PROJECT REPORT

PREDICTING THE ENERGY OUTPUT OF WIND TURBINE BASED ON WEATHER CONDITIONS

Date	19 November 2022
Team ID	PNT2022TMID12567
Project Name	Project – Predicting the energy output of wind turbine based on weather conditions

Submitted by

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1.INTRODUCTION :

Wind speed/power has received increasing attention around the earth due to its renewable nature as well as environmental friendliness.

With the global installed wind power capacity rapidly increasing, the wind industry is growing into a large-scale business. Reliable short-term wind speed forecasts play a practical and crucial role in wind energy conversion systems, such as the dynamic control of wind turbines and power system scheduling.

A precise forecast needs to overcome problems of variable energy production caused by fluctuating weather conditions.

Power generated by wind is highly dependent on the wind speed. Though it is highly nonlinear, wind speed follows a certain pattern over a certain period of time. We exploit this time series pattern to gain useful information and use it for power prediction.

1.1 PROJECT OVERVIEW :

Human beings has a long utilization history of wind energy. In modern society, people use wind turbine blade to convert the wind mechanical energy into electricity. Back to the ancient years, people use the mechanical energy collected by windmills to grind grains and pump water. Although, the utilization history of wind energy can be traced back till BC, but the development of wind energy technology is slow, people do not take wind energy seriously. Until the global oil crisis in 1973, under the double pressure of lack of conventional energy sources and global environmental deterioration, wind energy receives a considerable development as a part of the new energy sources. Wind energy maintains a huge development potential, especially for the offshore islands, mountain areas, grasslands and so on. It is a reliable way to generate electricity for the daily supply. Also, wind energy is a important energy source for the developed countries. The United States Department of Energy has made researches Wind power generation differs from conventional thermal generation due to the stochastic nature of wind. Thus wind power forecasting plays a key role in dealing with the challenges of balancing supply and demand in any electricity system, given the uncertainty associated with the wind farm power output. Accurate wind power forecasting reduces the need for additional balancing energy and reserve power to integrate wind power. For a wind farm that converts wind energy into electricity power, a real-time prediction system of the output power is significant. In this guided project , a prediction system is developed with a method of combining statistical models and physical models. In this system, the inlet condition of the wind farm is forecasted by the auto regressive model

1.2 Purpose :

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

With this project paper, a computer science perspective using applied data science on energy predictions based on weather data and analysing the important parameters on the energy output is depicted. To determine this, symbolic regression tree method based on the genetic programming tool Data-Modeler is used.

2. LITERATURE SURVEY :

We are going to deploy an application that will utilize multiple Watson AI Services including Cloud function, Watson Machine Learning and Node-RED/other web frame-work services. During the course of this project, we'll learn about combining Watson services, and how they can build interactive customer satisfaction interactive portals for prediction on current conditions

2.1 EXISTING PROBLEM:

- **Turbines produce noise and alter visual aesthetics :** Wind farms have different impacts on the environment compared to conventional power plants, but similar concerns exist over both the noise produced by the turbine blades and the visual impacts on the landscape .
- **Sound and visual impact** are the two main public health and community concerns associated with operating wind turbines. Most of the sound generated by wind turbines is aerodynamic, caused by the movement of turbine blades through the air.

2.2 REFERENCE:

S.NO	AUTHOR/YEAR	TITTLE	TECHNIQUE USED	MERITS	DEMERITS
1.	A.Clifton/2012	Using machine learning to predict wind turbine power output.	Machine learning.	Strong function wind speed.	Affected by turbulence and shear.
2.	Aman Bahugun/2013	Predicting the energy output of wind turbine based on weather conditions watson auto AI	IBM WATSON AUTO AI machine learning.	Predicted more accurately.	However,in another study it was found that the prediction errors do not satisfy the KolmogoroveSmirnov test for normal distribution.

3.	Haroon Rashid/2020	Forecasting of wind turbine output power using machine Learning.	Machine learning	Accurate predicting of output power.	Absolute errors for the proposed model.
4.	Katya Vladislavleva/ 2019	Predicting the Energy Output of Wind Farms Based on Weather Data: Important Variables and their Correlation	wind energy, prediction, genetic programming, DataModeler	A good prediction of the energy output.	However, levels of production of wind energy are hard to predict as they rely on potentially unstable weather conditions present at the wind farm.
5.	J K Lundquist and P.Fleming1/2012	Using machine learning to predict wind turbine power output	Machine learning, classification and regression trees, wind energy, wind turbine	Reduce bias in power predictions that arise because of the different turbulence and shear at the new site, compared to the test site.	Changes of wind direction with height, non-uniform shear, and the state of the turbine were not considered here but may impact turbine deployment sites.
6.	Aoife M. Foley/2020	Review Current methods and advances in . forecasting of wind power generation	Meteorology Numerical weather prediction Probabilistic forecasting Wind integration wind power forecasting	Thus wind power forecasting plays a key role in dealing with the challenges of balancing supply and demand in any electricity system, given the uncertainty associated with the wind farm power output.	Overall accurate wind power prediction reduces the financial and technical risk of uncertainty of wind power production for all electricity market participants.

2.3 PROBLEM STATEMENT DEFINITION :

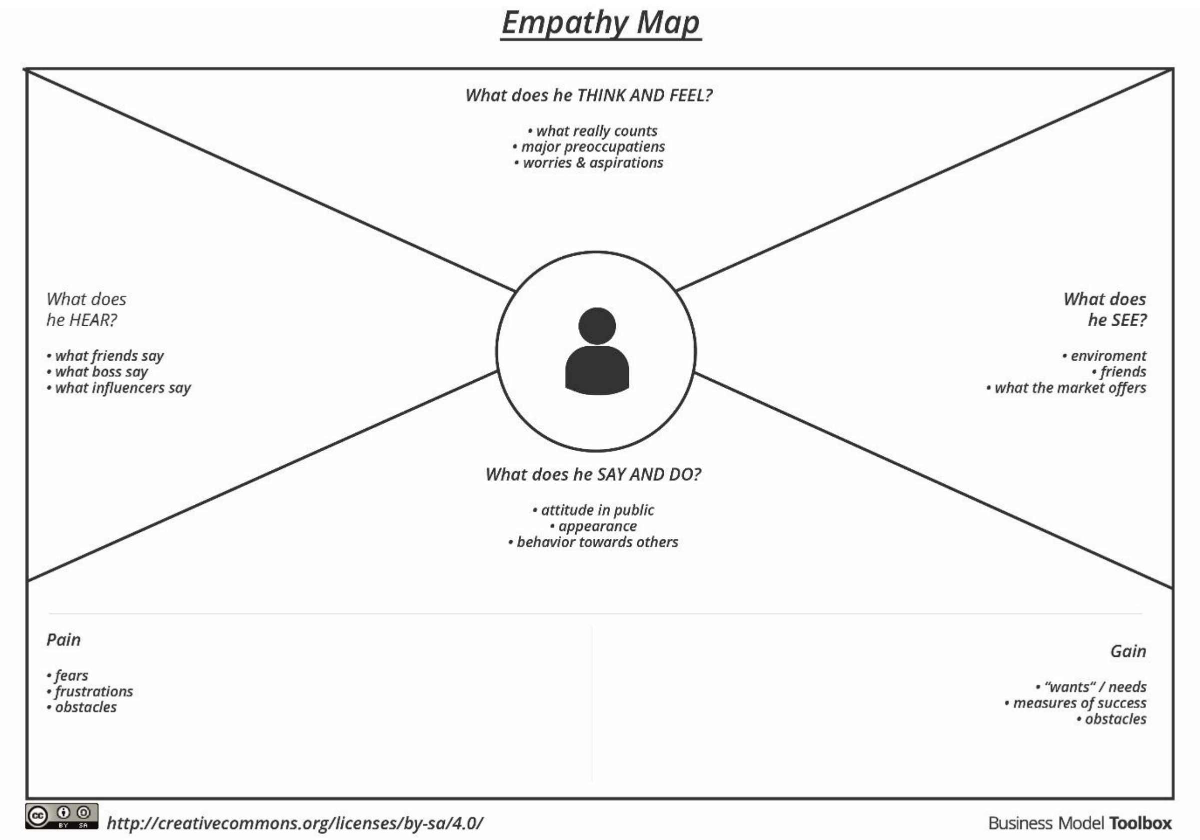
3. IDEATION & PROPOSED

3.1 EMPATHY MAP CANVAS:

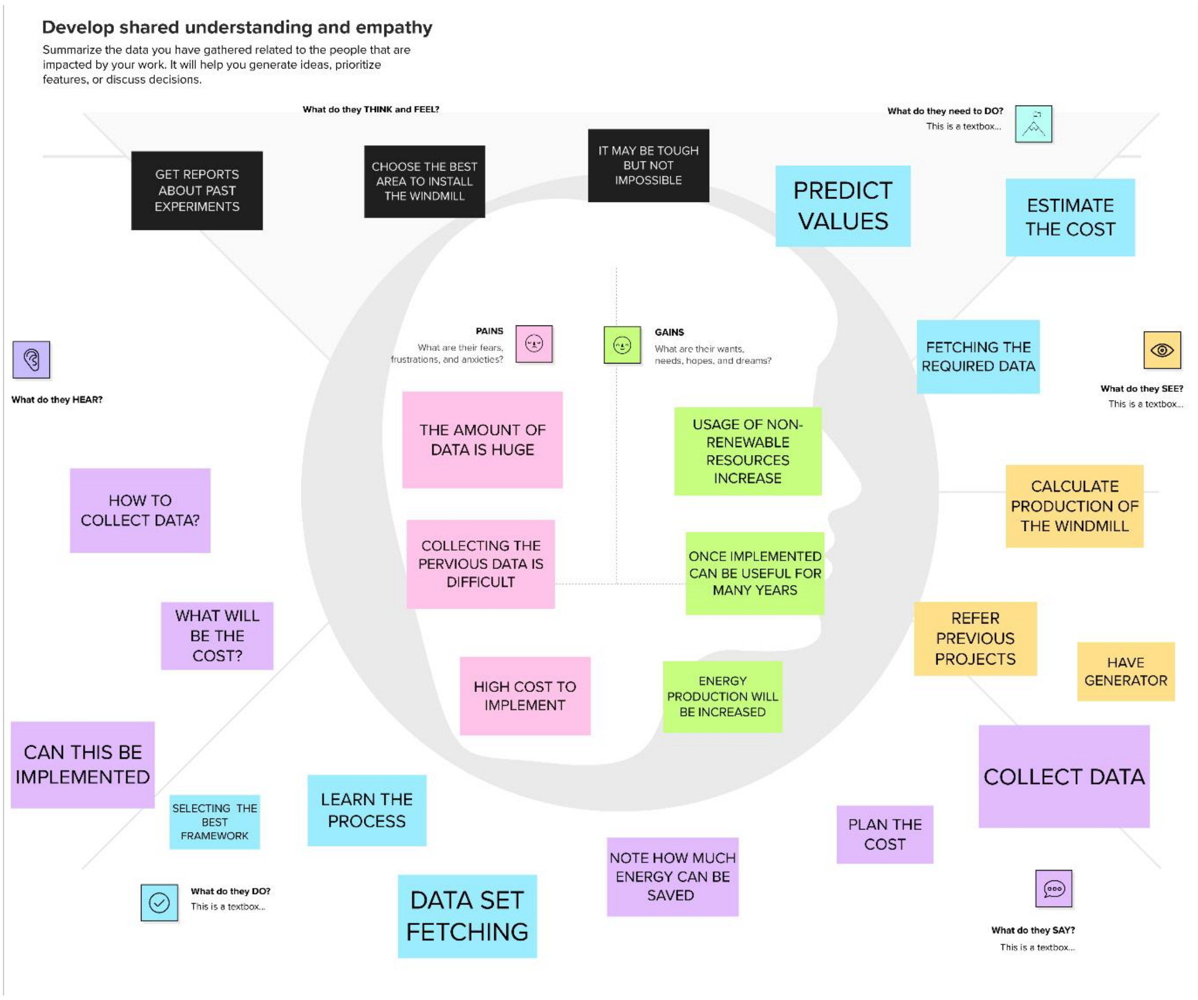
An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes.

It is a useful tool to helps teams better understand their users.
Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

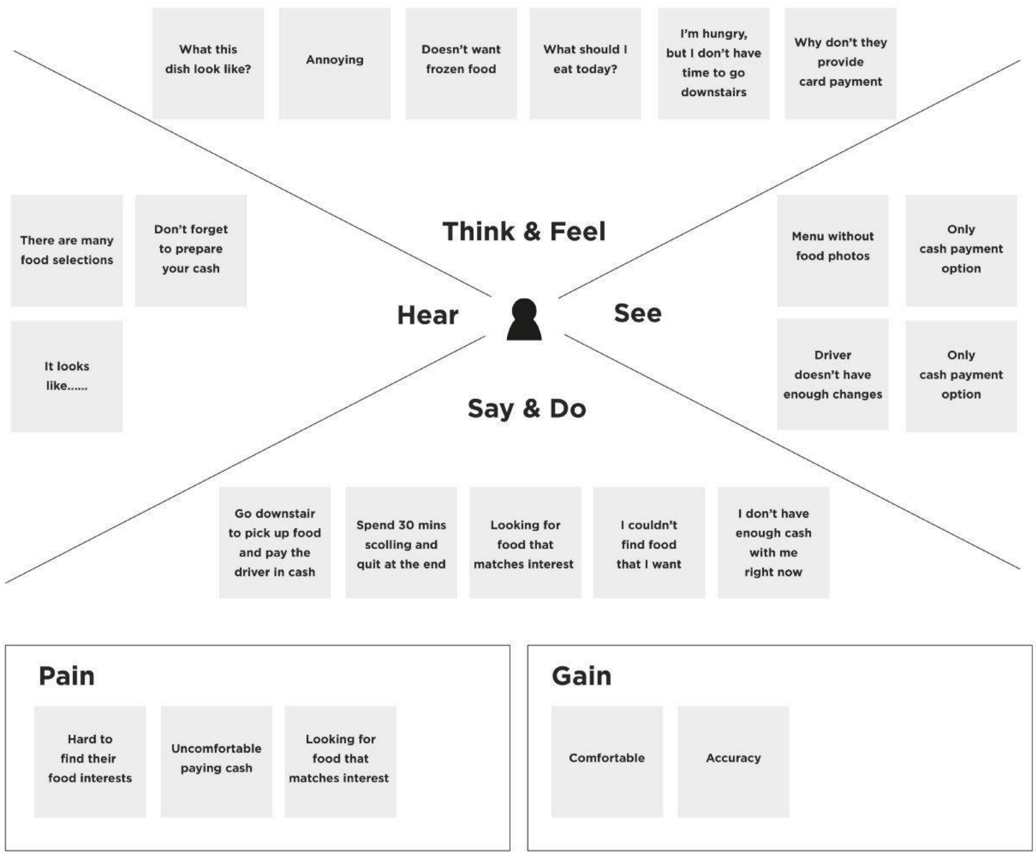
Example:



Reference: https://www.mural.co/templates/empathy-map-canvas



Develop shared understanding and empathy
Summarize the data you have gathered related to the people that are impacted by your work. It will help you generate ideas, prioritize features, or discuss decisions.
What do they THINK and FEEL?
GET REPORTS ABOUT PAST EXPERIMENTS
CHOOSE THE BEST AREA TO INSTALL THE WINDMILL
IT MAY BE TOUGH BUT NOT IMPOSSIBLE
What do they need to DO?
This is a textbox...
PREDICT VALUES
ESTIMATE THE COST
PAINS
What are their fears, frustrations, and anxieties?
GAINS
What are their wants, needs, hopes, and dreams?
FETCHING THE REQUIRED DATA
What do they SEE?
This is a textbox...
What do they HEAR?
THE AMOUNT OF DATA IS HUGE
USAGE OF NON-RENEWABLE RESOURCES INCREASE
HOW TO COLLECT DATA?
CALCULATE PRODUCTION OF THE WINDMILL
COLLECTING THE PERVIOUS DATA IS DIFFICULT
ONCE IMPLEMENTED CAN BE USEFUL FOR MANY YEARS
WHAT WILL BE THE COST?
REFER PREVIOUS PROJECTS
HAVE GENERATOR
HIGH COST TO IMPLEMENT
ENERGY PRODUCTION WILL BE INCREASED
CAN THIS BE IMPLEMENTED
COLLECT DATA
SELECTING THE BEST FRAMEWORK
LEARN THE PROCESS
PLAN THE COST
NOTE HOW MUCH ENERGY CAN BE SAVED
What do they DO?
This is a textbox...
DATA SET FETCHING
What do they SAY?
This is a textbox...



What this dish look like?
Annoying
Doesn't want frozen food
What should I eat today?
I'm hungry, but I don't have time to go downstairs
Why don't they provide card payment
There are many food selections
Don't forget to prepare your cash
Think & Feel
Menu without food photos
Only cash payment option
Hear
See
It looks like......
Driver doesn't have enough changes
Only cash payment option
Say & Do
Go downstair to pick up food and pay the driver in cash
Spend 30 mins scolling and quit at the end
Looking for food that matches interest
I couldn't find food that I want
I don't have enough cash with me right now
Pain
Hard to find their food interests
Uncomfortable paying cash
Looking for food that matches interest
Gain
Comfortable
Accuracy

3.2 IDEATION & BRAINSTORMING:

Date	4 November 2022
Team ID	PNT2022TMID12567
Project Name	Project – Predicting the energy output of wind turbine based on weather conditions
Maximum Marks	4 Marks

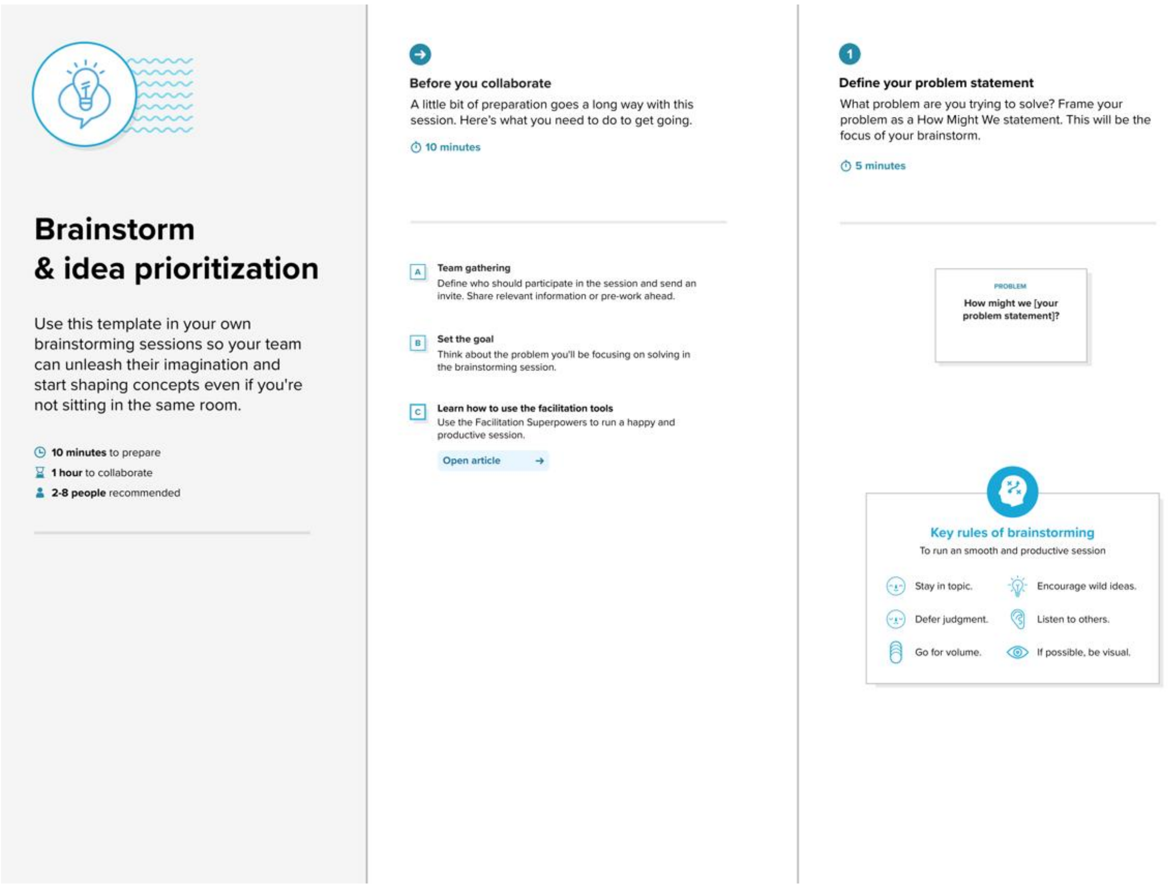
Brainstorm & Idea Prioritization Template:

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

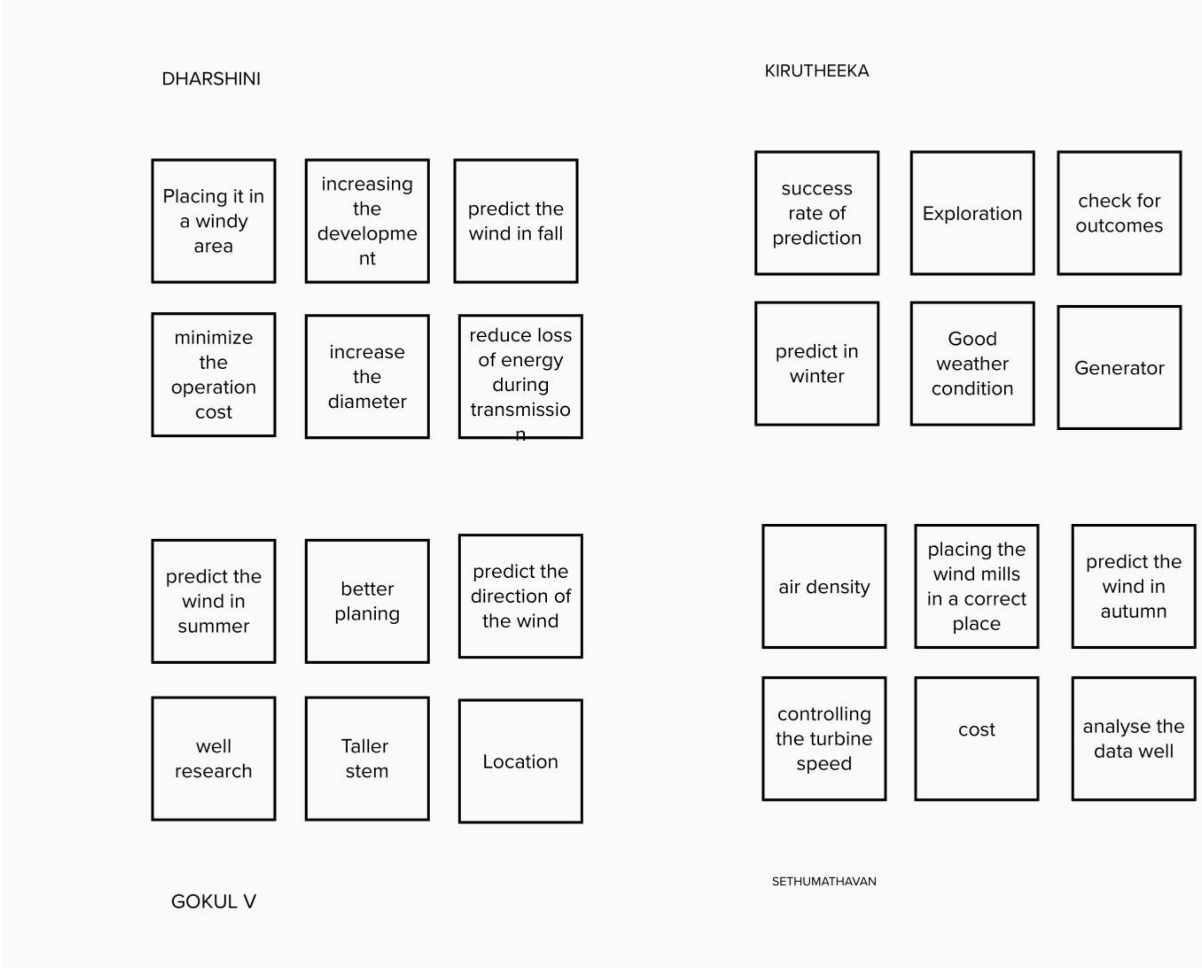
Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

Reference: https://www.mural.co/templates/empathy-map-canvas

Step-1: Team Gathering, Collaboration and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization

3.3 PROPOSED SOLUTION:

Proposed :

Project team shall fill the following information in proposed solution template.

S .No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Our time –tested kombi Box produce gives a higher priority to those forecasts having the lowest prediction error in respective weather situation.
2.	Idea/Solution description	Our aim is to map weather data to energy production
3.	Novelty/ Uniqueness	A good overview on the different methods that were recently applied in forecasting of wind power generation can be found in.

4.	Social Impact/ Customer Satisfaction	If there's a lot of wind, you get more energy output than if there's less wind, which means you will likely want to do maintenance when the winds are low to minimize downtime.
5.	Business Model(Revenue Model)	Real time projections for solar power, including behind-the-meter generation Grid-oriented forecasts
6.	Scalability of the Solution	The model prediction is then showcased on user interface to predict the energy output of wind turbine

3.4 PROBLEM SOLUTION FIT:

1. CUSTOMERSEGMENT(S):

Wind flows over the blades creating lift (similar to the effect on air plane wings), which causes the blades to turn.

The blades are connected to a drive shaft that turns an electric generator, which produces (generates).

1. JOBS-TO-BE-DONE/PROBLEMS:

Turbines produce noise and alter visual aesthetics

Wind farms have different impacts on the environment compared to conventional power plants ,but similar concerns exist over both the noise produced by the turbine blades and the visual impacts on the landscape.

3. TRIGGERS:

The wind speed is always fluctuating and thus the energy content of the wind is also always changing. Exactly how large the variation is depends both on the weather and
On local surface conditions and obstacles.

4. EMOTIONS:

BEFORE / AFTER

Before: who live in close proximity to wind turbines say they experience sleep disturbances, headaches and concentration problems.

After: Between working long hours, climbing turbines multiple times a day ,and dealing with extreme heat in the summer and cold in the winter.

5. AVAILABLE SOLUTIONS:

These residential windmills can generate electricity by churning the wind through its blades, which in turn rotates the turbine and generates power, which can meet the needs of a small family. The energy that is yielded from these wind turbines is clean, renewable, and are also cost-effective.

6. CUSTOMER CONSTRAINTS:

- Intermittent
- Low operating costs **Noise** and visual pollution Efficient use of land space
- Some adverse environmental impact
- Wind energy is a job creator

7. BEHAVIOUR:

The wind speed is always fluctuating and thus the energy content of the wind is also always changing.

Exactly how large the variation is depends both on the weather and on local surface conditions and obstacles.

8. CHANNELS OF BEHAVIOUR:

Online:

An efficient automated approach to wind farm operation monitoring is presented.

Offline:

Product is available for offline usage.

9. PROBLEM ROOT CAUSE:

The degradation, weakening and de bonding of the adhesive layers (in the trailing or leading edges or on the spar/shell joint) is one of the main processes leading to wind turbine blade failure.

10 .YOUR SOLUTION:

Larger rotor diameters allow wind turbines to sweep more area, capture more wind, and produce more electricity. A turbine with longer blades will be able to capture more of the available wind than shorter blades—even in areas with relatively less wind.

4. REQUIREMENT ANALYSIS:

4.1 FUNCTIONAL REQUIREMENTS:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement(Epic)	Sub Requirement(Story/Sub-Task)
FR-1	User Registration and logging in by entering their user name and password.	Registration through Form.
FR-2	User Confirmation by validating the user name with respect to the password	Confirmation via pop-up Message.
FR-3	Displaying the further information about the application.	By selecting the about button the details of the application will be displayed.
FR-4	Validating the city name.	System checks whether the city entered by the user is present or not. If present it will collect the further details else it will display the pop up message as error in the city.
FR-5	Checking the data type of the value.	System checks for the data type of the value entered by the user.
FR-6	Validating all required fields.	Before predicting the output the system checks whether all the values are entered by the user and checks whether all values are correct.
FR-7	Displaying weather Conditions for a given city.	It displays the weather of the city which have Been selected.
FR-8	Displaying predicted Energy output power.	The predicted output will be displayed as amount of wind energy power generated.

4.2 NON-FUNCTIONAL REQUIREMENTS:

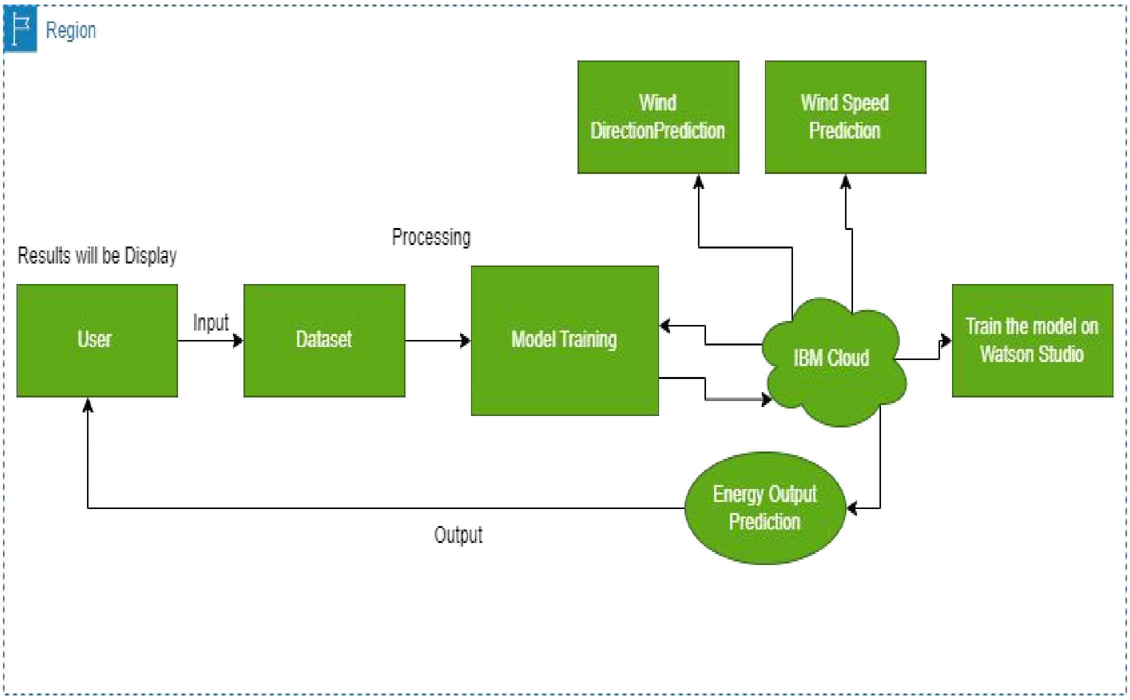
Following are the non-functional requirements of the proposed solution

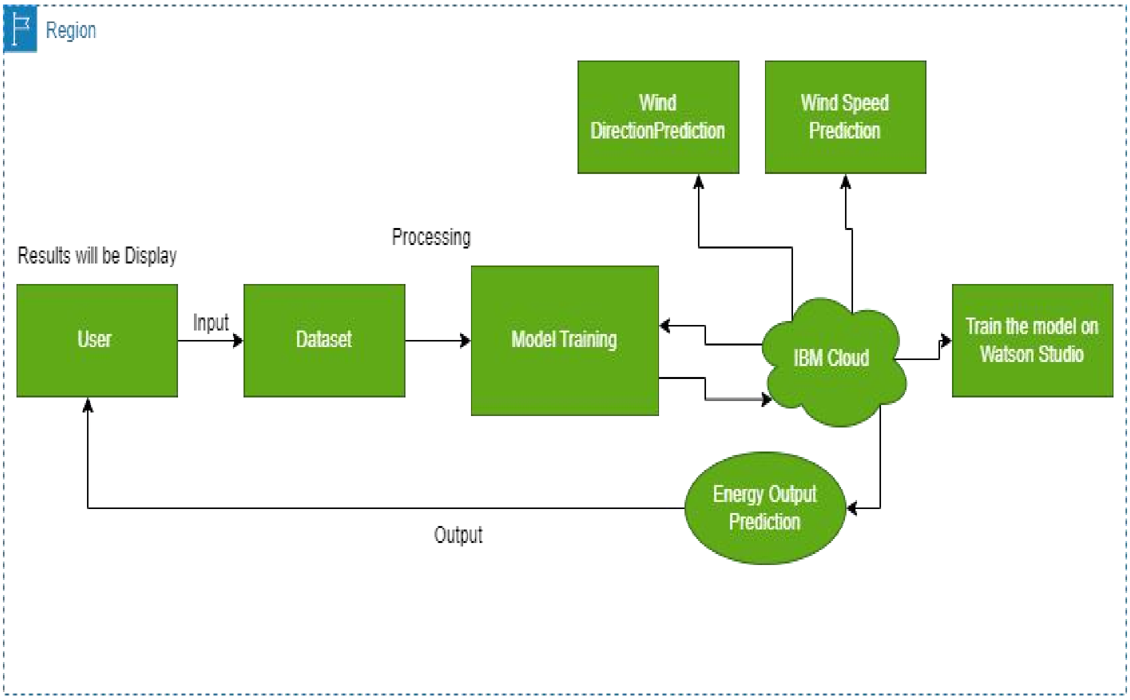
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	The system satisfies the user goals and the application is easy to use.
NFR-2	Security	The data provided to system will be protected from Attacks and unauthorized access
NFR-3	Reliability	The system will provide the consistency in output without producing an error.
NFR-4	Performance	The performance will never degrade even the work load is increased.

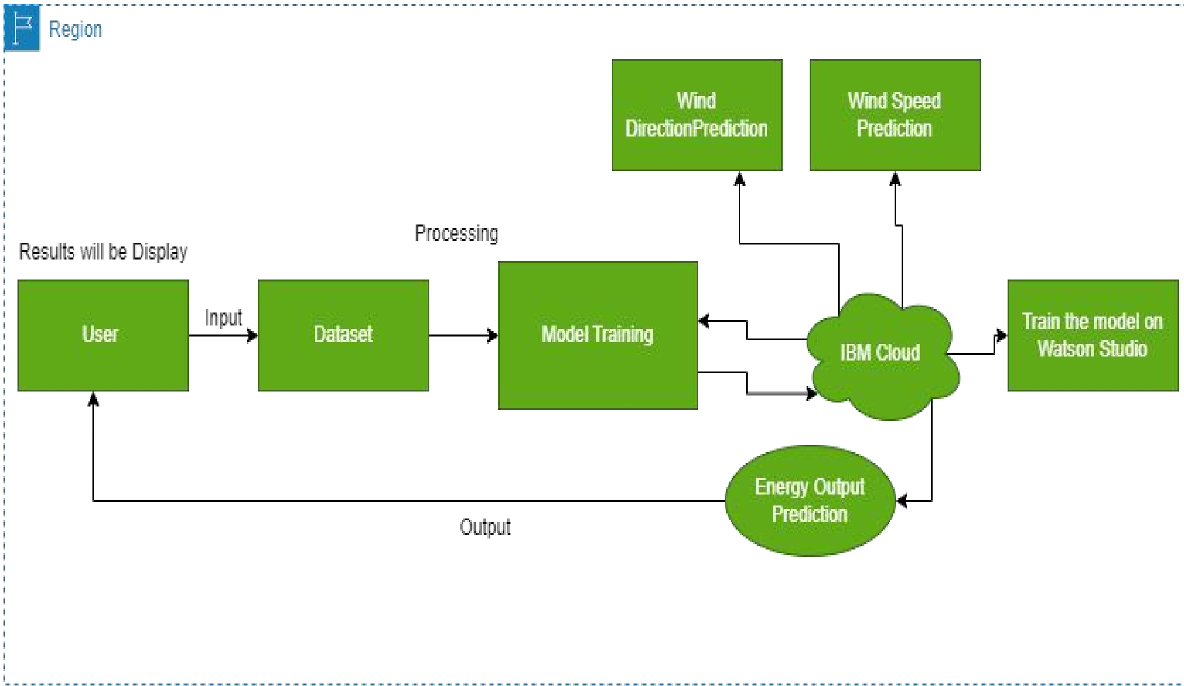
NFR-5	Availability	The application is available for24*7
NFR-6	Scalability	The system can be used as web application as well as mobile application with a sufficient internet availability.

PROJECT DESIGN :

5.1 DATA FLOW DIAGRAMS







1 . User enter input weather data.
2 . Send data to the central server.
3 . Train the model on Watson studio.
4 . W ind direction and speed is predicted.
5 . Result will be displayed.

5.2 SOLUTION & TECHNICAL ARCHITECTURE:

Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Wind power generation differs from conventional thermal generation due to the stochastic nature of wind.
- Thus wind power forecasting plays a key role in dealing with the challenges of balancing supply and demand in any electricity system, given the uncertainty associated with the wind farm power output.
- The inlet condition of the wind farm is forecasted by the auto regressive model.
- We report on the correlation of the different variables for the energy output.

Example - Solution Architecture Diagram:

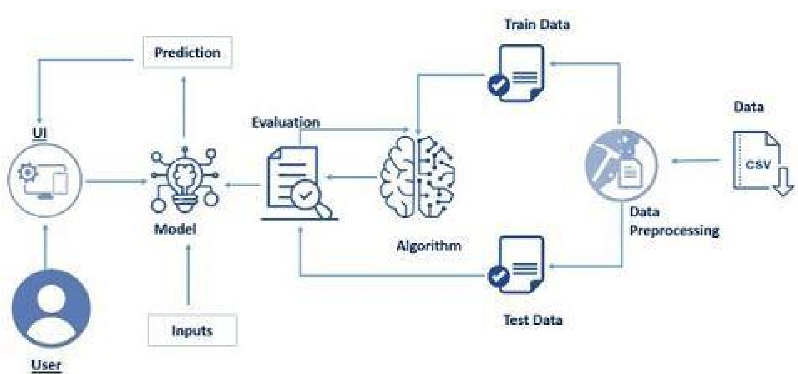


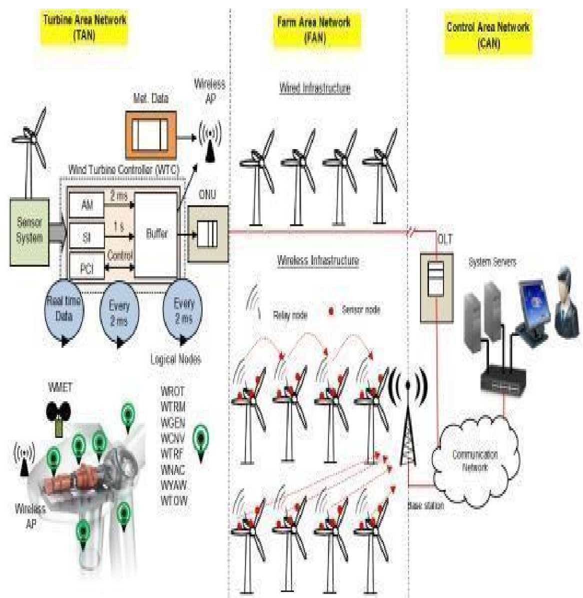
Figure 1: Architecture and data flow

Reference: https://github.com/SmartPracticeschool/llSPS-INT-3437-Predicting-the-Energy-Output-of-WindTurbine-Based-on-Weather-Conditions-Watson-Auto-

Technical Architecture:

The Deliverable shall include the architectural diagram as below and the information as per the table1&table2

Example:Predictingtheenergyoutputofwindfarmbasedonweatherconditions.
Reference: https://www.mdpi.com/1996-1073/7/6/3900



Guidelines:

The proposed communication network architecture for the Smart-WPF consists of three networks :the turbine area network (TAN), the farm area network(FAN), and the control area network (CAN).

It consists of hierarchical architectures whereLevel1isasensor network in a single wind turbine, Level2 is the wind turbine-to-wind turbine interaction in the WPF, Level 3 is the local control center to wind turbine interaction, and Level 4 is the farm-to-farm interaction to optimize grid operation.

In order to implement hierarchical network architecture, a hybrid communication solution is considered. EPON-based architecture represents a wired solution, while ZigBee-
Pro is considered for the wireless solution. In this work, Levels1 and 2 are explained in more detail, while Levels 3 and 4 are out the scope of this work

6 PROJECT PLANNING & SCHEDULING:

6.1SPRINT PLANNING & ESTIMATION:

Sprint	Sprint Start Date	Sprint End Date(Planned)	Story Points Completed (as on Planned End Date)
Sprint-1	01 Nov2022	14 Nov2022	20
Sprint-2	07 Nov2022	14Nov2022	20
Sprint-3	07Nov2022	15Nov2022	20
Sprint-4	09 Nov2022	15Nov2022	20

```
Saving Wind Dataset.csv to Wind Dataset.csv
```

In [2]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import joblib
```

Data Preprocessing

In [3]:

```
path = "Wind Dataset.csv"
df = pd.read_csv(path)
df.rename(columns={"Date/Time":"Time", "LV ActivePower (kW)":"ActivePower(Kw
                    "Wind Direction(°)":"Wind_Direction"},
                    inplace=True)
```

In [4]:

```
df.head()
```

6.2 SPRINT DELIVERY SCHEDULE:

Sprint	**SprintStartDate**	**SprintEndDate(Planned)**	**Story PointsCompleted (ason PlannedEndDate)**	**SprintReleaseDate(Actual)**
Sprint-1	01 Nov2022	14 Nov2022	20	14 Nov 2022
Sprint-2	07 Nov2022	14Nov2022	20	14 Nov2022
Sprint-3	07Nov2022	15Nov2022	20	15 Nov2022
Sprint-4	09 Nov2022	15Nov2022	20	15 Nov2022

7 CODING & SOLUTIONING:

7.1 FEATURE 1:

```
import pandas as pd
import numpy as np
import matplotlib.pylab as plt
import os

os.chdir("/home/skystone/Documents/TimeSeries")
df = pd.read_csv('T1.csv', delimiter=',')

dataset = df[['Date/Time','Wind Speed (m/s)']]
dataset = dataset.rename(columns = {"Date/Time" :"timeStamp","Wind Speed (m/s)":"
windSpeed"})
dataset = dataset[0:5000]

dataset.index = pd.to_datetime(dataset.timeStamp)
dataset = dataset.drop('timeStamp', axis=1)

dataset = dataset.sort_index()
dataset.fillna(df.mean())

                    windSpeed
timeStamp
2018-01-01 00:00:00  5.311336
2018-01-01 00:10:00  5.672167
2018-01-01 00:20:00  5.216037
2018-01-01 00:30:00  5.659674
2018-01-01 00:40:00  5.577941
...                       ...
2018-12-01 23:10:00  5.901831
2018-12-01 23:20:00  6.314789
2018-12-01 23:30:00  6.212303
2018-12-01 23:40:00  5.646367
2018-12-01 23:50:00  6.024518

[5000 rows x 1 columns]

# Testing whether there are null values
dataset[dataset.isnull()]
len(dataset[dataset.isnull()])
dataset = dataset.sort_index()
dataset.index

DatetimeIndex(['2018-01-01 00:00:00', '2018-01-01 00:10:00',
               '2018-01-01 00:20:00', '2018-01-01 00:30:00',
               '2018-01-01 00:40:00', '2018-01-01 00:50:00',
               '2018-01-01 01:00:00', '2018-01-01 01:10:00',
```

```
               '2018-01-01 01:20:00', '2018-01-01 01:30:00',
               ...
               '2018-12-01 22:20:00', '2018-12-01 22:30:00',
               '2018-12-01 22:40:00', '2018-12-01 22:50:00',
               '2018-12-01 23:00:00', '2018-12-01 23:10:00',
               '2018-12-01 23:20:00', '2018-12-01 23:30:00',
               '2018-12-01 23:40:00', '2018-12-01 23:50:00'],
              dtype='datetime64[ns]', name='timeStamp', length=5000, freq=None)
```

```
# Replacing NaN values with the previous effective data
dataset.windSpeed.fillna(method='pad', inplace=True)
dataset[dataset.windSpeed.isnull()]

dataset.describe()
```

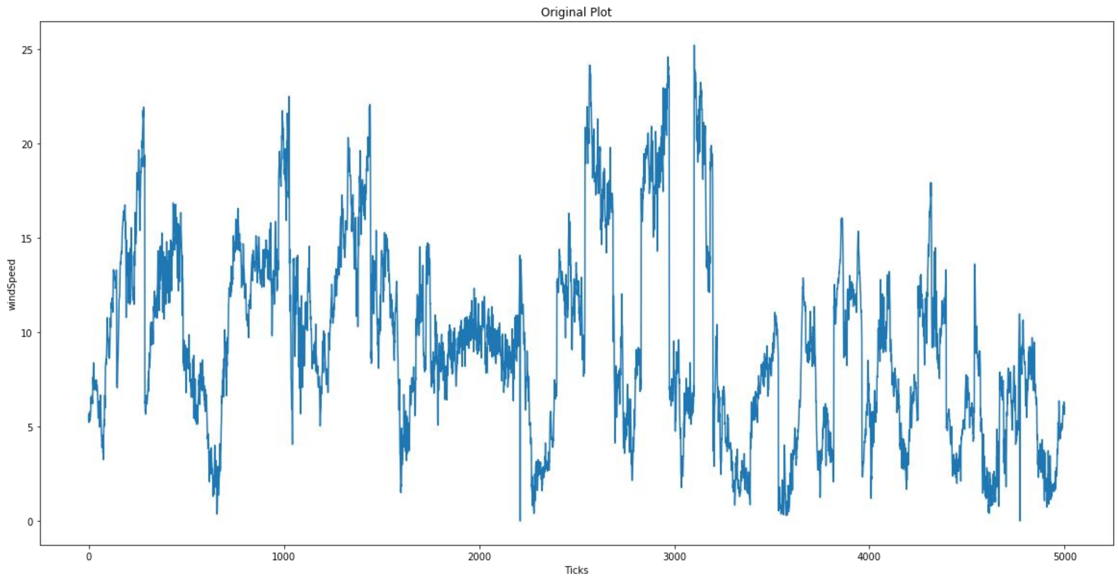
```
         windSpeed
count  5000.000000
mean      9.476864
std       5.038876
min       0.000000
25%       5.767437
50%       8.977808
75%      12.692423
max      25.206011
```

```
dataset
```

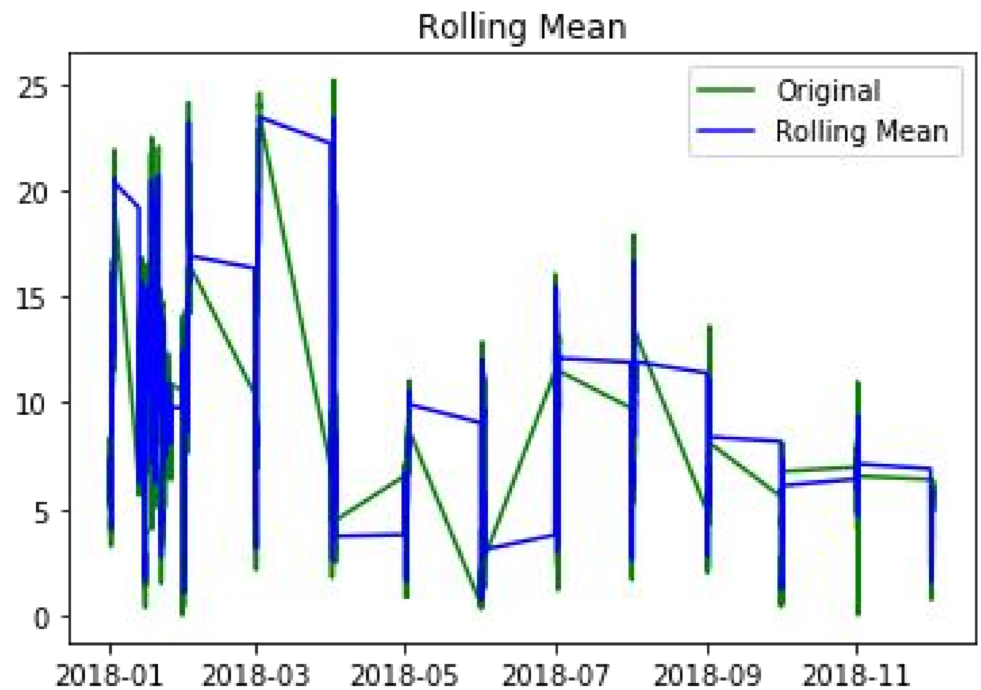
```
                     windSpeed  Ticks  Roll_Mean
timeStamp
2018-01-01 00:00:00   5.311336      0        NaN
2018-01-01 00:10:00   5.672167      1        NaN
2018-01-01 00:20:00   5.216037      2        NaN
2018-01-01 00:30:00   5.659674      3        NaN
2018-01-01 00:40:00   5.577941      4        NaN
...                        ...    ...        ...
2018-12-01 23:10:00   5.901831   4995   5.455411
2018-12-01 23:20:00   6.314789   4996   5.550649
2018-12-01 23:30:00   6.212303   4997   5.645635
2018-12-01 23:40:00   5.646367   4998   5.710854
2018-12-01 23:50:00   6.024518   4999   5.801940

[5000 rows x 3 columns]
```

```
dataset['Ticks'] = range(0,len(dataset.index.values))

#very simple plotting
fig = plt.figure(1,figsize=(20,10))
ax1 = fig.add_subplot(111)
ax1.set_xlabel('Ticks')
```

```
ax1.set_ylabel('windSpeed')
ax1.set_title('Original Plot')
ax1.plot('Ticks', 'windSpeed', data = dataset);
```



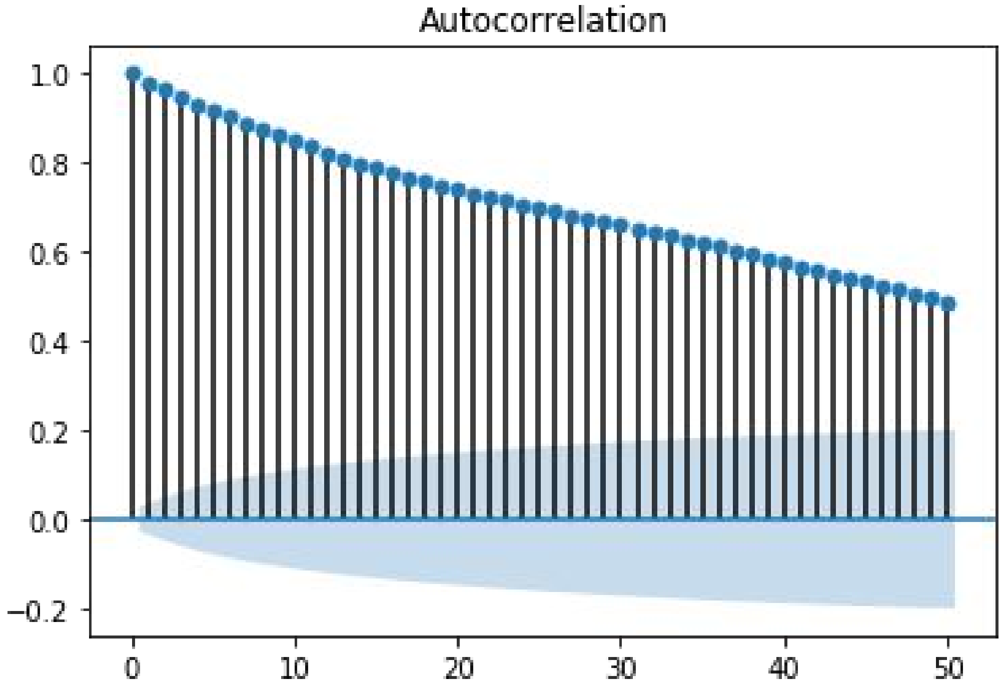

```
from statsmodels.tsa.stattools import adfuller
def stationarity_check(ts):
    # Determing rolling statistics
    #roll_mean = pd.rolling_mean(ts, window=12)
    roll_mean = ts.rolling(12).mean()

    # Plot rolling statistics:
    plt.plot(ts, color='green',label='Original')
    plt.plot(roll_mean, color='blue', label='Rolling Mean')
    plt.legend(loc='best')
    plt.title('Rolling Mean')
    plt.show(block=False)

    # Perform Augmented Dickey-Fuller test:
    print('Augmented Dickey-Fuller test:')
    df_test = adfuller(ts)
    print("type of df_test: ",type(df_test))
    print("df_test: ",df_test)
    df_output = pd.Series(df_test[0:4], index=['Test Statistic','p-value','#Lags Used','Nu
mber of Observations Used'])
    print("df_output: \n",df_output)
    for key,value in df_test[4].items():
        df_output['Critical Value (%s)'%key] = value
    print(df_output)

stationarity_check(dataset.windSpeed)
```

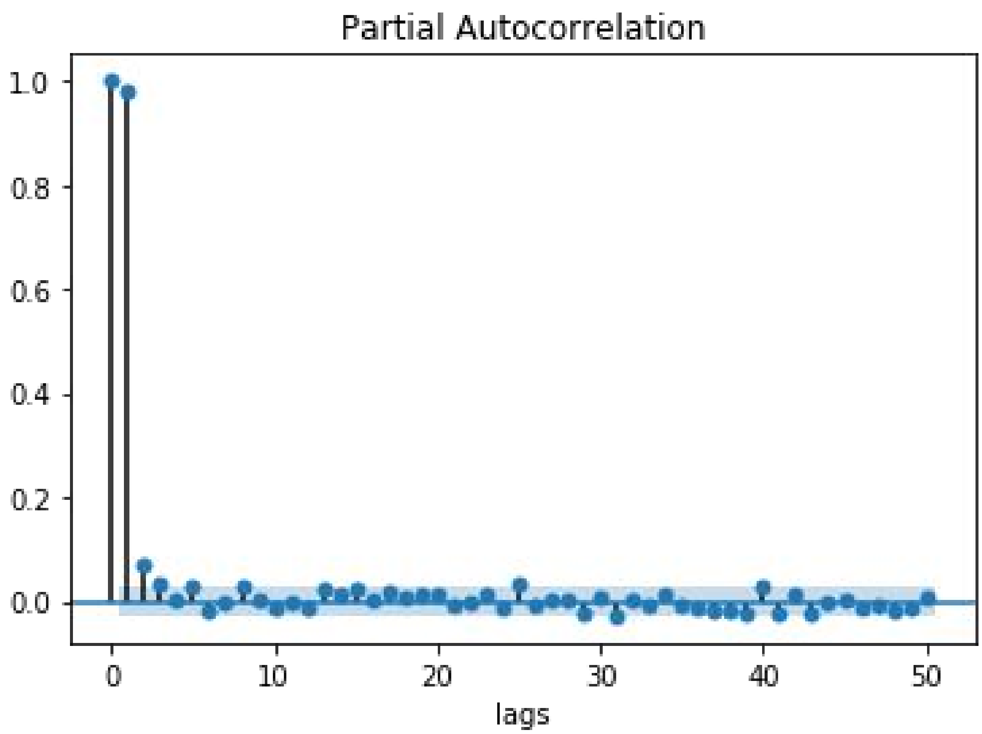



```
Augmented Dickey-Fuller test:
type of df_test:  <class 'tuple'>
df_test:  (-6.144307250627125, 7.834283924037626e-08, 4, 4995, {'1%': -3.431659842
59144, '5%': -2.8621188086591505, '10%': -2.5670781005730454}, 14219.983885584
175)
df_output:
 Test Statistic                -6.144307e+00
p-value                        7.834284e-08
#Lags Used                     4.000000e+00
Number of Observations Used    4.995000e+03
dtype: float64
Test Statistic                -6.144307e+00
p-value                        7.834284e-08
#Lags Used                     4.000000e+00
Number of Observations Used    4.995000e+03
Critical Value (1%)           -3.431660e+00
Critical Value (5%)           -2.862119e+00
Critical Value (10%)          -2.567078e+00
dtype: float64
```

```
#dfIndia['Roll_Mean'] = pd.rolling_mean(dfIndia.AverageTemperature, window=12)
dataset['Roll_Mean'] = dataset.windSpeed.rolling(12).mean()
dataset.windSpeed.rolling(12)

from statsmodels.graphics.tsaplots import plot_pacf,plot_acf
plot_acf(dataset.windSpeed, lags=50)
plot_pacf(dataset.windSpeed, lags=50)
```

```
plt.xlabel('lags')
plt.show()
```






```
from statsmodels.tsa.arima_model import ARMA

import itertools
p = q = range(0, 4)
```

```
pq = itertools.product(p, q)
for param in pq:
    try:
        mod = ARMA(dataset.windSpeed,order=param)
        results = mod.fit()
        print('ARMA{} - AIC:{}'.format(param, results.aic))
    except:
        continue

model = ARMA(dataset.windSpeed, order=(1,2))
results_MA = model.fit()
```

```
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
```

```
ARMA(0, 0) - AIC:30364.214754066536
ARMA(0, 1) - AIC:24801.85610422196
```

```
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
```

```
ARMA(0, 2) - AIC:21549.842835421237
```

```
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
```

```
ARMA(0, 3) - AIC:19423.919558228015
ARMA(1, 0) - AIC:14317.324221839566
```

```
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
```

```
ARMA(1, 1) - AIC:14294.56683695603
```

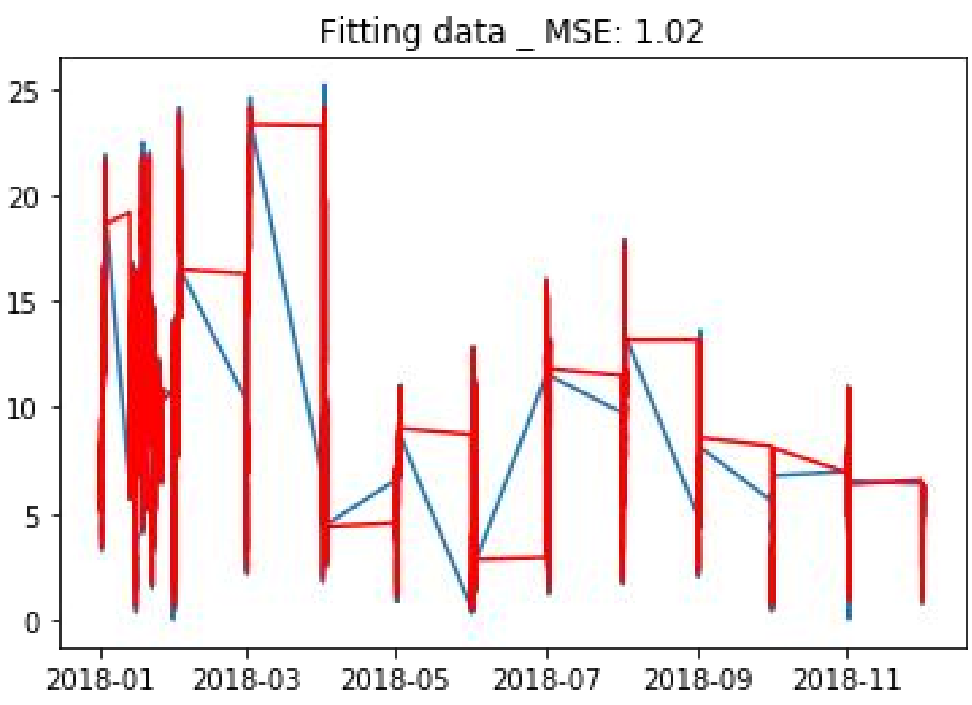
```
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)

ARMA(1, 2) - AIC:14291.390246671057

/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)

ARMA(1, 3) - AIC:14293.385547159249

/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)

ARMA(2, 0) - AIC:14296.264728508437

/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)

ARMA(2, 1) - AIC:14291.089556513361

/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)

ARMA(2, 2) - AIC:14292.461574414872

/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)

ARMA(3, 0) - AIC:14291.838978335647

/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)

ARMA(3, 1) - AIC:14293.21493205386
```

```
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
```

```
ARMA(3, 2) - AIC:14292.401015869655
```

```
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
/home/skystone/anaconda3/lib/python3.7/site-packages/statsmodels/tsa/base/tsa_mo
del.py:218: ValueWarning: A date index has been provided, but it has no associated fre
quency information and so will be ignored when e.g. forecasting.
  ' ignored when e.g. forecasting.', ValueWarning)
```

```
plt.plot(dataset.windSpeed)
plt.plot(results_MA.fittedvalues, color='red')
plt.title('Fitting data _ MSE: %.2f'% (((results_MA.fittedvalues-dataset.windSpeed)**2).m
ean()))
plt.show()
```




```
predictions = results_MA.predict('2018-12-01 18:50:00')
predictions
```

```
timeStamp
2018-12-01 18:50:00    4.460888
2018-12-01 19:00:00    4.389968
2018-12-01 19:10:00    5.277697
2018-12-01 19:20:00    6.305601
```

```
2018-12-01 19:30:00    6.055593
2018-12-01 19:40:00    5.467116
2018-12-01 19:50:00    4.672773
2018-12-01 20:00:00    4.762773
2018-12-01 20:10:00    4.660974
2018-12-01 20:20:00    4.604682
2018-12-01 20:30:00    4.463258
2018-12-01 20:40:00    4.824619
2018-12-01 20:50:00    5.023217
2018-12-01 21:00:00    4.946497
2018-12-01 21:10:00    4.849481
2018-12-01 21:20:00    4.988229
2018-12-01 21:30:00    5.224988
2018-12-01 21:40:00    5.147783
2018-12-01 21:50:00    4.963385
2018-12-01 22:00:00    5.015975
2018-12-01 22:10:00    5.063677
2018-12-01 22:20:00    5.223739
2018-12-01 22:30:00    5.483823
2018-12-01 22:40:00    5.769376
2018-12-01 22:50:00    6.126335
2018-12-01 23:00:00    6.164913
2018-12-01 23:10:00    6.040558
2018-12-01 23:20:00    5.975328
2018-12-01 23:30:00    6.344626
2018-12-01 23:40:00    6.262317
2018-12-01 23:50:00    5.756927
dtype: float64
```

```
from sklearn.externals import joblib
joblib.dump(results_MA, 'humidityModel.pkl')
```

8 TESTING:

8.1 TEST CASES:

	Testing Type	Function Result
TestingNo:1	Functionality testing	Yes
	Usability testing	Yes
	Interface testing	Yes
	Performance testing	Yes(medium)
	Security testing	Yes

	Testing Type	Function Result
TestingNo:2	Functionality testing	Yes
	Usability testing	Yes
	Interface testing	Yes
	Performance testing	Yes(medium)
	Security testing	Yes

	Testing Type	Function Result
TestingNo:3	Functionality testing	Yes
	Usability testing	Yes
	Interface testing	Yes
	Performance testing	Yes
	Security testing	Yes

	Testing Type	Function Result
TestingNo:4	Functionality testing	Yes
	Usability testing	Yes
	Interface testing	Yes
	Performance testing	Yes
	Security testing	Yes

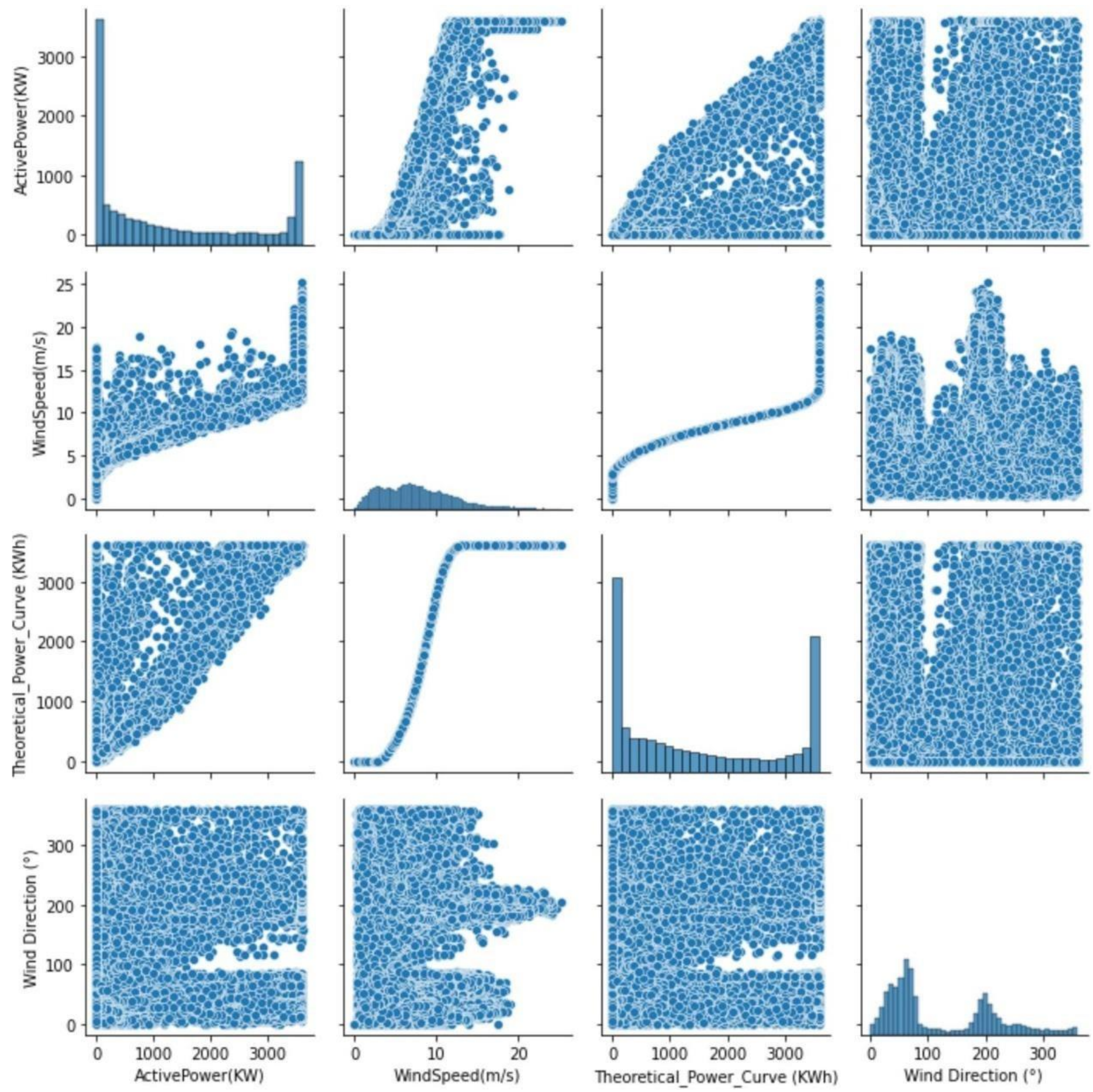
9. RESULT:

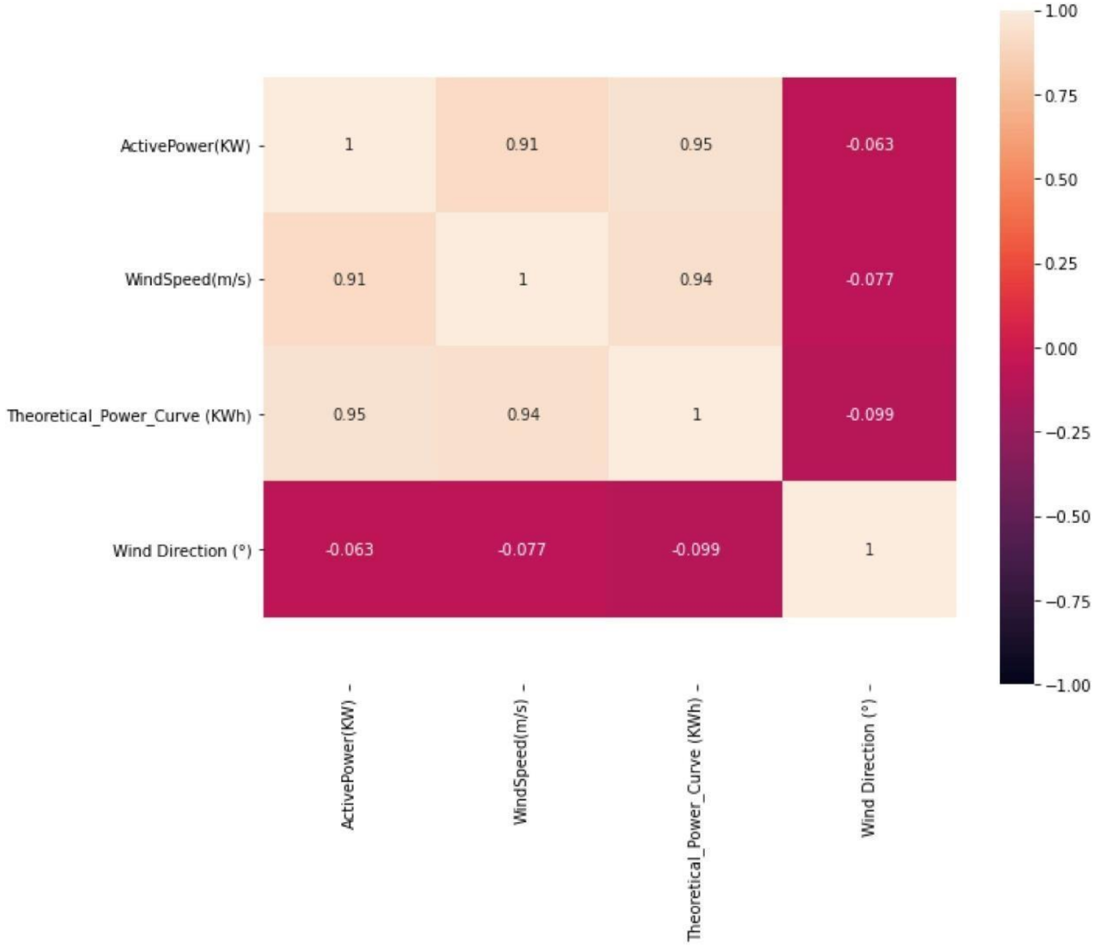
9.1 PERFORMANCE METRIES:

DATA PREPROCESSING:

Out[4]:

0	01 01 2018 00:00	380.047791	5.311336	416.328908	259.994904
1	01 01 2018 00:10	453.769196	5.672167	519.917511	268.641113
2	01 01 2018 00:20	306.376587	5.216037	390.900016	272.564789
3	01 01 2018 00:30	419.645904	5.659674	516.127569	271.258087
4	01 01 2018	380.650696	5.577941	491.702972	265.674286


ActivePower(KW)
WindSpeed(m/s)
Theoretical_Power_Curve (KWh)
Wind Direction (°)



ActivePower(KW)
WindSpeed(m/s)
Theoretical_Power_Curve (KWh)
Wind Direction (°)
1
0.91
0.95
-0.063
0.91
1
0.94
-0.077
0.95
0.94
1
-0.099
-0.063
-0.077
-0.099
1
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00

10 ADVANTAGE AND DISADVANTAGE

ADVANTAGE:

Generating energy from the wind does not release any carbon emissions.

The energy used in manufacturing and installing wind turbines can also be paid back relatively quickly.

It is a very clean energy source, which does not release any pollution or produce any waste during operation.

Harnessing wind to generate energy has its advantages and is an efficient option for many different parts of the world since it doesn't depend on direct sunlight exposure like solar energy.

Free Fuel

Since wind turbines themselves run strictly on the power of wind generated, there is no need for fuel. Once the turbine is complete and installed, it doesn't need to be fueled or connected to power to continue working. This also reduces the overall cost to continue to run large-scale wind farms in comparison to other forms renewable energies, which require may require some energy investment.

One of the Cleanest Forms of Energy

Since wind energy doesn't rely on fossil fuels to power the turbines, wind energy does not contribute to climate change by emitting greenhouse gases during energy production. The only time that wind energy indirectly releases greenhouse gases is during the manufacturing and transport of the wind turbines, as well as during the installation process. U.S. wind power lights homes and businesses with an infinitely available energy.

Advances in Technology

The latest advances in technology have transformed preliminary wind turbine designs into extremely efficient energy harvesters. Turbines are available in a wide range of sizes, increasing the market to many different types businesses and by individuals for use at home on larger lots and plots of land. As technology improves, so do the functionalities of the structure itself, creating designs that will generate even more electricity, require less maintenance, and run more quietly and safely.

Doesn't Disrupt Farmland Operations

Energy suppliers can build their wind turbines on pre-existing farmland and pay the farm owners to build on their property in the form of contracts or leases. This is a great boon to farmers who can use some extra income, and it wind turbine footprints take up very little space at the ground level, so it doesn't disrupt their farm's production. At present, less than 1.5% of contiguous U.S. land area is used by wind power plants. However, given all the plains and cattleman available on the interior of the country, there's a lot of opportunity for expansion if landowners and government land managers are up for it.

Reduces Our Dependence of Fossil Fuels

Energy generated from fossil fuels not only contributes to climate change, but we'll one day run out of it. As long as the sun heats the planet, then there's an endless supply of wind. Furthermore, developing and investing in technology that can only run on a finite resources that we may run out of our lifetime—is a terrible waste of human capital, private funds, and tax dollars

DISADVANTAGE:

Although wind energy is a renewable, greener option of energy, it still has its disadvantages and limitations.

Dangerous to Some Wildlife

Wind turbines are known to pose a threat to the wildlife. Flying birds and bats whose habitats or migratory paths could be injured or killed if they run into the blades that turn on the fanlike structure of wind turbines when they are spinning. The deaths of birds and bats are a controversial subject at wind farm sites, which has raised concerns by fish and wildlife conservation groups.[5] Aside from the wildlife that flies through the air, wildlife on the ground may also affected by the noise pollutions generated from whirring blades. Although wind turbines can cause problems for wildlife, other things such as skyscrapers and large windows are also hazardous and continue to be built without question or similar outcry.

Noisy

Wind turbines can be quite noisy, which is why they're mostly found in very rural areas where most people don't live. Depending on the location of the turbine, such as offshore, noise isn't an issue. With advancements in technology, newer designs have been shown to reduce the noise complaints and have a much quieter presence.

Expensive Upfront Cost

If you can imagine, these massive structures are often hundreds of feet tall and require substantial upfront investment. The placement of wind turbines in rural areas requires further investment in underground lines to send power to more populated areas like towns and cities where it's needed. The majority of the cost is the initial installation and building stage, but after that, wind energy produces an endless supply of energy as long as there is wind.

Unreliable/Unpredictable

Wind energy suffers from what is called intermittency, which is a disruption caused by the inconsistency of the wind itself. Since wind can blow at various speeds, it's hard to predict the amount of energy it can collect at a given time. This means suppliers and cities need to have an energy reserve or alternative sources of power in case the winds die down for longer lengths of time.

Supporting Sustainable Energy

As technology continues to advance, so will our choices of sustainable energy. Just Green is a simple energy option that we offer as an add-on to our energy plans. When you choose green energy options like just Green, you're offsetting your energy usage with renewable energy credits that stem from sustainable sources like wind, hydro, and solar energy.

CONCLUTION

There is now a range of sophisticated modelling tools, which can provide robust short-term forecasts of the output of wind farms and portfolios of wind farms. These models are being used in a range of markets for a range of different purposes. Key areas of use are by TSOs, to facilitate balancing of the grid, by energy traders to trade energy from wind farms on futures markets and by wind farm owners to optimise O&M arrangements. The use of wind energy forecasts in many countries is at an embryonic stage and there are substantial benefits to be gained from the wider adoption of current state-of-the-art forecasting in all of the areas mentioned above. In addition, changes need to be made in the way the power systems are operated and the markets are functioning. The tools are available; they just need to be more widely used.

12. FUTURE SCOPE:

Most wind power forecasting models study ‘regular’ wind conditions.

The EU funded project called ‘Safe wind’ aims to improve wind power prediction over challenging and extreme weather periods and at different temporal and spatial scales.

Development activities are on-going to reduce error in the wind power prediction, to improve regionalized wind power forecasting for on - shore windfarms and to derive methods for wind power prediction for offshore wind farms.

It is possible that use of ensemble and combined weather prediction methods together may enhance forecasting.

If the error in wind power forecasting and prediction is reduced then electricity markets can trade with more certainty. Contract errors as a function of time in electricity markets can be as high as 39% for a forecasting lead time of 4 present a new tool called the WILMAR and ANEMOS scheduling Methodology (WALT) to reduce the number of thermal generators on stand-by or in reserve using the probability of generation outages and load shedding are system reliability criteria instead of generation adequacy based solely on generation outage.

The wind and load forecast errors are modelled using a Gaussian stochastic variable approach.

However, in another study it was found that the prediction errors do not satisfy the Kolmogorov Smirnov test for normal distribution.

In Carta , it was shown that, the use of auto correlated (and thus not independent) successive hourly mean wind speeds, though invalidating all of the usual statistical tests, has no appreciable effect on the shape of the pdf estimated from the data.

13 APPENDIX:

13.1 SOURCE CODE:

app.py

```
import numpy as np
from flask import Flask, request, jsonify, render_template
import joblib
import requests

app = Flask(__name__)
model = joblib.load('Power_Prediction.sav')


@app.route('/')
def home():
    return render_template('intro.html')


@app.route('/predict')
def predict():
    return render_template('predict.html')


@app.route('/windapi', methods=['POST'])
def windapi():
    city = request.form.get('city')
    apikey = "a802b0f626c637d04185e582b5ad0d58"
    url = "http://api.openweathermap.org/data/2.5/weather?q="+city+"&appid="+apikey
    resp = requests.get(url)
    resp = resp.json()
    temp = str((resp["main"]["temp"])-273.15) + " °C"
    humid = str(resp["main"]["humidity"])+" %"
    pressure = str(resp["main"]["pressure"])+" mmHG"
    speed = str((resp["wind"]["speed"])*3.6)+" Km/s"
    return render_template('predict.html', temp=temp, humid=humid, pressure=pressure,
speed=speed)
```

```python
@app.route('/y_predict', methods=['POST'])
def y_predict():
    '''
    For rendering results on HTML GUI
    '''
    x_test = [[float(x) for x in request.form.values()]]
    prediction = model.ppredict(x_test)
    print(prediction)
    output = prediction[0]
    return render_template('predict.html', prediction_text='The energy predicted is {:.2f}
KWh'.format(output))


if __name__ == "__main__":
    app.run(debug=False)
```

predict.html

```html
<html>
    <head>
        <meta charset="UTF-8" />
        <meta name="viewport" content="width=device-width, initial-scale=1.0" />
        <meta http-equiv="X-UA-Compatible" content="ie=edge" />
        <link rel="stylesheet"
href="https://use.fontawesome.com/releases/v5.7.2/css/all.css"
            integrity="sha384-
fnmOCqbTlWIlj8LyTjo7mOUStjsKC4pOpQbqyi7RrhN7udi9RwhKkMHpvLbHG9Sr"
crossorigin="anonymous" />
        <link href="https://fonts.googleapis.com/css?family=Dosis" rel="stylesheet" />
        <link rel="stylesheet" href="static/css/main.css"/>
        <link rel="stylesheet" href="static/css/media.css"/>
        <link rel="stylesheet" href="static/css/items_grid.css"/>
```

```
    <title>Wind Energy Prediction</title>
    <style>
#page {
  max-width: 80%;
  margin: auto;
}
body {
    background-image: url(https://images2.alphacoders.com/753/753985.jpg);
    width: 100%;
    height: 100%;
    background-repeat: no-repeat;
    background-attachment: fixed;
    background-size: cover;
    overflow: hidden;

}
table {
        width: 100%;
        border-collapse: collapse;
}

.card {
            margin-right: auto;
            margin-left: 15%;
            width: 300px;
            box-shadow: 0 15px 25px rgba(129, 124, 124, 0.2);

            border-radius: 5px;
            backdrop-filter: blur(14px);
            background-color: rgb(180, 180, 180);
            padding: 15px;
            text-align: center;
        }
        .head {
```

```
        top:0px;
        margin:0px;
        left: 0px;
        right: 0px;
        position: fixed;
        background: #aeb90f;
        color: white;
        overflow: hidden;
        padding-bottom: 30px;
        font-size: 2.25vw;
        width: 100%;
        padding-left:0px;
        text-align: center;
        padding-top:20px;
    }
    .second{
        top:80px;
        bottom:0px;
        margin:0px;
        left: 0px;
        right: 0px;
        position: fixed;
        padding: 0px;
        width: 100%;

        font-family:Georgia, serif;
        color:black;
        font-size:20px;
    }
    .inside{
        top:80px;
        bottom:0px;
        margin:0px;
        left: 51%;
        right: 0%;
```

```
        position: fixed;
        padding-left: 40px;
        padding-top:8%;
        padding-right:40px;

        font-family:Georgia, serif;
        color:#96f400;
        font-size:20px;
        text-align:justify;

    }
    .myButton{
         border: none;
         text-align: center;
         cursor: pointer;
         text-transform: uppercase;
         outline: none;
         overflow: hidden;
         color: #fff;
         font-weight: 700;
         font-size: 12px;
         background-color: #183a1d;
         padding: 10px 15px;
         margin: 0 auto;
         box-shadow: 0 5px 15px rgba(0,0,0,0.20);
         margin-left:17%;
    }
input {
width:50%;
margin-bottom: 10px;
background: #e1eedd;
border: none;
outline: none;
padding: 10px;
font-size: 13px;
```

```
    color: #6c493a;
    text-shadow: white;
    border: #6c493a;
    border-radius: 4px;
    box-shadow: white;
}
::placeholder {
  color: black;
  opacity: 1;
}

.left{
        top:80px;
            bottom:0px;
            margin:0px;
            left: 0%;
            right: 45.5%;
            position: fixed;
            padding-left: 10%;
            padding-top:5%;
            padding-right:40px;

            font-family:bold,Georgia, serif;
            color:rgb(238, 255, 0);;
            font-size:25px;

}
    select {
    width:50%;
    margin-bottom: 10px;
    background: white;
    border: none;
    outline: none;
    padding: 10px;
    font-size: 13px;
```

```
    color: #183a1d;
    text-shadow: white;
    border: #6c493a;
    border-radius: 40px;
    box-shadow: white;
}

input:focus { box-shadow: inset 0 -5px 45px rgba(100,100,100,0.4), 0 1px 1px
rgba(255,255,255,0.2); }



          table, th, td {
  border: 1px solid rgb(86, 72, 128);
  border-collapse: collapse;
  color: #3f00ff;
}

@media screen and (max-width: 500px) {

  .left,
  .second,
  .third {
      width: 70%;
  }
}



    </style>
    </head>
    <body>


        <header id="head">
```

```
        <div class="head">Predicting The Energy Output Of Wind Turbine Based On
Weather Condition</div>
        </header>


        <div class="second">
        <div class="left">

            <p style="padding: 8px; border: 1px solid rgb(0, 110, 255); width: 575px;"> GIVE
YOUR CITY NAME TO KNOW THE WEATHER CONDITIONS</p>

        <div style="margin-left:10%">
        <form action="{{ url_for('windapi')}}"method="post" >
                <select name="city"  required >
                    <option value="" selected>select City</option>
                    <option value ="Ariyalur"   >   Ariyalur    </option>
                    <option value ="Andimadam"  >   Andimadam   </option>
                    <option value ="Coimbatore" >   Coimbatore  </option>
                    <option value ="Chengalpattu"   >   Chengalpattu    </option>
                    <option value ="Cuddalore"  >   Cuddalore   </option>
                    <option value ="Chennai"    >   Chennai </option>
                    <option value ="Dindigul"   >   Dindigul    </option>
                    <option value ="Dharmapuri" >   Dharmapuri  </option>
                    <option value ="Erode"  >   Erode   </option>
                    <option value ="Karur"  >   Karur   </option>
                    <option value ="Kancheepuram"   >   Kancheepuram    </option>
                    <option value ="Krishnagiri"    >   Krishnagiri </option>
                    <option value ="Kallakurichi"   >   Kallakurichi    </option>
                    <option value ="Madurai"    >   Madurai </option>
                    <option value ="Mayiladuthurai" >   Mayiladuthurai  </option>
                    <option value ="Nagapattinam"   >   Nagapattinam    </option>
                    <option value ="Kanyakumari"    >   Kanyakumari </option>
                    <option value ="Namakkal"   >   Namakkal    </option>
                    <option value ="Perambalur" >   Perambalur  </option>
                    <option value ="Pudukottai" >   Pudukottai  </option>
```

```
          <option value ="Ramanathapuram" >   Ramanathapuram  </option>
          <option value ="Ranipet"     >   Ranipet </option>
          <option value ="Salem"  >   Salem   </option>
          <option value ="Sivagangai" >   Sivagangai  </option>
          <option value ="Tenkasi"     >   Tenkasi </option>
          <option value ="Thanjavur"  >   Thanjavur   </option>
          <option value ="Theni"  >   Theni   </option>
          <option value ="Thiruvallur"     >   Thiruvallur </option>
          <option value ="Thiruvarur" >   Thiruvarur  </option>
          <option value ="Tuticorin"  >   Tuticorin   </option>
          <option value ="Trichirapalli"  >   Trichirapalli   </option>
          <option value ="Thirunelveli"   >   Thirunelveli    </option>
          <option value ="Tirupathur" >   Tirupathur  </option>
          <option value ="Tiruppur"   >   Tiruppur    </option>
          <option value ="Tiruvannamalai" >   Tiruvannamalai  </option>
          <option value ="The Nilgiris"   >   The Nilgiris    </option>
          <option value ="Vellore"    >   Vellore </option>
          <option value ="Viluppuram" >   Viluppuram  </option>
          <option value ="Virudhunagar"   >   Virudhunagar    </option>


        </select><br><br>
        <div style="margin-left:-15%"><button type="submit"
class="myButton" >Check the Weather Conditions</button></div>

      </form>
      </div>
      <br>

      <div class="card">
      <table style="margin-left:2%; text-align:center; border-spacing:20px;">
        <tr>
          <td colspan="2" style="font-size:25px;">The weather conditions of the
city are</td>
        </tr>
```

```
            <tr>
                <td>Temperature</td><td>{{temp}}</td>
            </tr>
            <tr>
                <td>Humidity</td><td>{{humid}}</td>
            </tr>
            <tr>
                <td>Pressure</td><td>{{pressure}}</td>
            </tr>
            <tr>
                <td>Wind Speed</td><td>{{speed}}</td>
            </tr>
        </table>
        </div>
    </div>
        <div class="inside">
        <div style="font-size:23px;font-weight:bold;">Predict the Wind Energy!!</div>
        <br><br>
        <form action="{{ url_for('y_predict')}}"method="post">
            <input type="text" name="theo" placeholder="Theoretical Power in KWh"
required="required"  />
            <input type="text" name="wind" placeholder="Wind Speed in m/s"
required="required"  /><br><br>
            <button type="submit" class="myButton" >Predict</button>

        </form>


       <br>
       <br>
       {{ prediction_text }}

    </div>



    </div>
```

```
    </body>

</html>
```

Intro.html

```
<html>
    <head>
    <title>Wind Energy Prediction</title>
    <style>

        .header {
            top:0px;
            margin:0px;
            left: 0px;
            right: 0px;
            position: fixed;
            background: #a4a717;
            color: rgb(255, 255, 255);
            overflow: hidden;
            padding-bottom: 30px;
            font-family:Georgia, 'Times New Roman', Times, serif, serif;
            font-size: 2.5vw;
            width: 100%;
            padding-left:0px;
            text-align: center;
            padding-top:20px;
        }
        .second{
            top:90px;
            bottom:0px;
            margin:0px;
            left: 0px;
            right: 0px;
            position: fixed;
```

```
        padding: 0px;
        width: 100%;
        background-
image:url(https://i.pinimg.com/originals/c4/d2/f9/c4d2f98e88a85b702f8ff257d74714d
8.gif);
        background-repeat:no-repeat;
        background-size: contain;
    }
    .inside{
        top:90px;
        bottom:0px;
        margin:0px;
        left: 35%;
        right: 0%;
        position: fixed;
        padding-left: 40px;
        padding-top:15%;
        padding-right:40px;
        background-color:#f5e3c5;
        opacity: 100%;
        font-family:Georgia, serif;
        color:black;
        font-size:20px;
        text-align:justify;

    }
    .myButton{
          border: none;
          text-align: center;
          cursor: pointer;
          text-transform: uppercase;
          outline: none;
          overflow: hidden;
          color: #fff;
          font-weight: 700;
```

```
            font-size: 15px;
            background-color: #6c493a;
            padding: 10px 15px;
            margin: 0 auto;
            box-shadow: 0 5px 15px rgba(0,0,0,0.20);
        }
    </style>
    </head>
    <body>

        <div class="header">Predicting The Energy Output Of Wind Turbine Based On
Weather Condition</div>
        <div class="second">
            <div class="inside">A wind turbine turns wind energy into electricity using the
aerodynamic force from the rotor blades, which work like an airplane wing or helicopter
rotor blade. <br><br>
                The amount of electricity generated by wind increased by almost 273 TWh
in 2021 (up 17%), 45% higher growth than that achieved in 2020 and the largest of all
power generation technologies. Wind remains the leading non-hydro renewable
technology, generating 1 870 TWh in 2021, almost as much as all the others combined.
        <br><br><br>
        <a href="{{url_for('predict')}}"><button type="button" class="myButton" >Click
Here To Predict The wind Energy!</button></a>
        </div>



        </div>
    </body>
</html>
```