
Energy Optimizer
"POWERING WITH EFFICIENCY"
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IBM HACK CHALLENGE 2020

THE EVOLUTION AND FUTURE OF WIND MARKETS

1. Rising concerns about climate change, the health effects of air pollution, energy security and energy access, along with volatile oil prices in recent decades, have led to the need to produce and use alternative, low-carbon technology options such as renewables.

2. Wind power has been a pioneering renewable technology in recent decades. In terms of total installed capacity, wind power is the leading renewable energy technology after hydropower, with more than half a terawatt installed globally as of the end of 2018. Along with solar, wind also dominated total renewable capacity additions, with around 43 GW of wind capacity added globally in 2018 (IRENA, 2019).

3. The evolution of the wind industry has been remarkable, and in the last four decades several milestones have been achieved in installations, technology advancements and cost reductions along with the establishment of key wind energy associations. By 2020, onshore wind is set-to consistently offer a less expensive source of new electricity than the least-cost fossil fuel alternative in most regions (IRENA, 2019c).

Key Milestones in the Industry

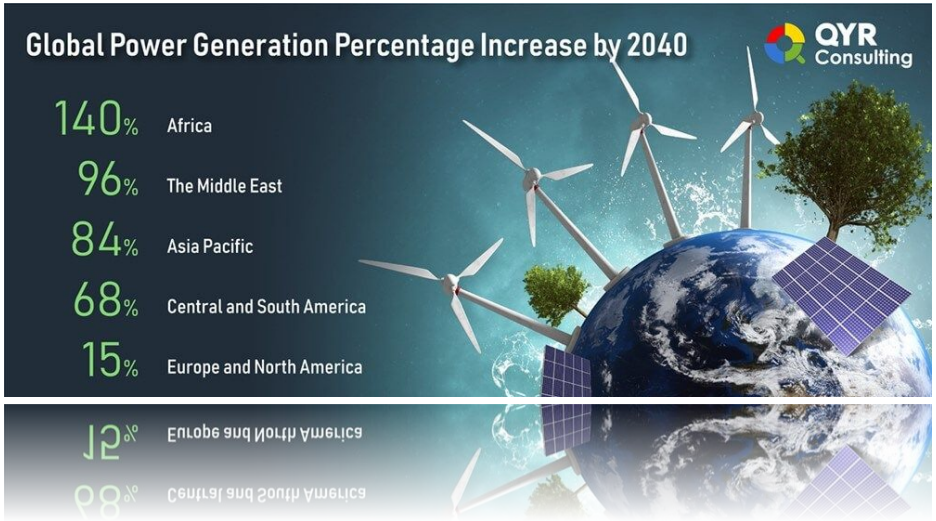
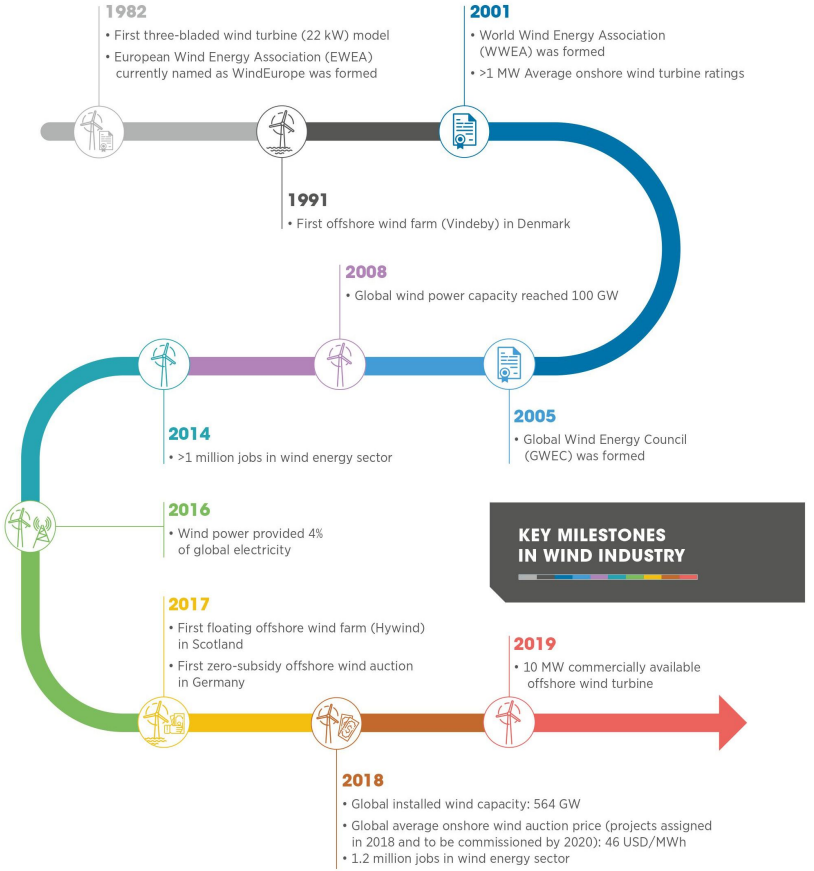


Figure 6: Overview of key milestones achieved by the wind industry since 1982.



THE QUESTION IS WHY?..

OUR PURPOSE...

1. To tackle the problem such as uncertainty in Active Wind Power extraction or costly overproduction, an application needs to be built for accurate prediction of the active wind power output from the wind farm. So, in order to create sustainable energy system, our world needs new technology to step into, to ensure more efficient and reliable production of wind energy.

2. According to many reports also, it is estimated that wind energy will constitute to more than 40% of the total renewable energy production of the world in about 10-20 years. But due to insufficient technology, and frameworks, there occurs a huge wastage in wind energy generation due to the variable nature of wind.

3. To counter this huge wastage of resources, we can actually bring digital technologies that can effectively make the energy production easy and profitable. The Mobile Applications are easiest to do so, as they have turned out to be used by most of the people nowadays. We also aim at reducing the chances of overproduction of energy because this ultimately results in a problem for the power grid managers.

Our Problem Statement

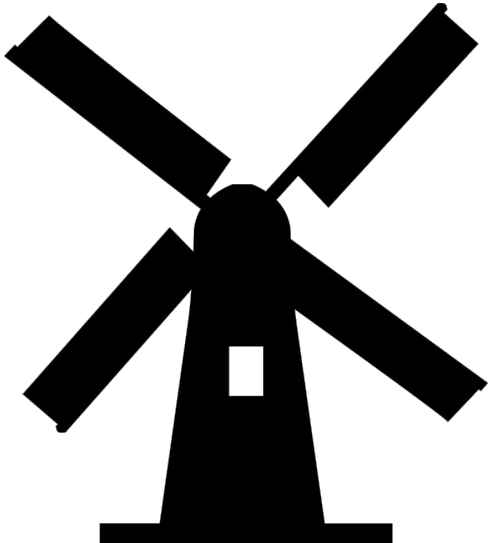
Title:

Predicting the energy output of wind turbine based on weather condition

Description:

Wind energy plays an increasing role in the supply of energy world-wide. The energy output of a wind farm is highly dependent on the wind 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.

OUR APPROACH



Rapid Growth in Wind Generation of Electricity

Over the last decade, there has an enormous increase in the production of electrical energy through wind farms, which also leads to huge wastage of energy because of variable nature of wind.

Brainstorm ideas

As wind is inherently variable, wind power is a fluctuating source of electrical energy.Short term forecasts(ranging from 1 h upto 72h) are useful in power system planning for unit commitment and dispatch, and for electricity trading in certain electricity markets where wind power and storage can be traded or hedged.

Building a deep learning model

The problem can be solved by building a deep learning model which can predict the next 72 hour Power Outputs based on the weather forecast.

Creating an Android Application

A standalone app will give the end user the Power output data, and users can see a complete graph of Power Output vs Time to get more insights of the data.

Testing and Deploying the Model

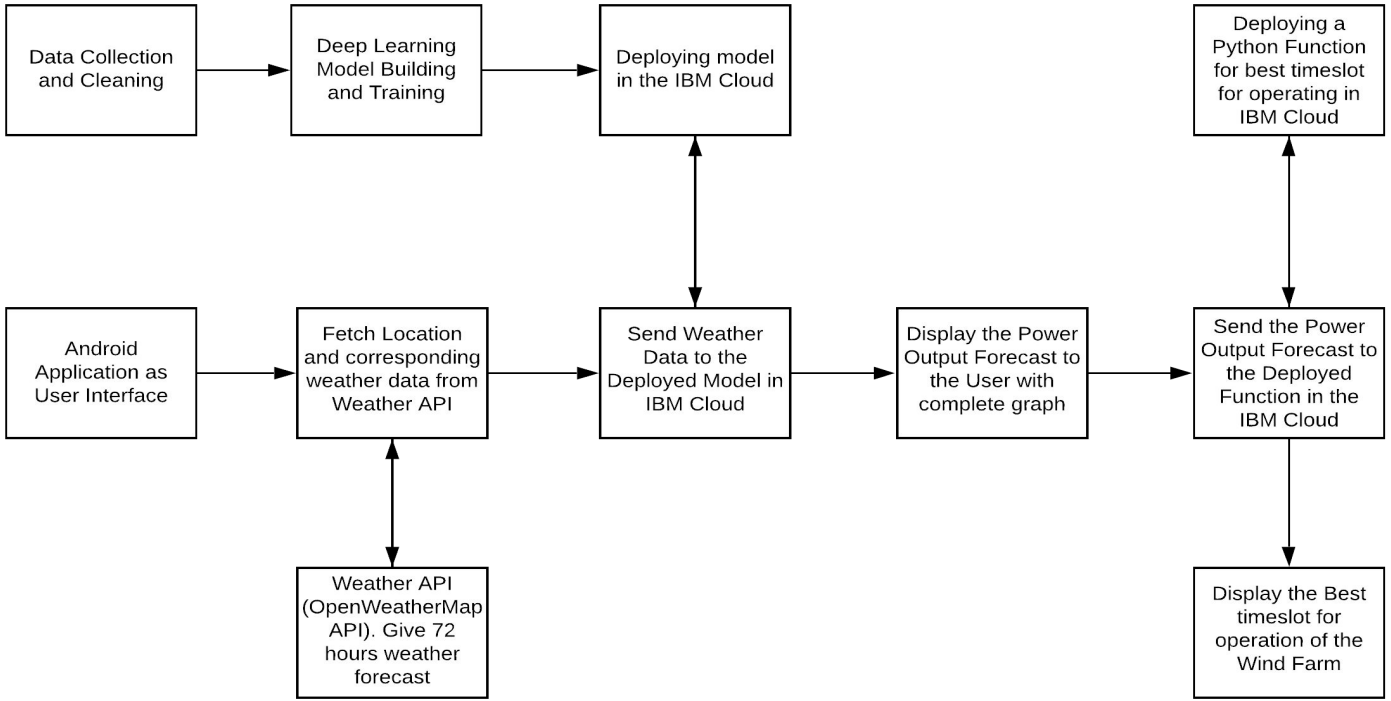
The deep learning model, which was built to give the predictions, will then be tested through the application for different locations and values.

Making the application ready for use

Once, the deep learning model is well tested for different values, our application is now ready for use.

How did we Plan?

The Block Pipeline

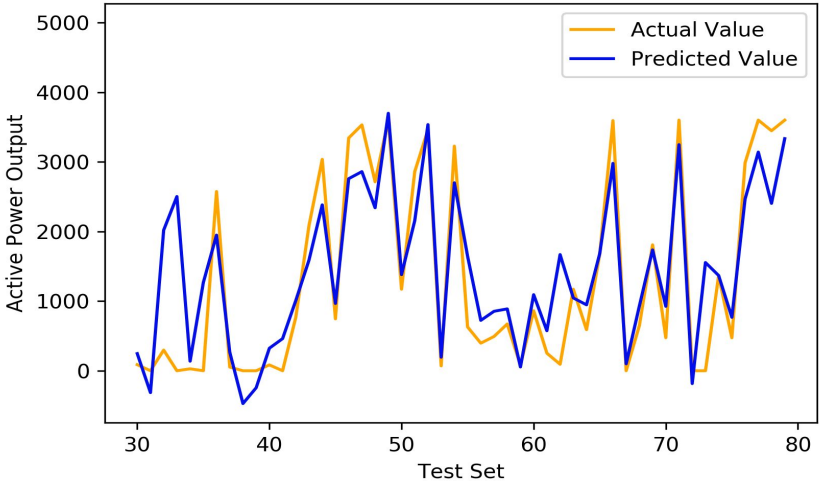


PREDICTION MODEL
WHAT WE TRIED?

Multivariate Linear Regression:

The input features included the wind speed and wind direction(normalized).

Test Set Mean Absolute Error:
388.6834758143794

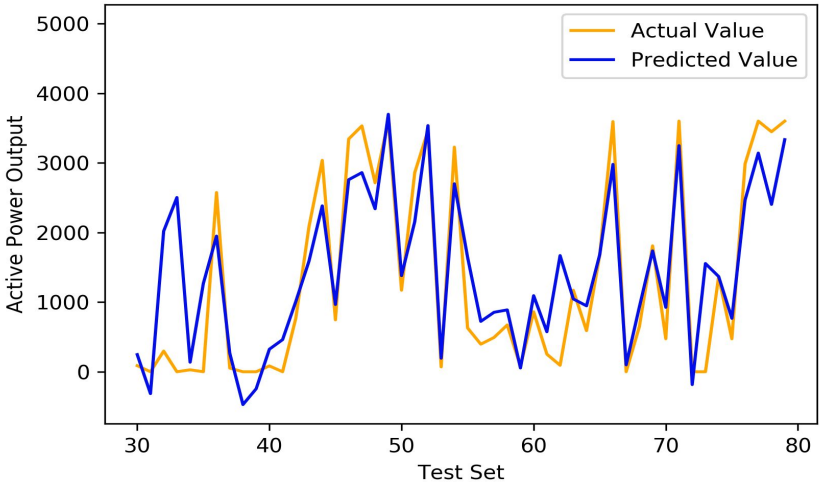


PREDICTION MODEL
WHAT WE TRIED?

Random Forest Regressor :

(Maximum Depth of the Tree had been tuned to remove over fitting)

Test Set Mean Absolute Error:
192.75887749214806

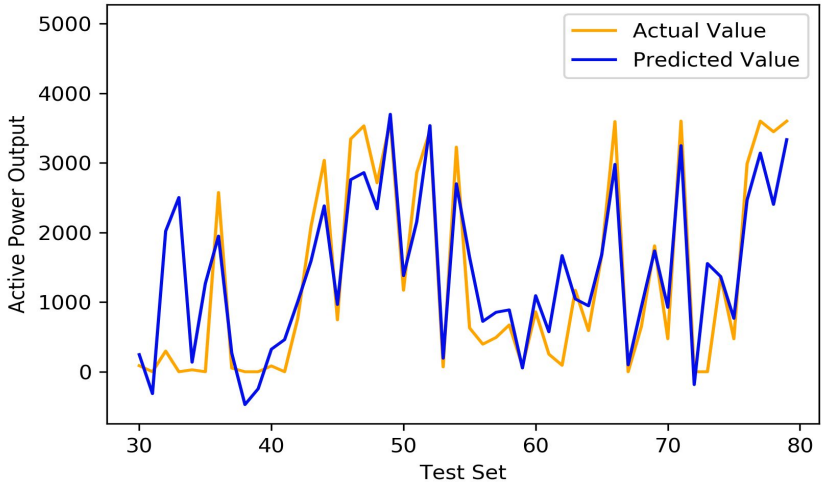


PREDICTION MODEL
WHAT WE TRIED?

Artificial Neural Network:

(Simple Architecture without Regularization)

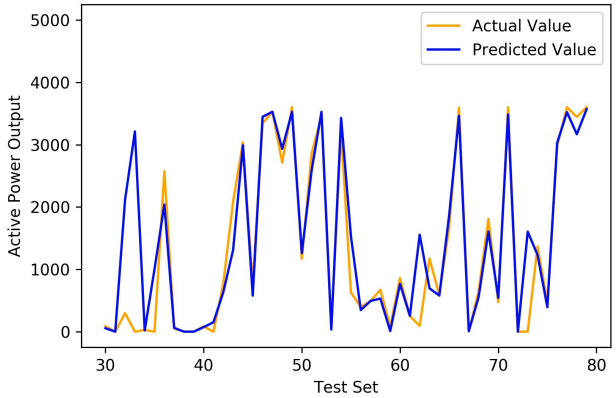
Test Set Mean Absolute Error: 185.13300537517875

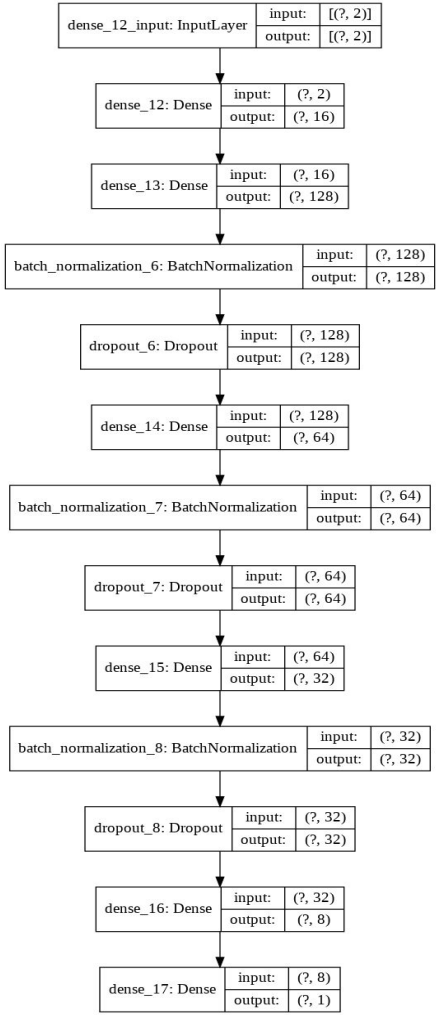


The Final ANN Model

Artificial Neural Network (With Batch Normalization and Dropouts) :

Test Set Mean Absolute Error:
160.1541670167519





IBM CLOUD DEPLOYMENT

1. We used WatsonMachineLearningAPIClient to deploy all our models to the cloud and further use it for our Android Application.

2. The deployments were made on the Watson Machine Learning Service Instance created on IBM Cloud.

3. Node-red applications were deployed to verify proper integration of UI applications to the cloud.

How do we interface?

Android Application

User Location/Location of Wind Farm

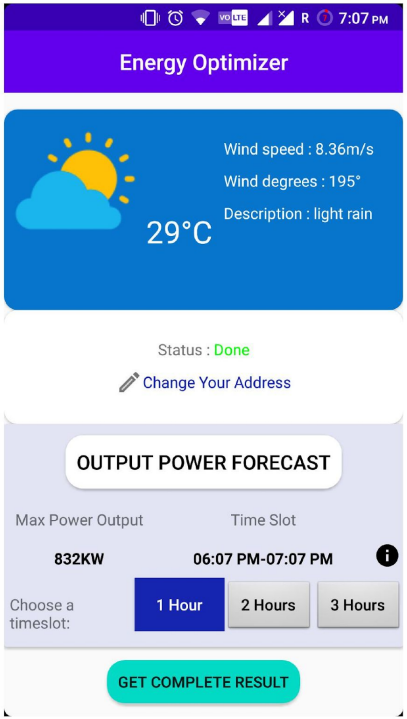
Next 72 hour Weather Data of that Location

OpenWeather

Next 72 hour Active Power Output Forecast Prediction by the ANN Model

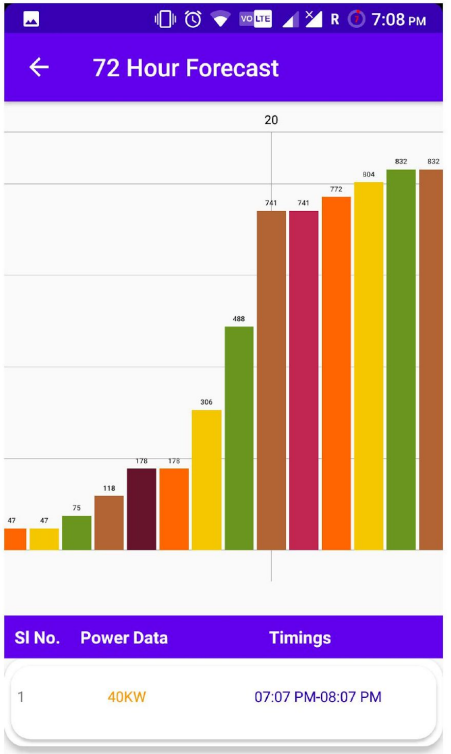
Next 72 hour Weather Data of that Location

How do we interface?
Android Application(Screen Shot)

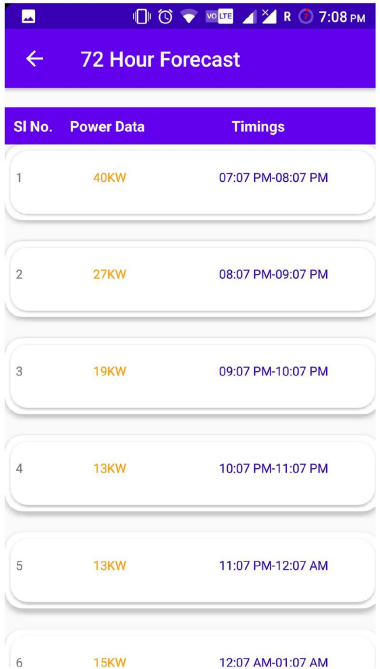


Home Screen

Get Complete Result

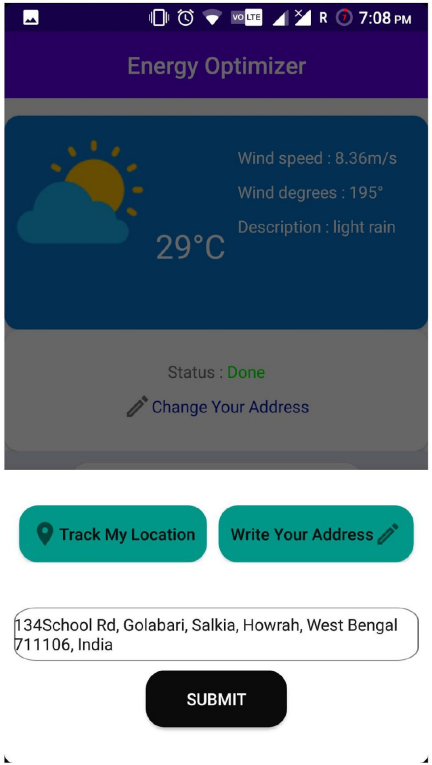


How do we interface?
Android Application(Screen Shot)



72 Hour Forecast

Enter Location of Wind Farm



Why Energy Optimizer Application?

- Accurate wind forecast is essential for integration of wind farms to power systems
- The impact of the wind uncertainty on the operation of gas plants was investigated.
- The android application can affect the wind energy sector significantly. This can help all the power grid user to decide the operation frequency as well the exact time for operation.
- Suppose the power grid user is planning for a collaborative extraction of wind energy with other sources which are more likely be extracted with proper planning, to achieve maximum efficiency they can use the application.
- The cost of overproduction can be reduced by accurate planning based on the forecast.

On long term usage farms of the application the power grid controller could also help the wind farm manger to find faults and disconnections if expected power output is not extracted as per the prediction. In future it may help the user to find ways to decreases all the physical losses during transmission as he would have a perfect goal to reach every time he improves the system.