Ciencias Técnicas y Aplicadas
Artículo de Investigación

Una revisión del alcance del modelo paramétrico de generadores eólicos

A Scoping Review on Parametric model of Wind Generators

Uma revisão do escopo do modelo paramétrico de geradores eólicos

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Resumen

El modelado paramétrico para la instalación de un segundo campo de Generadores Eólicos en el sector de Villonaco Loja se basa en la aplicación de un conjunto de software de propósito general y licencia pública, dinámica de fluidos computacional (CFD). Generar modelos matemáticos de los parámetros del viento del sector Villonaco Loja, utilizando las bases de datos proporcionadas por CELEC.

Este trabajo tiene como objetivo realizar un estudio de arte sobre la información existente en la simulación de flujo de aire, caracterizado por velocidad, presión, temperatura, así como el trabajo realizado en la identificación de áreas aptas para la instalación de parques eólicos, producción de energía. y la aplicación de modelos matemáticos en sectores ubicados en diferentes países. La revisión bibliográfica se centró en bases de datos de acceso abierto utilizando la metodología PRISMA, se obtuvieron 50 artículos cumpliendo criterios de exclusión e inclusión, sin embargo, se aplicó una etapa final donde las preguntas de investigación fueron obteniendo respuestas más detalladas y representativas, logrando llegar a una base de datos de 40 artículos, siendo esta la información más adecuada para el desarrollo de la investigación.

Palabras Claves: Modelo matemático; Parques eólicos; Base de datos; CFD; Generadores de viento.

Abstract

Parametric modeling for the installation of a second field of Wind Generators in the Villonaco Loja sector is based on the application of a set of general purpose and public license software, computational fluid dynamics (CFD). To generate mathematical models of the wind parameters of the Villonaco Loja sector, using the databases provided by CELEC.

This work aims to carry out an art study on the information existing in the simulation of airflow, characterized by speed, pressure, tempera- ture, as well as work carried out in the identification of suitable areas for the installation of wind farms, energy production and the application of mathematical models in sectors located in different countries. The bi- bliographic review focused on open access databases using the PRISMA methodology, 50 articles were obtained meeting exclusion and inclusion criteria, however, a final stage was applied where the research questions were obtaining more detailed and representative answers, achieving arrive at a database of 40 articles, this being the most appropriate information for the development of the research.

Keywords: Mathematical Model; Wind Farms; Database; CFD; Wind generators.

Resumo

A modelagem paramétrica para instalação de um segundo campo de Geradores Eólicos no setor Villonaco Loja é baseada na aplicação de um conjunto de softwares de uso geral e licença pública, dinâmica de fluidos computacional (CFD). Gerar modelos matemáticos dos parâmetros eólicos do setor Villonaco Loja, utilizando os bancos de dados fornecidos pela CELEC.

Este trabalho tem como objetivo realizar um estudo artístico sobre as informações existentes na simulação de fluxo de ar, caracterizado por velocidade, pressão, temperatura, bem como trabalhos realizados na identificação de áreas adequadas para instalação de parques eólicos, produção de energia e a aplicação de modelos matemáticos em setores localizados em diferentes países. A revisão bibliográfica focou em bases de dados de acesso aberto utilizando a metodologia PRISMA, foram obtidos 50 artigos atendendo aos critérios de exclusão e inclusão, porém, foi aplicada uma etapa final onde as questões de pesquisa foram obtendo respostas mais detalhadas e representativas, conseguindo chegar a uma base de dados de 40 artigos, sendo esta a informação mais adequada para o desenvolvimento da pesquisa.

Palavras-chave: Modelo matemático; Fazendas de vento; Base de dados; CFD; Geradores eólicos.

Introduction

The parameters that characterize a fluid are part of the equations of Navier Stokes, can be solved through complex mathematical procedures depending on the cases," An advection diffusion equation can be solved without any difficulty if the term diffuse dominates the advective; when this happens you have serious problems. [1]".

The parameters are spatial function (x,y,z) and temporal (t) and the existence of nonline terms within the equations of Navier Stokes, they are very difficult to solve.

There are approximate solutions by using the computer, allows iterative processes to be carried out with the input data and to extract data that are a solution to the parameters of the fluid under study, allow simulation of fluid behavior in the face of obstacles, the solution of fluid dynamics through computational use is known as CFDs.

Parametric fluid data such as speed can be measured with accurate measuring instruments and minimized errors, obtaining reliable data for analysis, that give rise to databases, parameters can

establish relationships, through software observe the distribution of data density, then find a mathematical model that simulates the database.

There are progressive studies in modeling wind parameters, each characterizing the place where it is possible to apply it, because each country's geographical position influences the movement of the wind. Ecuador is in the middle of the world, enjoys winds not exceeding 30 m/s its turbulence is moderate unlike the Nordic countries that suffer great turbulence, these winds can be compared as a laminar movement.

In the Villonaco sector is the place where the influence of winds is almost constant at heights of 2780 m above sea level, research with CFDs is cheaper and models are very flexible, allow data to change and see what happens, predict in a way that is approximate to reality and most importantly identify areas to install new wind generators, becoming one of the objectives in the development of this research.

In this topic each revised article serves as a guide to the conduct of new or similar research as is the realization of the theme "Parametric model for the installation of a second field of wind generators in Villonaco Loja".

1. Methology

Electronic search was performed on Scopus databases in relation to keywords, Similar topics, selection applied the metrics provided by the Scopus platform and filtered by the following flowchart based on the pyramid method, [40], (Fig.1).The review is based on the analysis of a database with parameters of parameters such as the level of acceptance confidence in the mathematical models, techniques to determine the wind speed, methods of solving the equations of fluid dynamics and study of wind farm facilities, which allow analysis of research based on questions, search for referenced documents, medium and high impact articles, through this review process researchers obtain relevant, pertinent and updated information to promote scientific research.

1.1. Research Questions

The research questions are based on parameters such as the level of acceptan ce confidence in the mathematical models, techniques to determine wind speed, methods of solving the equations of fluid dynamics and the study of wind farm facilities that allow the study prioritizing the places where an analysis of parame tric models of wind turbines and even the installation has already been carried out. The questions asked are listed below in the table 1.

Number Question	Research question	Motivation
Q1	Different techniques are applied in the articles to deter-mine wind speed?	Identify techniques of wind speed.
Q2	Apply different Methods of Fluid Dynamics Equation So-lution?	Identify methods of fluid dynamics
Q3	Do you use methods of validation of applied mathemati-cal models?	Identify methods sta-tisticians

Tabla 1. Research Questions

1.2. Document Search

In the bibliographic search, the publications were considered without limita- tion in time because all the studies carried out have their important investigative foundation and each one of them contributes significantly to the development of the research work, considering keywords the following searches are formu- lated, for the first point of view, Vp1in where information is sought on wind speed, the

following words are used (("wind" AND "speed") AND ("equation" AND "wind"), for the second point of view, Vp2 ("Methods" AND "Dynamics")) and (("Model" AND "air" AND "simulation"), for the third point of view, Vp3 ("installation" AND "wind turbine" AND "wind")). After analyzing the titles and abstracts of each document, they were considered under the following detail.

1.3. Paper Selection

At this stage, information is included or excluded by language, publication date, topic and duplication in the projection parameter, by relevance and perspective in the eligibility parameter, and due to research methods and conclusions, thus allowing a suitable review of each article. and finally the contribution in the introduction and conclusions of each article was reviewed with the questions formulated for the investigation. After that, the review of the references is very important for the future perspective of the same research. In the table 2 shows the inclusion and exclusion criteria considered. In this section based on the Pris- ma Methodology, the pertinent selection of the information obtained from the articles considered is made, for which four important parameters.

Through the selection of information in the previous section, 40 final full- text articles were obtained, which have fulfilled the requirements of the research work, more detailed information is obtained about 40 articles that have the necessary characteristics to reach an optimal review of relevant information that significantly contributes to the research.

Number	Inclusion	Exclusion
C1	Articles related to wind simulation	Articles in other simulations
C2	Articles published in recent years	Outdated items
C3	Articles written in English	Degree works as thesis

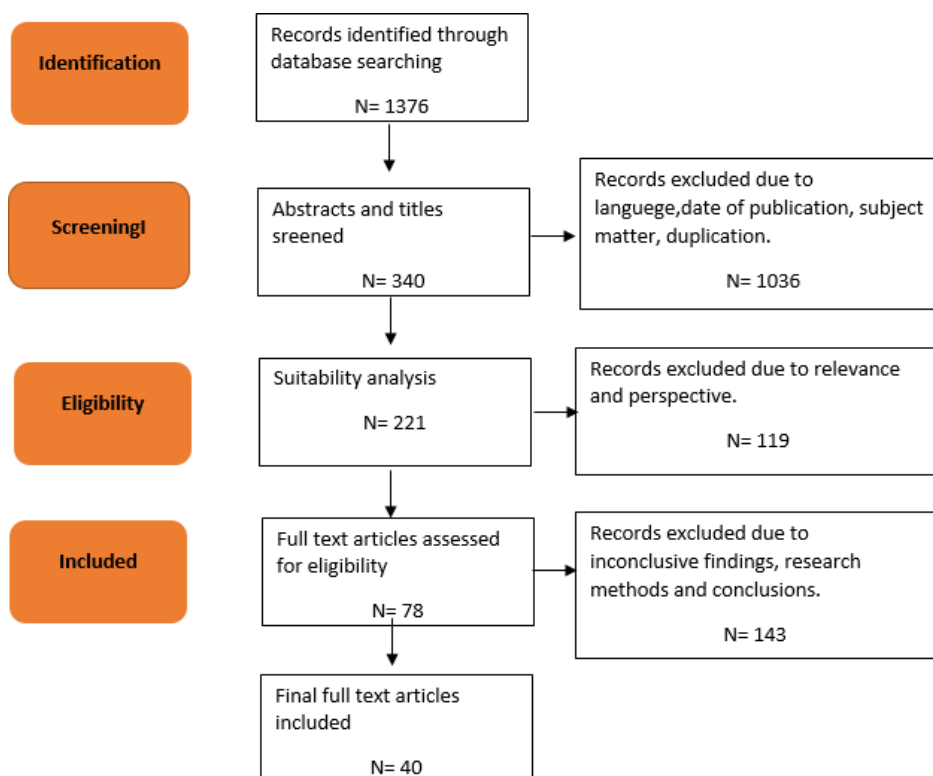| C4 | Articles related to the numerical analysis of fluid dynamics | Studies in another area of knowledge |
| C5 | Articles related to the installation of wind turbines | Articles not related to wind turbines |

Tabla 2. Inclusion and Exclusion

Figure 1. Process flow diagram PRISMA

1.4. Data Extraction

Finally, the extraction of the relevant information was carried out according to the need of the research such as: numerical models in fluid dynamics, analysis of wind speed, installation of wind turbines and the simulation of the physical phenomenon in temporal and spatial conditions. It has been concluded with a selection of 40 articles that have responded in an appropriate way to the research questions.

Tabla 3. Table analysis of papers

Paper	Title	Year	Point of view	Autor	abstract
P1	**Preliminary description of the average monthly wind speed and direction in Trelew**	2019	Vp1	Cúneo, Lucila Mercedes; Cerne, Silvia Bibiana; Llano, María Paula	The results indicate a reduction in the mean annual wind speed throughout the periods and especially a marked reduction in extreme winds, both high and calm speeds.
P2	**Characterization of the wind resource in the city of Juliaca**	2019	Vp1	Quiñonez Choquecota, José; Huanca Callata, Elmer; Holguino Huarza, Antonio	Characterize the exploitable potential of the wind resource in the city contour, with a quan-titative and qualitative analysis.
P3	**Prediction of Atmospheric Turbulence Characteristics for Surface Boundary Layer using Empirical Spectral Methods**	2021	Vp2	Dwivedi, Yagya Dutta; Nukala, Vasishta Bhargava; Maddula, Satya Prasad; Nair, Kiran.	They evaluated the computer simulation of the Von Karman, Kaimal methods for different surface roughnesses and for low (1 %), medium (10 %) and high (50 %) turbulence intensities.
P4	**Financial analysis of the energy potential of the wind to generate electricity: the case of Apan, Hidalgo**	2020	Vp3	Gómez Rodríguez, Tomás; Cortazar Martínez, Adriana; Zambrano Reyes, Adriana.	For the technical study, the Weibull probability density function is used. Likewise, for the financial analysis the following parameters are evaluated: net present value, the internal rate of return, the Levelized Cost of Electricity, the recovery period and the cost / benefit ratio.
P5	**A statistical exploration of interval-deficient wind speed data for application to wind power assessments.**	2019	Vp3	Lubbe, F.; Harms, T.; Maritz, J..	The effect of interval deficiency on the quality of wind speed data was investigated by studying the behavior of the Weibull scale and sha- pe factors as the size of the interval between wind speed measurements increased.
P6	**Regional management of the environment in a zenith greenhouse with computational fluid dynamics**	2019	Vp2	Flores-Velázquez, Jorge; Vega-García, Manuel	Model the environment of a tomato-grown greenhouse zenith using computational fluid dynamics (CFD), to propose environmental management alternatives and to estimate the energy expenditure and economic cost of using fans.

P7	**Emissions from Wind Turbine Blades**	2019	Vp3	Bhargava, Vasishta; Samala, Rahul	Predict computer simulation of acoustic emis-sions from wind turbine blades using a quasi-empirical model for a three-blade horizontal axis 3 MW turbine with a blade length of 47 m.
P8	**Wind Energy Forecasting with Neural Networks: A Literature Review**	2018	Vp1	Manero, Jaume; Béjar, Javier; Cortés, Ulises.	Wind power prediction is based on the ability to forecast the wind. There are many methods for forecasting wind based on the statistical properties of the wind time series and the in-tegration of meteorological information.
P9	**Time-series prediction of wind speed using machine learning algorithms: A case study Oso-rio wind farm, Brazil**	2018	Vp3	Khosravi, A., Macha-do, L., Nunes, R. O.	Time series prediction describes a model that predicts the future values of the system using only the past values.
P10	**Statistical study of wind speed and direction in the departments of Atl´antico and Bol´ıvar in Colombia**	2021	Vp1	De la Cruz Buel-vas, Jhonatan; Valen-cia Ochoa, Guiller- mo; Vanegas Chamo-rro, Marley.	They carry out a statistical study based on the analysis of wind variables such as wind speed and direction and, from the results, which show great potential, it can be inferred that the energy demand of the region could be sup-plied.
P11	**Short term forecast of wind speed through mathematical models**	2021	Vp3	MonikiFerreira, Ale-xandreSantos, Paulo-Lucio	It seeks to predict the average hourly wind speed in anemometric towers (at a height of 50 m) in two locations: a coastal region and another with complex terrain characteristics.
P12	**Dynamic modelling and design of various robust sliding mode controls for the wind turbine with estimation of wind speed**	2019	Vp2	Golnary, F. y Mora-di, H.	A new method based on ANFIS to estimate effective wind speed. The aerodynamic torque has a direct relationship with the power coef-ficient.
P13	**Wind speed forecasting for wind farms: A method based on support vector regression**	2016	Vp1	Santamar´ıa-Bonfil, G., Reyes-Ballesteros, A., Gershenson, C.	Using the autoregressive model called Time Delay Coordinates, feature selection is done through the phase space reconstruction proce-dure.
P14	**A new prediction method based on VMD-PRBF-ARMA-E model considering wind speed characteristic.**	2020	Vp2	Zhang, Y., Zhao, Y., Kong, C., Chen, B.	A new method of prediction of wind speed is proposed based on the characteristics of wind speed.
P15	**A combined forecasting model for time series: Application to short-term wind speed forecas ting**	2020	Vp2	Liu, Z., Jiang, P., Zhang, L. y Niu, X.	The results of point prediction and interval prediction reveal that the prediction system positively outperforms all contrastive models with respect to prediction accuracy and stabi-lity.

P16	**Dynamic ensemble wind speed prediction model based on hy brid deep reinforcement learning**	2021	Vp2	Chao Chen, Hui Liu	This study focuses on 1-hour, 1-step ahead de-terministic wind speed prediction with only wind speed as input.
P17	**Wind speed frequency distribution modeling and wind energy resource assessment ba sed on polynomial regression model**	2021	Vp3	International Journal of Electrical Power Energy Systems	Passive flow control through leading edge (LE) slats explored to reduce dynamic loss (DS) phenomenon and related blade wake inter-action in a H-type vertical axis (VAWT) - Darrieus wind turbine operating in low wind speed conditions.
P18	**Multistep short-term wind speed prediction using non-linear auto regressive neural network with exogenous variable selection**	2021	Vp3	FuadNoman, Gama-lAlkawsi, Ammar AhmedAlkahtani, Ali Q.Al-Shetwi, SiehKiong Tiong, NasserAlalwan, , Ahmed Ibrahi-mAlzahrani.	Uncorrelated multivariate variables used as exogenous input variables often have an ad-verse impact on the performance of prediction models.
P19	**Prediction of wind speed and wind direction using artificial neural network, support vector regression and adaptive neuro-fuzzy inference system**	2018	Vp3	Khosravi, A., Koury, R. N. N., Machado,L., Pabon, J. J. G.	The implementation of three models of machi-ne learning algorithms to predict wind speed,wind direction and power output of a wind turbine.
P20	**A new distribution for mode-ling the wind speed data in In ner Mongolia of China**	2020	Vp3	Junmei Jia, Zaizai Yan, Xiaoyan An.	The performance of the estimation methods is evaluated using Monte-Carlo simulation. Theyhave used long-term measured wind speed da-ta from ten stations in China's Inner Mongolia.
P21	**On the theoretical distribution of the wind farm power when there is a correlation between wind speed and wind turbine availability.**	2020	Vp3	CihangirKan, Yilser-Devrim, SerkanEryil-maz	The power output of a wind turbine is affected by two factors: wind speed and turbine availa-bility.
P22	**Computational evaluation of an optimum leading-edge slat deflection angle for dynamic stall control in a novel urban-scale vertical axis wind turbine for low wind speed operation.**	2020	Vp2	Tariq Ullah, Adeel Javed, Ali Abdullah, Majid Ali	Passive flow control through leading edge (LE) slats is explored to reduce dynamic loss (DS) phenomenon and related blade wake interac- tion in an H type vertical axis wind turbine (VAWT) .
P23	**Aerodynamic optimization for variable-speed wind turbines based on wind energy capture efficiency.**	2018	Vp2	Minghui Yin, Zhi-qiang Yang, Yan Xu, Jiankun Liu, Lianjun Zhou, YunZou.	Objective function for multipoint aerodyna-mic optimization is derived first as wind energy capture efficiency. efficiency of captu-ring wind energy.
P24	**A combination forecasting model of wind speed based on de-composition**	2021	Vp2	ZhongdaTian, Hao Li, FeihongLi	Present a novel decomposition-based wind speed combination forecast model. The inno-vation of the forecasting model is as follows.

P25	Determination of rated wind speed for maximum annual energy production of variable speed wind turbines	2017	Vp3	Sedaghat, A., Hassanzadeh, A., Jamali,J., Mostafaeipour, A. y Chen, WH	Formulate nominal wind speed suitable for variable speed wind turbines operating continuously at maximum power coefficient to maximize AEP.
P26	predictive control with finite control set for variable-speed wind tur- bines	2017	Vp3	Song, D., Yang, J., Dong, M. y Joo, YH	An alternative MPC method using a finite control set, which is used to control the WTs on the first try. To do this, first, the nonlinear WT model is linearized with information provided by a non-standard extended Kalman filter.
P27	Characterization of Air Flow in Hills Emplacement of Wind Farms.	2016	Vp1	Reinoso-Avecillas, F.,Jara-Cobos, N.,Gomez-del Pino,P.	This article presents the analysis of the behavior of air flow on a hill in the bottom of the atmospheric boundary layer, using a general purpose software Computational Fluid Dynamics (CFD).
P28	Wind energy, England.	2017	Vp1	T. Burton, D. Sharpe, N. Jenkins y B. Ervin,	Based on the experimental investigation, this paper presents empirical formulae of torque spectra, RMS torque coefficients and Strouhal number, as well as coherence functions of tor- que. An analytical model of wind-induced dy- namic torque on rectangular tall buildings is established accordingly.
P29	Prediction of speeds and wind potential for higher heights.	2015	Vp1	O. Carvente Muñoz, A. Borges Pool, M. Palmero Bojóquez, B. González Carrillo, E. Ordóñez López, M. Pérez Cortés y H. Valdivieso Sogbi	Using the mathematica software the values of the scale parameters c , and shape k , which best fit the Weibull probability distribution function (PW) to experimental data and ex- trapolation curves.
P30	Solucion Statistical study of wind speed and direction in the departments of Atl´antico and Bolivar in Colombia	2018	Vp2	De La Cruz, J., Valencia, G., Vanegas,M.	A statistical study based on the analysis of wind variables such as wind speed and direc- tion is carried out, and from the results, which show a great potential, it can be inferred that the energy demand of the region could be sup- plied from wind farms, so that there would be an efficient use of the energy resource availa- ble in the region, specifically in the Atlantic department, where appreciable values of this resource were found.
P31	Analysis of Atmospheric Wind Speeds Extreme Annual Half Hour through Probabilistic Analysis of Short Records.	2018	Vp1	De Bortoli, M., Carnavasio, O.	Develops and compares various approaches to derive a probabilistic wind gust analysis for Germany. Such an analysis provides a probabi- lity that a gust wind exceeds a certain warning level.

P32	**A New MCP Method of Wind Speed Temporal Interpolation and Extrapolation Considering Wind Speed Mixed Uncertainty.**	2017	Vp2	SLiu,X.,Lai, X., Zou, J.	A method of interpolation and temporal extrapolation of wind speed data that is lacking in the wind power industry was investigated.
P33	**Long-term prediction of wind speed in La Serena city (Chile) using hybrid neural network - particle swarm algorithm**	2017	Vp3	Lazzús,J., Salfate, I	Used an artificial neural network to forecast long-term wind speed data (24 and 48 hours earlier) in the city of La Serena (Chile). In order to obtain a more effective correlation and prediction, a particle swarm algorithm was implemented to update the weights of the network.
P34	**Application of multivariate methods for the characterization of meteorological drought periods in Venezuela.**	2018	Vp3	Olivares, BO., Zingaretti, ML	The objective of this work was to analyze the occurrence of meteorological drought through time series of the Normalized Precipitation Index during the period.
P35	**Preliminary wind speed study in San Julian in reference to wind power generation.**	2017	Vp3	Otero, F., Cerne, B.,Campetella, C.	A preliminary description of the characteristics of the wind speed at 10 m was made at the San Julián Aero meteorological station, Santa Cruz, Argentina.
P36	**Systematization of the calculation of the standardized precipitation index as a methodology to generate meteorological drought information**	2020	Vp1	Cotez, A.Olivares, BO,	He objective of this research was to systematize the calculation of the SPI as a methodology to generate meteorological information on drought.
P37	**Parametric analysis and optimization of entropy generation in unsteady MHD flow over a stretching rotating dis- kusing artificial neural network and particle swarm optimization algorithm.**	2015	Vp1	M.M.Rashidi, M.Ali, N. Freidoonimehr, F.Nazari	The present study first of all concerns the first and second law analyzes of an electrically conducting fluid past a rotating disk in the presence of a uniform vertical magnetic field, analytically via Homotopy Analysis Method (HAM), and then applies Artificial Neural Network (ANN) and Particle Swarm Optimization (PSO) algorithm in order to minimize the entropy generation..
P38	**Climate change impacts on meteorological drought using SPI and SPEI: case study of Ankara, Turkey.**	2020	Vp2	Sorman, AU., Kahy,E.	Using regionally downscaled and adjusted outputs of three global climate models (GCMs), meteorological drought analysis was accomplished across Ankara, the capital city of Turkey.
P39	**Changes in drought frequency, severity and duration for the British Isles projected by the PRUDENCE regional climate models.**	2017	Vp2	Blenkinsop, S.,Fowler, HJ	The performance of the integrations of six regional climate models (RCM) driven by four different general circulation models (GCM) was evaluated for the statistics of mean precipitation and drought using two drought severity indices based on monthly data. precipitation anomalies.

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A Scoping Review on Parametric model of Wind Generators

| P40 | **Shape optimization to reduce wind pressure on the surfaces of a rectangular building with horizontal limbs** | 2021 | Vp1 | Paul, R.,Dalui, SK | The present study consists of shape optimization of a rectangular plan shaped tall building with horizontal limbs under wind attack, which would minimize the wind pressure on all the faces of the building model simultaneously. |

2.   Results

The following section shows the summary of the selected works, which have been reviewed taking into account the points of view Vp1, Vp2 and Vp3. The fluid under study is wind, so articles [1-40] make contributions in the study of this type of fluid.

2.1.   Acoustic Emissions from Wind Turbine.

The study of air velocity using temporal and spatial techniques due to the non-linear behavior of a spherical shape has been an important objective within the VP1 point of view outlined below:

Cu´neo, Lucila Mercedes; Cerne, Silvia Bibiana; Llano, Mar´ıa Paula, [1]. The results indicated a decrease in the annual mean wind speed throughout the periods and especially a marked reduction in extreme winds, both high and calm speeds. Furthermore, although the westerly winds are the most frequent throughout the year, they do not represent the most intense average speeds and a change in the direction of these speeds was observed at the seasonal level.

T. Burton, D. Sharpe, N. Jenkins y B. Ervin. [3] They propose an analysis 300 years ago, wind energy was used in the windmill to grind grains and pump water. Nowadays it is used to generate electricity. In our country, in the Villonaco sector, 4 km from Loja, is did the preliminary studies for the installation of the first group of wind turbines, it is in operation and they have carried out wind speed and direction measurements since June 2012, for the installation of the second and third groups of wind turbines there are tenders, [4], in In response to this, the Universities and Polytechnic Schools carry out technical feasibility studies of the project.

Santamar´ıa-Bonfil, G., Reyes-Ballesteros, A., Gershenson, C., [4]. They pro- pose a hybrid methodology based on the regression of support vectors for the prediction of wind speed. Using the autoregressive model called Time Delay Coordinates, feature selection is done through the phase space reconstruction procedure. Then, a support vector regression model is trained using univariate

wind speed time series. Support vector regression parameters are adjusted by a genetic algorithm. The proposed method is compared with the persistence mo- del and the autoregressive models (AR, ARMA and ARIMA) adjusted by the Akaike information criterion and the ordinary least squares method.

Carvente Mun~oz, A. Borges Pool, M. Palmero Boj´oquez, B. Gonz´alez Carrillo, E. Ord´on~ez L´opez, M. P´erez Cort´es y H. Valdivieso Sogbi, [5]. They experimentally estimating the wind potential for heights greater than 30 meters requires, in general, a significant cost in infrastructure. Based on experimental measurements of wind speed at a reference height meters, and using Hellman's law, in this work we report the results of the extrapolated wind speed for heights. De Bortoli, M., Carnavasio, O, [6]. They make the spatial variability of wind gusts is probably as great as that of precipitation, but the network of observing meteorological stations is much less dense. The lack of an observational analysis

of the entire area makes it difficult to verify the forecast for wind gust warnings. This article develops and compares various approaches to derive a probabilistic wind gust analysis for Germany. Such an analysis provides a probability that a gust wind exceeds a certain warning level.

Paul, R.,Dalui, SK, [7].They Among the different methods to monitor drought, there is the Standardized Precipitation Index (SPI), this being one of the most used and easy to calculate. The objective of this research was to systematize the calculation of the SPI as a methodology to generate meteorological information. According to the established steps, the calculation of the index was obtained in a practical and easy way, using only the historical data of precipitation of a certain area and the mathematical functions in Excel, as a result of the application.

De la Cruz Buelvas, Jhonatan; Valencia Ochoa, Guillermo; Vanegas Chamo- rro, Marley, [8].They mention that the percentage of electricity generation from renewable sources is very low, with wind energy being the one with the largest share of electricity demand. To achieve more robust energy security in the me- dium and long term, there must be an energy policy that takes into account the complementarities and implementation of technologies and energy sources with significant availability throughout the national territory. They carry out a statistical study based on the analysis

of wind variables such as wind speed and direction and, from the results, which show great potential, it can be inferred that the energy demand of the region could be supplied from parks wind power.

Paul, R.,Dalui, SK, [9].The present study consists of optimizing the shape of a tall rectangular building with horizontal branches under wind attack, which would minimize wind pressure on all faces of the building model simultaneously. For this purpose, the external pressure coefficients on different faces of the buil- ding (C pe) are selected as objective functions. The position of the limbs and the angle of incidence of the wind are taken as design variables. The design of the experiment (DOE) is carried out by random sampling.

Quin̄onez Choquecota, Jos´e; Huanca Callata, Elmer; Holguino Huarza, An- tonio, [10].They carried out a quantitative and qualitative evaluation of the wind resource in order to characterize the exploitable potential of the wind resource in the city contour. The quantitative analysis consisting of the characterization of the mean hourly and monthly mean speed of the wind for a height of 25 m from the ground. The qualitative analysis corresponds to the estimation of the wind potential which was carried out with the Weibull distribution.

Manero, Jaume; B´ejar, Javier; Cort´es, Ulises, [11]. They define renewable energy as intermittent by nature and to integrate this energy into the Grid, while ensuring security and stability, the precise forecast of renewable energy genera- tion is essential. Wind power prediction is based on the ability to forecast the wind. There are many methods for forecasting wind based on the statistical pro- perties of the wind time series and the integration of meteorological information, these methods are being used commercially all over the world.

2.2. Fluid dynamics method.

The resulting non-linear behavior, which is difficult to solve, then arises se- veral techniques and approximate mathematical models that allow solutions, emerging CFDs, using temporal and spatial techniques due to the non-linear behavior of a spherical shape has been an important objective within the VP2 point of view outlined below: Dwivedi, Yagya Dutta; Nukala, Vasishta Bhargava; Maddula, Satya Prasad; Nair, Kiran, [12], they have empirically studied turbu- lence as a boundary layer of the

surface, atmospheric turbulence is an unstable phenomenon found in nature and plays an important role in the prediction of natural events and the prediction of the life of structures. They evaluated the computer simulation of the Von Karman, Kaimal methods for different surface roughnesses and for low, medium and high turbulence intensities.

Flores-Vel´azquez, Jorge; Vega-Garc´ıa, Manuel. [13]. They manipulated en- vironmental conditions, ventilation rate and thermal gradients were estimated to infer a local climatic potential as a function of optimal tomato temperatu- res. In addition, the ventilation rate and thermal gradients were estimated to infer a local climatic potential as a function of optimal tomato temperatures. It has been observed that in regions with mild summers, the use of mechanical ventilation combined with natural ventilation is a viable alternative by reducing temperature and energy costs.

Moniki Ferreira, Alexandre Santos, Paulo Lucio, [14]. They seek to predict the mean hourly wind speed in anemometric towers (at a height of 50 m) in two locations: a coastal region and another with complex terrain characteristics. For this, Holt-Winters time series models, Artificial and Hybrid Neural Networks were used. Observational Data Evaluated by Modern Era Retrospective Analy- sis for Research and Applications Reanalysis-Version 2 (MERRA-2) at the same height of the towers. The results show that the hybrid model had a better performance in relation to the others, even in comparison with the evaluation with MERRA-2.

Golnary, F. and Moradi, H., [15]. They extract the maximum efficiency from a variable speed wind turbine, which is modeled as an electromechanical system with two-mass dynamics. Maximum efficiency can be obtained by tracking the optimal rotor speed, which is controlled by the generator torque as input. One of the most important information required to design the control system is the measurement of the effective wind speed. They develop a new method based on to estimate the effective wind speed. Aerodynamic torque has a direct relationship with the power coefficient.

Zhang, Y., Zhao, Y., Kong, C., Chen, B., [16]. They make an accurate and efficient prediction of wind speed. In the paper, a new wind speed prediction method based on wind speed characteristics is proposed. It is used to decompose the wind speed into the non-linear part, the linear part and the noise part. The non-linear part reflects the non-linear characteristic of wind speed, the linear part embodies the linear process of wind speed formation, the noise part is the error sequence (ER) decomposed the wind speed by VMD.

Liu, Z., Jiang, P., Zhang, L. and Niu, X., [17]. They have widely employed many forecasting methods to forecast short-term wind speed for wind that is irregular, non-linear, and non-stationary. However, they neglect the efficiency of data pre-processing and optimization of model parameters, posing a huge challenge for accurate and stable wind speed forecasting and safe operation of the wind power industry. The results of point prediction and interval prediction reveal that the prediction system positively outperforms all contrastive models with respect to prediction accuracy and stability.

Chao Chen, Hui Liu, [18]. They predicted of wind speed can provide a refe- rence for the reliable utilization of wind energy. This study focuses on 1-hour, 1-step ahead deterministic wind speed prediction with only wind speed as in- put. To consider the time-varying characteristics of wind speed series, a dynamic ensemble wind speed prediction model based on deep reinforcement learning is proposed.

Minghui Yin, Zhiqiang Yang, Yan Xu, Jiankun Liu, Lianjun Zhou, Yun- Zou., [19]. They state the objective function for multipoint aerodynamic opti- mization is derived first as wind energy capture efficiency. Then, they propose a new multipoint aerodynamic design method whose objective function can ap- proximate the efficiency of capturing wind energy.

ZhongdaTian,Hao Li, FeihongLi., [20]. They present a novel decomposition- based wind speed combination forecast model. The innovation of the forecasting model is as follows. (a) In view of the unstable characteristics of wind speed, a variational mode decomposition algorithm is introduced to decompose his- torical wind speed data to obtain a series of stable components with different frequencies. An echo state network with good forecasting ability is selected as the forecasting model for each component.

De La Cruz, J., Valencia, G., Vanegas, M., [21]. A statistical study based on the analysis of wind variables such as wind speed and direction is carried out, and from the results, which show a great potential, it can be inferred that the energy demand of the region could be supplied from wind farms, so that there would be an efficient use of the energy resource available in the region, specifically in the Atlantic department, where appreciable values of this resource were found.

Sorman, AU., Kahy,E., [22].A method of interpolation and temporal ex- trapolation of wind speed data that is lacking in the wind power industry was investigated.The importance of considering the mixed uncertainty of the wind speed and the suitability of using the granular calculation method are illustra- ted, and the analysis of the mixed uncertainty of the wind speed is implemented.

Recommended values and estimation tools are provided for the uncertainty of the wind speed measurement and the combined uncertainty.

Blenkinsop, S.,Fowler, HJ, [23]. Using regionally downscaled and adjusted outputs of three global climate models (GCMs), meteorological drought analy- sis was accomplished across Ankara, the capital city of Turkey. To this end, standardized precipitation index (SPI) and standardized precipitation evapo- transpiration index (SPEI) were projected under (representative concentration pathway) RCP4.5 and RCP8.5 greenhouse gas scenarios. In general, our results show that Ankara experienced six severe and two extreme drought events during the reference period, 1971–2000.

Blenkinsop, S.,Fowler, HJ, [24]. The use of multiple climate models for im- pact assessment allows examining the uncertainty in change projections, thus providing improved tools for adaptation and mitigation of the impacts of future change. Evaluating the performance of the integrations of six regional climate models (RCM) driven by four different general circulation models (GCM) for the statistics of mean precipitation and drought.

2.3. Analysis of a wind power plant

For the prediction of wind speed and wind potential as a function of height and considering the topology of the sector carried out in other countries, it is based on mathematical models of Hellman and Weibull Distribution to generate their contributions that characterize each sector.These technical studies have been an important objective within the VP3 point of view detailed below:

G´omez Rodr´ıguez, Tom´as; Cortazar Mart´ınez, Adriana; Zambrano Reyes, Adriana, [25], [26] .They used two types of analysis: technical analysis and financial analysis. For the technical study, the Weibull probability density fun- ction is used. Likewise, for the financial analysis the following parameters are evaluated: net present value, the internal rate of return, the Levelized Cost of Electricity, the recovery period and the cost / benefit ratio.The effect of interval deficiency on the quality of wind speed data was investigated by studying the behavior of the Weibull scale and shape factors as the size of the interval bet- ween wind speed measurements increased.Comparison experiments were perfor- med between the Weibull single distribution model and the proposed approach. Then, the optimal polynomial regression model, the mixture of two truncated normal distributions, and the mixed tri-Weibull model are compared from the performance of the fit. [29]

Bhargava, Vasishta; Samala, Rahul. [27] They predict the computer simu- lation of acoustic emissions from wind turbine blades using a quasi-empirical model for a three-bladed horizontal axis 3 MW turbine with a blade length of 47 m. Sound power levels are investigated for the source and receiver at a height of 80 m and 2 m above the ground and located at a distance equal to the total height of the turbine. FuadNoman, GamalAlkawsi, Ammar AhmedAlkahtani, Ali Q.Al-Shetwi, SiehKiong Tiong, NasserAlalwan, , Ahmed IbrahimAlzahrani, [30]. They used uncorrelated multivariate variables as exogenous input variables that often have an adverse impact on the performance of the prediction models, they present multi-step short-term wind speed prediction using multivariate exoge- nous input variables. Khosravi, A., Koury, R. N. N., Machado, L., Pabon, J.

J. G., [31]. They implement three models of machine learning algorithms to predict wind speed, wind direction, and power output of a wind turbine.Used an artificial neural network to forecast long-term wind speed data (24 and 48 hours earlier) in the city of La Serena (Chile). In order to obtain a more effective correlation and prediction, a particle swarm algorithm was implemented to update the weights of the network, [37].

Junmei Jia, Zaizai Yan, Xiaoyan An., [32]. They study the mathematical properties of the TLL distribution. The estimation of the unknown parameters is obtained using the methods of maximum likelihood, least squares and maximum spacing of products. The performance of the estimation methods is evaluated using Monte-Carlo simulation. They have used long-term measured wind speed data from ten stations in China's Inner Mongolia.

CihangirKan, YilserDevrim, SerkanEryilmaz, [33].They obtain information on the potential power output of a wind turbine and a wind farm consisting of a specific number of wind turbines prior to the installation of the turbines.The power output of a wind turbine is affected by two factors: wind speed and turbine availability.

Tariq Ullah, Adeel Javed, Ali Abdullah, Majid Ali, [34]. They explore pas- sive flow control through leading edge (LE) slats to reduce dynamic loss (DS) phenomenon and related blade wake interaction in an H-type vertical axis wind turbine (VAWT). -Darrieus operating in low wind speed conditions.

Sedaghat, A., Hassanzadeh, A., Jamali, J., Mostafaeipour, A. and Chen, WH., [35]. Formulate the nominal wind speed suitable for variable speed wind turbines operating continuously at maximum power coefficient to maximize AEP. A capacity value is entered that relates the AEP to an integral

function of the nominal wind speed using the Weibull distribution of wind speeds and the constant power coefficient of variable speed wind turbines.

Song, D., Yang, J., Dong, M. and Joo, YH., , [36].Present an alternative MPC method using a finite control set, which is used to control WTs on the first try. To do this, first, the non-linear model of WT is linearized with information provided by a non-standard extended Kalman filter. Second, a discrete time linear model of the system is used to predict the future value of the interested state variable for possible control sets.

Olivares, BO., Zingaretti, ML and Otero, F., Cerne, B.,Campetella, C. [38], [39].The study constitutes the backbone for space planning and the strengthening of strategies for food security in these localities.A comprehensive quality control process was carried out on the wind data series where periods of malfunction and instrumental changes were found, so the series was not homogeneous.The results show the difficulty of carrying out any study of wind variability and / or extreme values with short series because they are sensitive to the length of the record, type and quality of the instruments and also to changes in the location and height of the measuring instrument and nearby obstacles.

3.   Selection of articles

In the analysis of fluid such as air, speed being a very important parameter is analyzed using non-linear equations focused on time and space, Navier's experimentation equations managed to project future wind turbine installations to significantly contribute to the generation of renewable sources. In the following graphs, the selection of the 40 articles can be observed in percentage based on the three important points of view in the investigation. Most of the articles are based on the use of predictive processes to find velocity values, the fluid dyna- mics methods also work with neural networks, was conducted if poor interval wind speed data is useful for wind power assessments to have considerable variation. The effect of interval deficiency on the quality of wind speed data was investigated by studying the behavior of the Weibull scale and shape factors as the size of the interval between wind speed measurements increased.

In Figure 2, it can be observed that, of the 40 selected articles, 27.5 % corres- ponded to point of view 1 (Wind speed parameters), 32.5 % centered on point of view 2 (Fluid Dynamics Methods) and finally, 40 % focused on viewpoint 3 (Facility Studies and Model Validation).
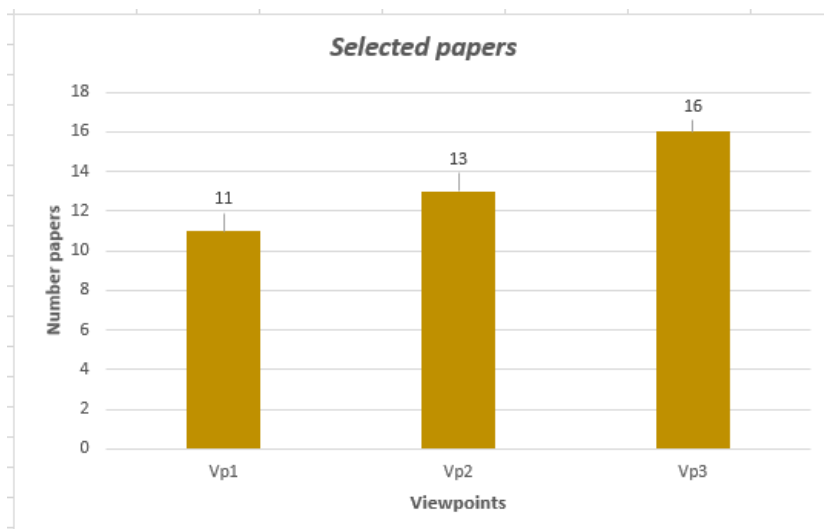
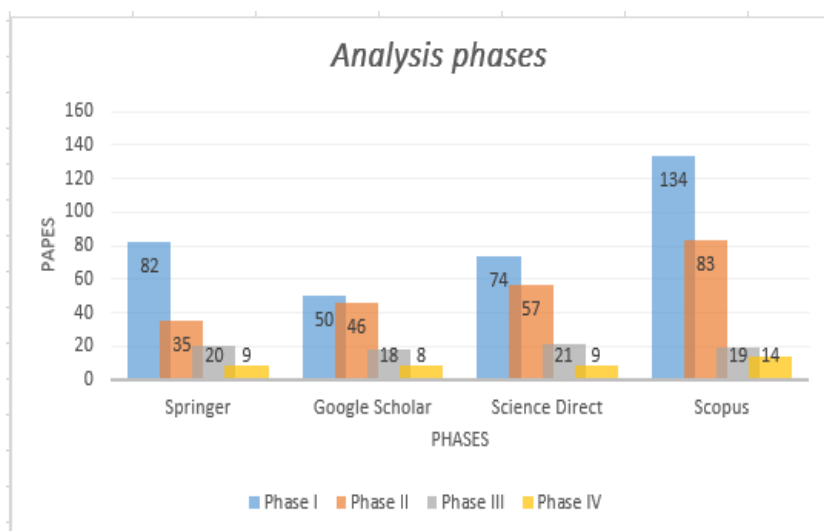**Figure 2.** Selected papers

Figura 3. Phases analysis

Finally, for the first identification phase, it can be observed that there is a reduction of 75.29 %, in the second phase there was a 65 % reduction, in the third eligibility phase there was a 35.29 % reduction. What's more, As can be seen, the databases that contain the most relevant information

among those explored are Google Scholar, Springer, Science Direct and Scopus. In Figure 4. It can be seen that as of 2017, 92.5 % corresponds to research pertinent to the literature reviewed.
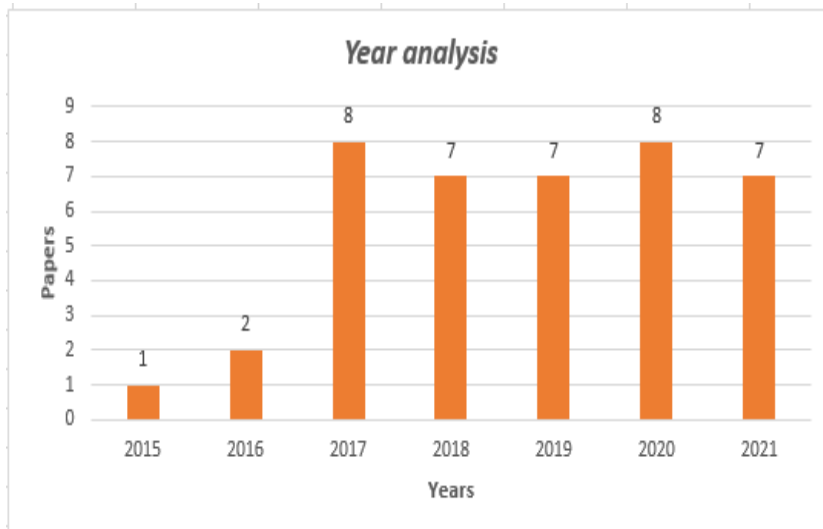

Figura 4. Years analysis

4. Discussion

4.1. Research Questions

The 40 selected articles present relevant information that allow the analysis and development of a methodology for the study of air in wind turbines and thus lead to the generation of renewable energy. The answers to the research questions are presented below.

Q1: Different techniques are applied in the articles to determine wind speed?

In the articles found, they mention that the instantaneous values of the one- minute time series for the longitudinal turbulent wind at an average wind speed of 12 m / s using both spectra show a strong correlation in the validation trends. The influence of integral length scales on the production of turbulence kinetic energy at different heights is illustrated. The time series for the mean wind speed

of 12 m / s with a surface roughness value of 0.05 m have shown that the variance for length The components of speed.

Quantitative and qualitative evaluations of the wind resource have been ca- rried out in order to characterize the exploitable potential of the wind resource in the city contour. The quantitative analysis consisting of the characterization of the mean hourly and monthly mean speed of the wind for a height of 25 m from the ground. The qualitative analysis corresponds to the estimation of the wind potential which was carried out with the Weibull distribution.

Q2: Apply different Methods of Fluid Dynamics Equation Solution?

A complete 2D evaluation of unstable computational fluid dynamics (CFD) has been carried out, the unstable approach of Navier-Stokes averaged by Reynolds with k-shear stress transport (SST) turbulence model and sliding mesh technique has been applied. in Ansys Fluent. The optimal deflection angle of the slats has been evaluated using the oscillating case of a single leaf with and without the slats LE, the results indicate reductions in the optimal at a nominal wind speed. When comparing experiments between the Weibull single distribution model, then the optimal polynomial regression model, the mixture of two Truncated normal distributions and the tri-Weibull mixed model are compared based on the performance of the fit.

Meanwhile, the annual power production and the cost of wind power genera tion are calculated based on the frequency distribution model of the wind speed. The results show that the proposed polynomial regression model provides an excellent approximation for different wind speed frequency distributions. The effect of interval deficiency on the quality of wind speed data was investigated by studying the behavior of the Weibull scale and shape factors as the size of the interval between wind speed measurements increased.

Q3: Do you use methods of validation of applied mathematical models?

Uncorrelated multivariate variables as exogenous inputs often have an adverse impact on the performance of prediction models, they present multi-step short-term wind speed prediction using multivariate exogenous inputs. Implement different variable selection methods to select the best set of variables that significantly improve the performance of the prediction models. They evaluate the performance of eight transfer learning methods, four surface neural networks (NN), and the persistence method to predict future values of wind speed using ultrashort, short, and multistep time horizons.

There are three models of machine learning algorithms for predicting wind speed, wind direction, and power output of a wind turbine. The first model is a multilayer feedforward neural network (MLFFNN) that is trained with different data training algorithms. The second model is support vector regression with a radial basis function (SVR-RBF). The third model is an adaptive neuro-fuzzy inference system (ANFIS) that is optimized with a partial swarm optimization algorithm (ANFIS-PSO). Temperature, pressure, relative humidity, and local time are considered input variables for the models.

4.2.   Paper Selection Analysis

As can be seen, most of the documents provide the scientific basis for speed calculation, mathematical and statistical modeling. These documents generally contain a critical review of scientific and technical information. The application of the PRISMA guide in several stages to be able to select the articles analyzed in detail in this review of the literature Maintains a clear and transparent method for collecting essential items documents that have been investigated and have made it possible to understand a great percentage of models used to simulate wind power generation.

The validity of the study focuses on an analysis of the methodology correct to discretize the large number of reference posts that the topic and focus the study on what is being investigated, focusing on parameters such as speed, pressure, and temperature as important study variables. For the prediction of wind speed and wind potential as a function of height and considering the topology of the sector carried out in other countries, it is based on mathematical models of Hell- man and Weibull Distribution to generate their contributions that characterize each sector.

5.   Conclusions

The National Institute of Energy Efficiency and Renewable Energies, carried out a study on the analysis of the variables that affect the behavior of the Villona- co wind farm, where the applied methodology serves to identify the anemometer of the Villonaco meteorological tower that stopped work, and that were used for later simulations in fluid dynamics with WindSim.

Many years ago the wind energy was used in the windmill to grind grains and pump water, at present it is used to generate electrical energy, in our country in the Villonaco sector 4 km from Loja, the studies were carried out Group of wind turbines for the installation of the first group of wind turbines, is in operation and they have made preliminary measurements of wind speed and direction since June 2012, for the installation of the second and third groups of wind turbines there are tenders, in response to this Universities and Polytechnic Schools carry out technical feasibility studies for the project.

The information analyzed in the papers determines guidelines for research, facilitating development in parametric modeling of wind generators.The CFDs used in the papers have shown that it´s fundamental tools to discreetly solve the dynamics of fluids, with approximations to the reality of the phenomenon.

The algorithms put forward by researchers prove to be very useful espe- cially in the acquisition of wind parameters and the techniques for establishing relationships between them are effective.The realization of the study of art, fa- cilitates and contributes to the realization of the theme of parametric modeling of wind generators with better prospects for their development.

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