-local leisure users, with non-use prices accounting for around 35% of the losses. Djamel., et al.(**44**) The action of a wind farm incorporated into an electrical power system is described in this article, as well as the impact of this energy on various grid parameters such as voltage, load flow, and frequency. The primary purpose of this research is to obtain an understanding of the effect of wind turbines on voltage, load flow, and frequency, as well as to find a solution. In addition, at the close of this article, a comparison of the simulation outcomes is made.

Sharma, et al. (**45**) The appraisal of wind energy at two locations in the Fiji Islands is presented. The wind capabilities of the remote island of Kadavu, as well as the urban Suva Peninsula, are explored. At 20 m and 34 m above ground level, the former has average (mean) wind speeds of 3.59 ms1 and 3.88 ms-1, respectively (AGL). The other has 5.65 ms-1 and 6.38 ms-1 average wind speeds, respectively. The dominant wind direction at both locations is south-east. For the Suva location, a wind shear study reveals the differences in wind speeds during the day. The WAsP app is used to model a high resolution wind resource map of both sites for a distance of 5 km. According to the WasP review, the windward side of the Kadavu ridge in the eastern area has strong wind power generation capacity. Nayak, et al. (**46**) Manufacturing facilities are looking for structural and technological improvements to achieve energy savings in development as concerns about global warming and rising fuel prices rise. On-site electricity generation is a

cleaner and less costly source of energy, but since it is extremely stochastic and intermittent, it is difficult to schedule demand. In this article, we suggest a framework for an intelligent algorithm in a job shop manufacturing facility with the goal of minimising overall energy costs while controlling total order delays. A production plant with a wind turbine is considered a means of on-site renewable energy production.

Caporale, Diana, et al. (**47**) This research seeks to identify the factors that contribute to this obstructive conduct, as well as the most important topics to address in order to develop appropriate regulatory policies to promote at the neighbourhood level. This research is interesting in that it incorporates qualitative (Focus Group) and quantitative (Optimized-Analytic Hierarchy Method and Monte Carlo simulation) methods for the first time. are combined to promote the notion of societal adoption of wind energy.

II. CONCLUSION:

This paper discuss the research which was undertaken the author's view.a theoretical frame work of is developed from a literature search and this is used by the authors as the basis of an analytical method.the data is used to demonstrate that our understand can be significantly increased and this is discussed in the light of the previous work.

- Power generation for the vertical axis wind turbine will be more efficient due to the geographical characteristics of our region.
- Additive manufacturing is rapidly gaining traction as a cost-effective way to construct complex three-dimensional materials in a short period of time.
- The weight of the blade can be minimised to increase strength by replacing the blade material with lightweight materials and adding new materials.
- The tip speed ratio and oscillation frequency of one rigid and three flexible hydrofoils of different stiffnesses was investigated.
- the very large physical interaction between wind (and hence turbulence) and other environmental variables such as thermal heat loss and species metabolic rates, as well as the exchange of trace gases such as CO2, and then ends with a study of the most important basic aspects of wind effects in the ecological literature.
- The UAV components are made using the binder jetting process. Multiple post-processing steps were used to create models with excellent surface quality.

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REFERENCES:

[1] Vignesh, J., Simon Christopher, A., Albert, T., Pravin Tamil Selvan, C., Sunil, J. (2020) Design and fabrication of vertical axis wind mill with solar system Materials Today: Proceedings, Volume 21, 2020

[2] Seralathan Sivamani Premkumar, M.T., Hariram, V., Kumar, P., John, G. (2020) Design and Numerical Analysis of Gearless Transmission Used in Small Wind TurbineLecture Notes in Mechanical Engineering.

[3] Hussain M. Zahir , S.Sendilvelan ,(2020) Charging of car battery in electric vehicle by using wind energy.

[4] Dathu, K.P.M.Y.V. R.Hariharan , (2020) Design of wind turbine blade material for higher efficiency.

[5] Morales-Ruvalcaba , Carlos F., O. Rodríguez-Hernández ., O. Martínez-Alvaradoc, Estimating wind speed and capacity factors in Mexico using reanalysis data , October 2020, Pages 158-166

[6] Camffo. D, Measurement, Risk Assessment, Conservation, Restoration, and Maintenance of Indoor and Outdoor Monuments 2019, Pages 483-511

[7] Dan zhao, Naumin Han , Ernust Goh , Wind Turbines and Aerodynamics Energy Harvesters 2019, Pages 167-338

[8] A. Allouhi Journal of Cleaner Production , October 2019, Pages 123-137

[9] Dawn Subhojit , Prashant Kumar Tiwari , Arup Kumar , Goswami , Ankit Kumar Singh, Rajesh Panda Department of Electrical Engineering, National Institute of Technology Silchar, Assam, India , January 2019, Pages 178-199

[10] Hoerner Stefan , Shokoofeh baszadeh , Thierry Maitre , Olivier Cleynen , Dominique The venina , Chair of Fluid Dynamics and Technical Flows, Institute of Fluid Dynamics and Thermodynamics, July 2019, Pages 13-30

[11] Salaha Mukhtar M. , Ahmed G. Abo-khalila , R. P .Praveen Wind speed characteristics and energy potential for selected sites in Saudi Arabia February 2019, Pages 119-128

[12] Kaffine Daniel T. , Microclimate effects of wind farms on local crop yields July 2019, Pages 159-173

[13] García-Seoane R. J.A Fernandez , A. Chilaj , R. Aboal , Improving the uptake of pollutants in moss bags: The wind effect , December 2019, 105577

[14] N.C. Brintha , J.T. Winowlin Jappes , N. Johnny Christo , M. Adam Khan , (2019) Adopting cloud computing for service integration – Wind mill blade manufacturing SMEs in India

[15] Mamanpush, Seyed Hossein , Karl Englund , HuiLi , Composite Materials and Engineering Center, Washington State University, October 2018, Pages 658-661

[16] Jensen Cathrine Ulla , Toke Emil Panduro , Thomas Hedemark Lundhedeab , Anne Sofie Elberg Nielsen , Mette Dalsgaard , Jellesmark Thorsena The impact of on-shore and off-shore wind turbine farms on property prices May 2018, Pages 50-59.

[17] Stathopoulos Ted , Hatem Alrawashdeh , Ayman Al-Quraan , Aierken Dilimulatie , Journal of Wind Engineering and Industrial Aerodynamics Volume 179, August 2018, Pages 146-157.

[18] Lee Ka Lok, Alfonso Chinnici , Mehdi Jafarian, Bassam Dally , Experimental investigation of the effects of wind speed and yaw angle on heat losses from a heated cavity May 2018, Pages 178-188.

[19] Simiu Emil, and Robert H. Scanlan. Wind Effects , January 2019.
[20] Thapar Sapan, Seema Sharma , Ashu Verma , Key determinants of wind energy growth in India: Analysis of policy and non-policy factors November 2018, Pages 622-638.
[21] Imholte,D.D , R.T.N guyen , A.Vedamtam , M.Brown , A.Iyer , An assessment of U.S. rare earth availability for supporting U.S. wind energy growth targets , February 2018, Pages 294-305.
[22] Dilimulate Aierken , Ted Stathopoulos , Wind turbine designs for urban applications: A case study of shrouded diffuser casing for turbines , April 2018, Pages 179-192.
[23] lamy Julian , Wandi bruine de bruin , ines M.L.Azevedo , Perceptions of wind energy projects in two coastal Massachusetts communities , November 2018 101377.
[24] Mühle, Franz, Muyiwa S. Adaramola, and Lars Saetran The effect of rotational direction on the wake of a wind turbine rotor – a comparison study of aligned co- and counter rotating turbine arrays , July 2017.
[25] Viba, Janis , The control of blades orientation to air flow in wind energetic device JULY 2017.
[26] Stefan junk , werner Schroder , steffen schrock , Design of Additively Manufactured Wind Tunnel Models for Use with UAVs , 2017, Pages 241-246.
[27] Matha, Denis **,** Fabrication and installation constraints for floating wind and implications on current infrastructure and design , 2017.
[28] Hangan Horia , Maryam Refan , Chowdhury Jubayer , Dan Parvu Novel techniques in wind engineering December 2017, Pages 12-33.
[29] Ambach Daniel , wolfgang schmid , A new high-dimensional time series approach for wind speed, wind direction and air pressure forecasting , September 2017, Pages 833-850
[30] Schleich, Joachim , Rainer Walz , and Mario Ragwitz , Effects of policies on patenting in wind-power technologies , 2017.
[31] wong Kok Hoe, wen tong chong , sin chew poe , Performance enhancements on vertical axis wind turbines using flow augmentation systems: A review , June 2017, Pages 904-921.
[32] Brian Hand , AndrewCashman Conceptual design of a large-scale floating offshore vertical axis wind turbine , December 2017, Pages 83-88.
[33] Masoud Ghasemian , Z. NajafianAshrafi , AhmadSedaghat , A review on computational fluid dynamic simulation techniques for Darrieus vertical axis wind turbines , October 2017, Pages 87-100.
[34] J.D.M.Botha , A.Shahroki , H.Rice An implementation of an aeroacoustic prediction model for broadband noise from a vertical axis wind turbine using a CFD informed methodology , December 2017, Pages 389-415.
[35] Stefan Junk , Steffen Schrock , Design of Additively Manufactured Wind Tunnel Models for Use with UAVs , 2017, Pages 241-246.
[36] Min - Hsiung Yang , Guan-Ming Huang , Rong - Hua Yeh Performance investigation of an innovative vertical axis turbine consisting of deflectable blades , October 2016, Pages 875-887.
[37] Moj taba Ahmadi-Baloutaki , Rupp Carriveau , David S-K.Ting , A wind tunnel study on the aerodynamic interaction of vertical axis wind turbines in array configurations , October 2016, Pages 904-913.
[38] Qing'anLi , TakaoMaeda , YasunariKamada , JunsukeMurata , Effect of solidity on aerodynamic forces around straight-bladed vertical axis wind turbine by wind tunnel experiments (depending on number of blades),October 2016, Pages 928-939.
[39] Baloch , Mazhar H , Ghulam S. Kaloi , Zubair A. Memon , Current scenario of the wind energy in Pakistan challenges and future perspectives , 2016.
[40] Lion Hirth , The benefits of flexibility: The value of wind energy with hydropower , November 2016, Pages 210-223.
[41] Tummala , Abhishiktha , A review on small scale wind turbines , 2016.
[42] Sunny, Kalakanda Alfred, and Nalla paneni Manoj Kumar, Vertical Axis Wind Turbine: Aerodynamic Modelling and its Testing in Wind Tunnel, 2016.
[43] García, Jorge H., Willingness to accept local wind energy development: Does the compensation mechanism matter , 2016.
[44] D jamel , Labed , Mansour Zohra , and Fetissi Selwa , Influence of the wind farm integration on load flow and voltage in electrical power system , 2016.
[45] Sharma, Kaushik, and M. Rafiuddin , Ahmed Wind energy resource assessment for the Fiji Islands: Kadavu Island and Suva Peninsula, 2016.
[46] Nayak, Ashutosh, Seokcheon Lee, and John W. Sutherland , Dynamic Load Scheduling for Energy Efficiency in a Job Shop with On-site Wind Mill for Energy Generation , 2016.
[47] Caporale, Diana , Multi-criteria and focus group analysis for social acceptance of wind energy , 2016.