LITERATURE SURVEY:

**Predicting the Energy Output of Wind Turbine Based on Weather Condition**

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## **Abstract**

Wind energy plays an increasing role in the supply of energy worldwide. The energy output of a wind farm is highly dependent on the weather conditions present at its site. If the output can be predicted more accurately, energy suppliers can coordinate the collaborative production of different energy sources more efficiently to avoid costly overproduction. In this paper, we take a computer science perspective on energy prediction based on weather data and analyze the important parameters as well as their correlation on the energy output. To deal with the interaction of the different parameters, we use random forest regression of machine learning algorithms. Our studies are carried out on publicly available weather and energy data for a wind farm. We report on the correlation of the different variables for the energy output. The model obtained for energy prediction gives a very reliable prediction of the energy output for supplied weather data.

* February 2013
* [Renewable Energy](https://www.researchgate.net/journal/Renewable-Energy-0960-1481) 50:236-243

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* With this paper, we take a computer science perspective on energy prediction based on weather data and analyze the important parameters as well as their correlation on the energy output. To deal with the interaction of the diﬀerent parameters we use symbolic regression based on the genetic programming tool DataModeler.
* Our studies are carried out on publicly available weather and energy data for a wind farm in Australia. We reveal the correlation of the diﬀerent variables for the energy output. The model obtained for energy prediction gives a very reliable prediction of the energy output for newly given weather data.
* Renewable energy such as wind and solar energy plays an increasing role in the supply of energy world-wide. This trend will continue because the global energy demand is increasing and the use of nuclear power and traditional sources of energy such as coal and oil is either considered as non-safe or leads to a large amount of CO2emission.
* Wind energy is a key-player in the ﬁeld of renewable energy. The capacity of wind energy production was increased drastically during the last years. In Europe for example, the capacity of wind energy production has doubled since 2005. However, the production of wind energy is hard to predict as it relies on the rather unstable weather conditions present at the wind farm. In particular, the wind speed is crucial for energy production based on wind and the wind speed
* may vary drastically during diﬀerent periods of time. Energy suppliers are interested in accurate predictions, as they can avoid overproductions by coordinating the collaborative production of traditional power plants and weather dependent energy sources.
* Our aim is to map weather data to energy production. We want to show that even data that is publicly available for weather stations close to wind farms can be used to give a good prediction of the energy output. Furthermore, we examine the impact of diﬀerent weather conditions on the energy output of wind farms. We are, in particular, interested in the correlation of diﬀerent components that characterize the weather conditions such as wind speed, pressure, and temperature
* **The modeling goals of this study are:**

1. To identify the minimal subset of driving weather features that are signiﬁcantly related to the wind energy output of the wind farm,

* 2. To let genetic programming express these relationships in the form of explicit input-output regression models, and
* 3. To select model ensembles for improved generalization capabilities of energy predictions and to analyze the quality of produced model ensembles using an unseen test set.

**Conclusion**

* Conclusions
* In this study we showed that wind energy output can be predicted from publicly available weather data with accuracy at best 80% R2on the training range and at best 85,5% on the unseen test data. We identiﬁed the smallest space of input variables (windGust2 and dewPoint), where reported accuracy can be achieved, and provided clear trade-oﬀs of prediction accuracy for decreasing the input space to the windGust2 variable. We demonstrated that an oﬀ-the-shelf data modeling and variable selection tool can be used with mostly default settings to run the symbolic regression experiments as well as variable importance, variable contribution analysis, ensemble selection and validation.

# Predicting the Wind Turbine Power Generation based on Weather Conditions

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**Abstract:**

Extracting electricity from renewable resources has been widely investigated in the past decades to decrease the worldwide crisis in the electrical energy and environmental pollution. For a wind farm which converts the wind power to electrical energy, a big challenge is to predict the wind power precisely in spite of the instabilities. The climatic conditions present in the site decides the power output of a wind farm. As the schedule of wind power availability is not known in advance, this causes problems for wind farm operators in terms of system and energy planning. A precise forecast is required to overcome the difficulties initiated by the fluctuating weather conditions. If the output is forecasted accurately, energy providers can keep away from costly overproduction. In this paper, an end-to-end web application has been developed to predict and forecast the wind turbine's power generation based on the weather conditions. The prediction model has been developed using Bidirectional Long Short-Term Memory which is a unique kind of RNN (Recurrent Neural Network). It performs admirably in terms of capturing long-term dependencies along with the time steps and is hence ideal for wind power forecasting.

**PREDICTING POWER OUTPUT BASED ON WEATHER CONDITION ON WIND TURBINES**

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ABSTRACT:

The purpose of the project is to predict the electricity output based on the rotating speed of the wind turbines; here we get the output based on the previous data. In this we have two independent variables LV Active Power, Wind Speed and two dependent variable Theoretical Power and wind direction. For that we use one of the regression algorithm like polynomial regression and predict the output by using r2\_score.In this we train the model with the previous data and test the data by giving the independent variables and predicting whether it is giving expected output or not. We use a node red for deploying the nodes, we used http request, timestamp, for sending the message we used message payload, for power detection we used theoretical power, inputs as Active Power and Wind Speed and to implement the user interface. There are two steps in the process of wind power prediction. In the first step raw data is collected by the power plant information system and is filtered. This prepares a valid data to be used for building a prediction model. In the second step we use all the regression algorithms to build a model to predict the wind power. It is to achieve a high accuracy with respect to the measured data.

Methods for predicting wind power generation can be categorized into physical methods, statistical methods, methods based on neural networks, and hybrid methods. The physical methods rely heavily on numeric whether prediction, which is confined by the sensors and monitoring devices placed within the WPP. The quality of hardware chosen, the parameters settings, the computation time, the time delay, and the sampling rates influence the accuracy of data collected from the WPP.

Wind power estimation models are majorly classified as models based on physical or numerical weather prediction models, statistical models. [1] Physical models are based on the meteorological data and open boundary fluid flow equations. Other energy equations are solved as nonlinear solvers in predicting wind energy potential of selected space.

A number of different approaches have been applied to forecast wind speed and the power produced by wind farms. Potter and Negnevitsky [2] applied the adaptive neurons fuzzy inference approach to forecast short-term wind speed and direction. Barbounis et al. [2] used the nonlinear recursive least-squares method to train a recurrent neural network (NN) based on the meteorological data. Their model has improved the accuracy of long-term wind speed and power forecasting. Damousiset al.[8] developed a fuzzy logic model and trained it with a genetic algorithm. The model was then used to forecast wind speed over horizons ranging from 0.5 to 2 h. Li et al. [2] compared regression and NN models for wind turbine power estimation, and reported that the NN model outperformed the regression model. Sfetsos [2] presented a novel method to forecast the mean hourly wind speed using a time series analysis, and showed that the developed model outperformed the conventional forecasting models.

CONCLUSION AND FUTURE SCOPE:

In this study, we showed that wind energy output can be predicted from publicly available weather data with accuracy up to 80% R2 on the training range and up to 85, 5% on the unseen test data. We identified the smallest space of input variables where reported accuracy can be achieved, and provided clear trade-offs in prediction accuracy when decreasing the input space to the wind speed variable. We are pleased that the presented framework is so simple that it can be used by literally everybody for predicting Theoretical power based on wind energy production —for individual wind turbines on private farms or urban buildings, or for small wind farms. For future work, we are planning further study of the possibilities for longer-term wind energy forecasting. Several forecasting models were discussed and a lot of researches on the models, which have their own characteristics, were presented. The major focus was on emphasizing the diversity of various forecasting methods available and also on providing a comparison of present mechanisms to determine the best available.

Predicting the Amount of Energy Generated by aWind Turbine based on the Weather Data

Qusay Hassan et al 2019 :: IOP Conference Series: Earth and Environmental Science

In the literature, several studies concentrating on modelling or predicting the wind turbine power has been done. In a study conducted by [6] a parametric model for characterising the wind turbine (WT) power curve to serve planning, online monitoring, and wind energy assessment by using both parametric and non parametric approaches was proposed. The results proved that the performance of the model using the backtracking search algorithm (BSA) is superior in comparison to the other analysed models. In[7] authors used an artificial neural network for modelling the wind turbine power curve to improve power curve precision modelling. The results show that the multistage modelling techniques were able to reduce the relative and absolute errors when accurate wind turbine power curves were modelled using six parameters. In [8] authors improve the power of (NREL 5-MW) wind turbine by using the multi-plasma actuators tool. The results illustrated that the induced velocity could be enhanced by placing a (multi-DBD) actuator in parallel and close to the hub of the wind turbine rotor and by increasing the number of actuators, lead to improving the wind velocity profile.

**Results and discussion**

For calculation of the real wind turbine power output at the real local weather conditions, the actual instantaneous air density must be evaluated in addition to the wind velocity measurements at the height 10m as illustrated in the previous section. For this case, wind speed has to be extrapolated to the hub height- here Zhub=20m.

**Air density calculation**

The analysis performed below shows which environmental parameters are essential for local air density evaluation. 3.1 Air density calculation The air density ρ of the humid air has a direct influence on the wind turbine power production. There are three parameters which can play an essential role in air density evaluation: air temperature, humidity and pressure

**Wind turbine hub height**

the wind speed at the anemometer height (Z2=10m) during the entire period of January 2015. In the same Figure the calculations of the wind speed at the height Z1=5m and Z3=15m are presented.The surface roughness lengthwas assumed to be equal to 3.0 (city centre, tall buildings). One may infer from this Figure that, increasing the height, the velocity magnitude as well as the magnitude of the fluctuations increases.

**Surface roughness effect**

the surface roughness length of the surrounding terrain effect on the calculated wind speed. Three different values of roughness were taken into consideration: a few trees Zo=0.1, forest and woodlands suburbs Zo=0.5 and city centre, tall buildings Zo=3 (as shown in Table 1). For this analysis the hub height was Zhub=20m. The analysis performed at winter time – during January 2015– shows that the surface roughness length has a direct influence on the wind speed and city centre, tall buildings terrain recorded the highest value.

**Conclusions**

Wind turbines are one of the most competitive sources of renewable energy. Although many studies have been done analysed wind energy at different parts of the world, different patterns of energy from wind have led to the fact that research is continuing and a large number of problems need to be solved. Within the framework of this research, a robust and straight forward dynamic model for the calculation of wind turbine power output has been presented. Evaluation of environmental components on the power output calculation was performed. The results show that the air density has a high influence on the wind turbine output power and this value is affected by several environmental factors such as pressure, humidity and temperature. In the present paper, the electrical energy generated by (RW-5kW) wind turbine based on the experimental data of weather in addition to comprehensive evaluation of wind turbine performance with the weather properties has been performed. The investigation gives an excellent choice for predicting the amount of energy for any given site based on the real or predictedweather data.