

Overview:

The wind is a clean, free and readily available renewable energy source. Each day, around the world, wind turbines are capturing the wind's power and converting it to electricity. However change in wind speeds due to environmental factors and unpredicted failure of machinery like rotor malfunctioning etc. can make it unpredictable energy source. The power grid rely on sources that can deliver power at set time. Hence wind forecasting plays a crucial role here by predicting the amount of electric energy that will be produced beforehand and forward that respective information to power grids. Also anomaly detection plays an important role in identifying faults in machinery beforehand which directly affects electricity production.

Methods:

Fascinated by sustainable development and clean energy. I read the article of google deep mind [1], regarding the problem they are solving to address wind energy forecasting and electricity generation, here I found the initial glimpse of this idea, and also I read the article [2] by Energy Education to understand the parameters that affect wind energy forecasting. The main parameter that affects electricity generation are Wind Speed, Air Density and turbine design. Also to find the information for anomaly detection in wind turbines, I went through the research article of Machine Learning methods for wind turbine condition monitoring [5].

Discussion:

Unable to get data of Wind Energy production from Energy Education Article [2]. I researched and collected the real electric generation data of Sotavento wind farm in Spain [3]. Data of May'2019 shows respective electricity generation trends. The data emphasis on two parameters i.e Wind Speed and it's direction and their impact on electric energy production (Visual representation in Fig 1, Fig 2, Fig 3).

Wind Speed

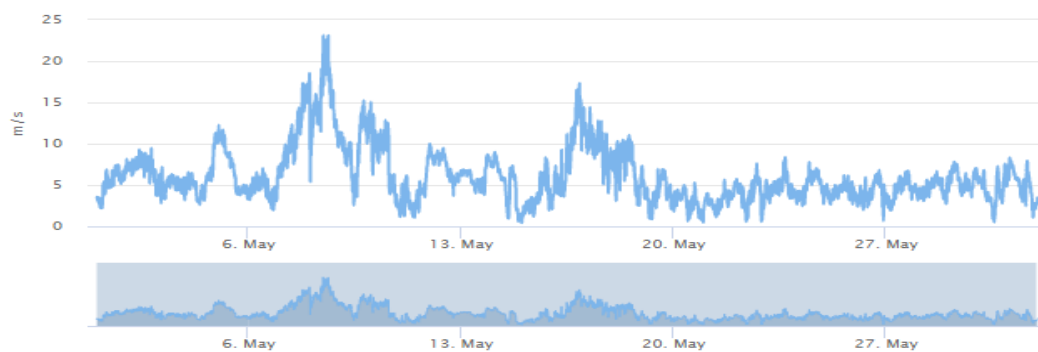


Fig 1. Trend in Wind Speed of Sotavento Wind Farm

Wind Direction

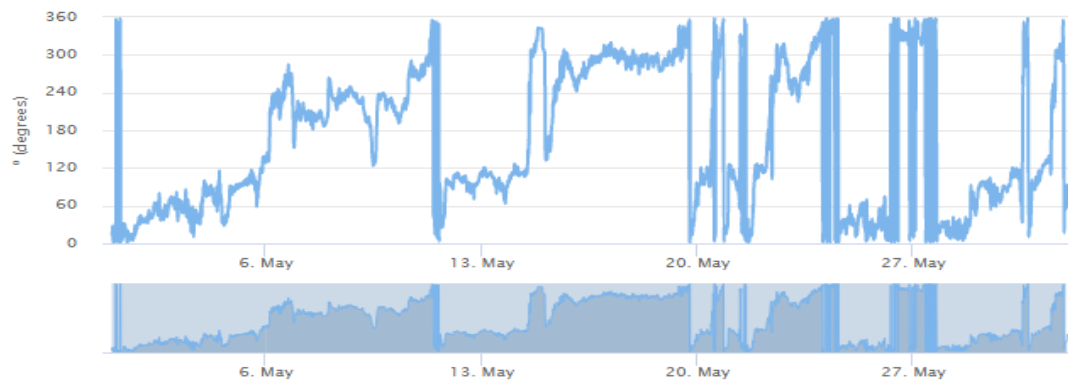


Fig 2. Trend in Wind Direction of Sotavento Wind Farm

Energy

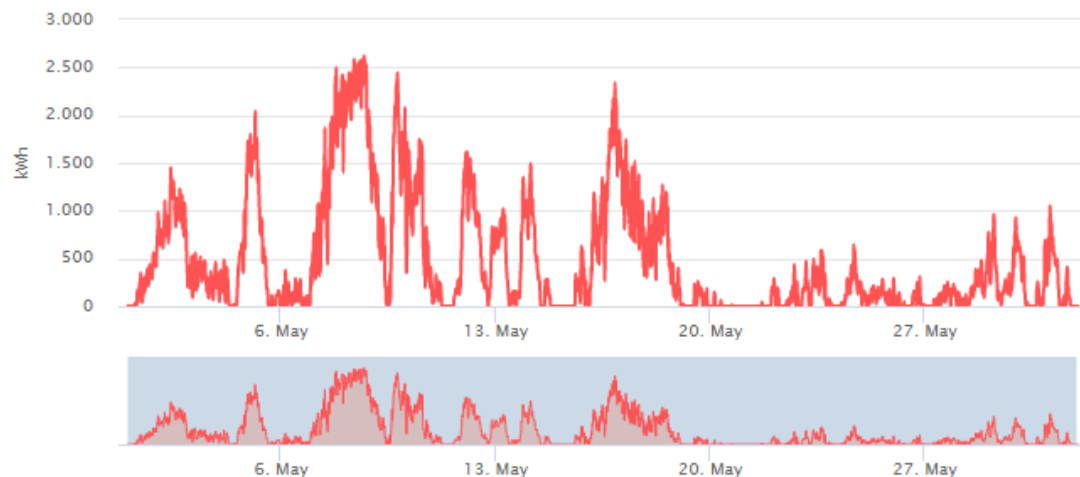


Fig 3. Trend in Electric Energy Generation of Sotavento Wind Farm

For anomaly detection the research done on wind turbine condition monitoring [5], shows use of different ML models for real time fault detection and prediction, where 144 papers that used ML for wind turbine CM(Condition Monitoring) are screened and an aggregated summary of the methods was developed.

Data:

Current data of Sotavento Wind farm contains two attributes i.e Wind Speed and it's direction, which are the recorded in every 10 minute interval of a day and contains data for every month. Size of data is enough but I believe adding more attributes to this dataset like air thickness, turbine design, weather forecast of that particular region can add more value to this data. For anomaly detection the data will be provided by the SCADA system as mentioned in the data section of condition monitoring section[5]

Assumptions and Risks:

Assuming that data provided by Sotavento Wind Farm is accurate and sensors recorded the wind speed and angle data precisely.

Materials:

Forecasting api provided by Schneider electric can be used on Sotavento Wind Farm dataset as this dataset has timestamp attribute as well. Model performance evaluation api can be used to predict the difference between the calculated value and actual value. For anomaly detection as different models are need to be used in combination like SVM, neural networks and different regression and classification .Forecasting api can play a role here as well. For clustering healthy behaviour of turbine functioning Advanced fault detection api by Schneider electric can play a role.

Results:

I expect the forecasting api will give a good result(=70%+ accuracy) as dataset provided by Sotavento Wind farm[3] is highly organised with no null values and less outliers. Whereas in anomaly detection process the data pose the big data challenges as there will be huge signal data from sensors installed in wind turbine but by combing different models to reach at higher granularity level can increase the accuracy.

Others:

I will also like to include the weather data with other attributes of Sotavento Wind Farm as weather of current region also influences the nature of wind, which will further influence the electric energy production.

References:

- [1]<https://www.blog.google/technology/ai/machine-learning-can-boost-value-wind-energy/>
- [2] https://energyeducation.ca/encyclopedia/Wind_power
- [3] <http://www.sotaventogalicia.com/en/real-time-data/historical>
- [4] <https://shop.exchange.se.com/home#!category/1118/1758>
- [5] <https://www.sciencedirect.com/science/article/pii/S096014811831231X>