A Project Report
on

PREDICTING THE ENERGY OUTPUT OF WINDTURBINE BASED ON WEATHER CONDITION

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TABLE OF CONTENTS

Chapter No	TITLE	PAGE NO
1.	INTRODUCTION	5
2.	LITERATURE SURVEY	6
3.	IDEATION AND PROPOSED SOLUTION	11
4.	REQUIREMENT ANALYSIS	18
5.	PROJECT DESIGN	21
6.	PROJECT PLANNING & SCHEDULING	27
7.	CODING AND SOLUTIONING	31
8.	TESTING	35
9.	RESULTS	40
10.	ADVANTAGES & DISADVANTAGES	42
11.	CONCLUSION	43
12.	FUTURE SCOPE	44
13.	APPENDIX	45

LIST OF TABLES

Table No	TITLE	Page no
3.1	Proposed Solution table	15
4.1	Functional Requirement	18
4.2	Non-Functional Requirements	19
5.1	Components &Technologies	23
5.2	Application characteristics	24
5.3	User Stories	25
6.1	Sprint Planning & Estimation table	27
6.2	Sprint Delivery Schedule table	29

LIST OF FIGURES

Figure No	TITLE	Page No
3.1	Empathy map canvas	11
3.2	Team gathering, collection and Select the problem statement	12
3.3	Brain Storm	13
3.4	Idea Prioritization	14
3.5	Prolem Solution Fit	17
5.1	Data Flow Diagram Level 0	21
5.2	Data Flow Diagram Level 1	22
5.3	Data Flow Diagram Level 2	22
5.4	Solution & Technical Architecture	23
6.1	Burndown Chart	30
7.1	Collection of datasets	32
7.2	Checking null Entries	33
7.3	Splitting of Dataset	34
8.1	Test Case	35
8.2	Home Page	36
8.3	About Page	36
8.4	Services Page	37
8.5	Contact Page	37
8.6	Input Page	38
8.7	Weather report from API	38
8.8	Predicting the energy output for wind turbine	39
9.1	Performance Metrics	40
9.2	Network function	41

CHAPTER 1
INTRODUCTION

1.1 PROJECT OVERVIEW

Wind power generation is increasing rapidly and the availability of wind energy depends on the wind speed, which is a random variable. This highly dependson the weather conditions at that place. In our project, we propose an intelligent technique for forecasting wind speed and power output of a wind turbine from several hours up to 72 hours ahead. We will carry out this problem on publicly available weather and energy data sets correlating and considering different featuresin our project. This will enable us to cut down on production costs and collaborate on different energy sources more efficiently. 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.

1.2 PURPOSE

In our project, we propose an intelligent technique for forecasting wind speed and power output of a wind turbine from several hours up to 72 hours ahead. This will enable us to cut down on production costs and collaborate on different energy sources more efficiently. 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 windfarm. In particular, the wind speed is crucial for energy production based on windand 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.

CHAPTER 2
LITERATURE SURVEY

2.1 EXISTING PROBLEM

Wind power generation is rapidly picking up in many countries. With the ever-increasing demand for electricity which powers our industries, technology and our homes, it is of importance to consider using it in a responsible way. That iswhere the concept of non-conventional energy sources like wind energy comes in. The one disadvantage with this form of generating power is the uncertainty in thewind direction, speed, and other climatic changes in the concerned area.

2.2 REFERENCES

2.2.1. TITLE: Predicting the Wind Turbine Power Generation based on Weather Conditions

AUTHOR: S. Preethi, H. Prithika, M. Pramila and S. Birundha

DESCRIPTION: 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.

2.2.2. TITLE: Wind turbine power output prediction model design based on artificial neural networks and climatic spatiotemporal data

AUTHOR: B. Bilal *et al*.

DESCRIPTION: This paper deals with the prediction of wind turbines power output and proposes an approach to building a prediction model using the Artificial Neural Networks (ANN). The wind speed and output power measured on the site of Sendou, in Senegal, were used to identify the structure of the ANN. Spatiotemporal data on the climatic variables (wind speed, solar radiation, temperature, humidity, wind direction) collected on the same site were used to train the ANN. Data collected on three other sites (Goback, Keur Abdoul Ndoye and Sine Moussa Abdou), located on the northwest coast of Senegal, were used to validate the model and to analyze the influence of the spatial climatic variables on the performance of the model. Results showed the interest of considering climatic variables (wind speed, wind direction, solar radiation, temperature and humidity) as inputs to the ANN for wind turbines output power prediction. Further, this study showed that the prediction of the produced power depends strongly on the characteristics of the sites and the direction of the wind.

2.2.3. TITLE: Wind Turbine Power Output Estimation with Probabilistic Power Curves

AUTHOR: S. Ge, M. J. Zuo and Z. Tian

DESCRIPTION: Wind turbine power output estimation is an important problem in wind energy research work. Deterministic and probabilistic power curve models were reported when predicting the wind turbine power output. This paper proposes a probabilistic power curve model, and demonstrates it using field data from a wind farm in Alberta, Canada. Normal distribution and Weibull distribution are used to represent the probability density function of power output at various wind speed. Monte Carlo simulation is used to generate random predicting power output. The predicted result is compared with the observed data by 3 measurements and the proposed model is found performs better than other deterministic models and probabilistic models.

2.2.4. TITLE: Wind Power Forecasts Using Gaussian Processes and Numerical Weather Prediction

AUTHOR: N. Chen, Z. Qian, I. T. Nabney and X. Meng

DESCRIPTION: Since wind at the earth's surface has an intrinsically complex and stochastic nature, accurate wind power forecasts are necessary for the safe and economic use of wind energy. In this paper, we investigated a combination of numeric and probabilistic models: a Gaussian process (GP) combined with a numerical weather prediction (NWP) model was applied to wind-power forecasting up to one day ahead. First, the wind-speed data from NWP was corrected by a GP, then, as there is always a defined limit on power generated in a wind turbine due to the turbine controlling strategy, wind power forecasts were realized by modeling the relationship between the corrected wind speed and power output using a censored GP. To validate the proposed approach, three real-world datasets were used for model training and testing. The empirical results were compared with several classical wind forecast models, and based on the mean absolute error (MAE), the proposed model provides around 9% to 14% improvement in forecasting accuracy compared to an artificial neural network (ANN) model, and nearly 17% improvement on a third dataset which is from a newly-built wind farm for which there is a limited amount of training data.

2.2. REFERENCES

1. S. Preethi, H. Prithika, M. Pramila and S. Birundha, "Predicting the Wind Turbine Power Generation based on Weather Conditions," *2021 5th International Conference on Electronics, Communication and Aerospace Technology (ICECA)*, 2021, pp. 132-139, doi: 10.1109/ICECA52323.2021.9676051.

2. B. Bilal *et al*., "Wind turbine power output prediction model design based on artificial neural networks and climatic spatiotemporal data," *2018 IEEE International Conference on Industrial Technology (ICIT)*, 2018, pp. 1085-1092, doi: 10.1109/ICIT.2018.8352329.

3. S. Ge, M. J. Zuo and Z. Tian, "Wind Turbine Power Output Estimation with Probabilistic Power Curves," *2020 Asia-Pacific International Symposium on Advanced Reliability and Maintenance Modeling (APARM)*, 2020, pp. 1-6, doi: 10.1109/APARM49247.2020.9209346.

4. N. Chen, Z. Qian, I. T. Nabney and X. Meng, "Wind Power Forecasts Using Gaussian Processes and Numerical Weather Prediction," in *IEEE Transactions on Power Systems*, vol. 29, no. 2, pp. 656-665, March 2014, doi: 10.1109/TPWRS.2013.2282366.

2.3 PROBLEM STATEMENT DEFINITION

The prediction of wind power plays an indispensable role in maintaining the stability of the entire power grid. Due to its renewable resources and environmental friendliness, wind speed/power has gained increasing interest worldwide. The wind industry is rapidly expanding into a large-scale industry as a result of the fast-rising amount of installed wind generating capacity worldwide. When it comes to scheduling power systems and other practical aspects of wind energy conversion, such as the dynamic management of wind turbines, reliable short-term wind speed forecasts are essential. A precise forecast is required to solve issues with variable energy production brought on by changing weather patterns. The wind speed has a big impact on how much power is produced by the wind. Despite being quite nonlinear, wind speed exhibits a consistent pattern over a specific amount of time. 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.

CHAPTER 3

IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

An empathy map is a collaborative tool team can use to gain a deeper insight into their customers. In this empathy map, we added What they Think andFeel, Hear, See, Say and do.

Figure: 3.1 - Empathy map canvas

3.2 IDEATION & BRAINSTORMING

Brainstorm & Idea Prioritization:

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

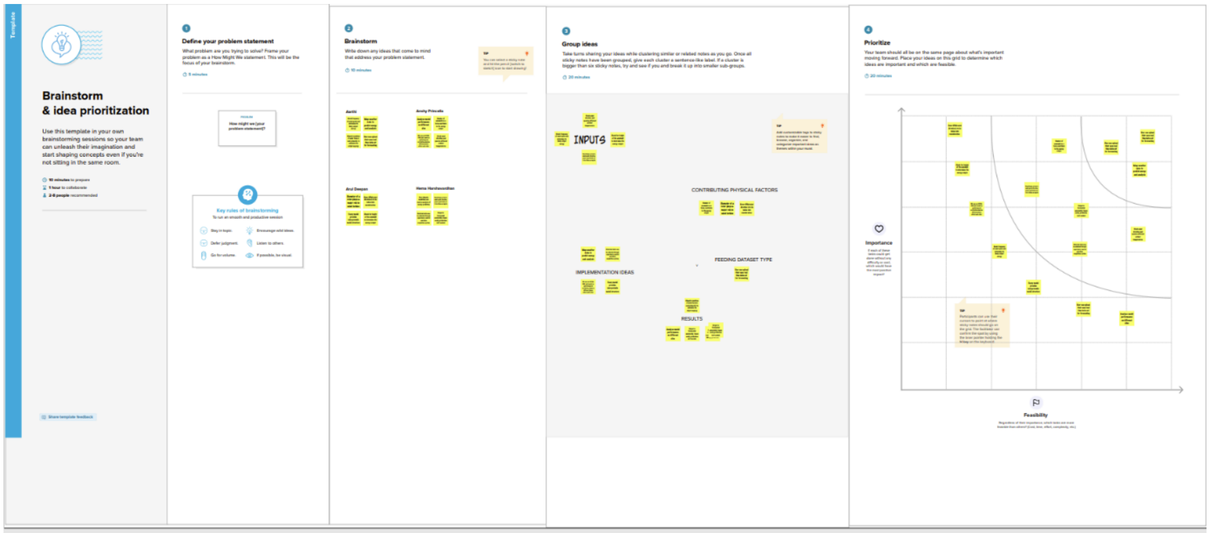
Step 2: Brain Strom, Idea Listing, and Grouping

In this step, we listed the idea for each member of the team and grouped the ideaaccordingly.

Step 3: Idea Prioritization

In this step, we decide the most prioritized process to do first to deploy the project using the cloud to give a complete executable application.

FIGURE: 3.2 - IDEATION & BRAINSTORMING



3.1 PROPOSED SOLUTION

The project team shall fill in the following information in the proposed solution.

I am	I'm trying to	But	Because	Which makes me feel
A manufacturer	Produce high quality of wind energy	I don't know where to place the windmills	I don't have an analysis of weather conditions	Concerned
A user	Prevent power cuts and find a reliable energy source	I don't know if wind energy is the most efficient solution to my dilemma	I don't know the wind patterns of my region	Worried
An organization	produce wind energy	I face overproduction and high cost issues	I can't accurately predict the wind energy	Sad

Table: 3.1 - Proposed Solution table

3.1 PROBLEM SOLUTION FIT

Figure: 3.5 - Problem Solution Fit

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 Functional requirement

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 username and password.	Registration through Form.
FR-2	User Confirmation by validating the username with respect to the password	Confirmation via pop-up Message.
FR-3	Displaying the further information about the application.	By selecting the about button thedetails 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.

Table: 4.1 - Functional Requirement

4.2 NON - FUNCTIONAL REQUIREMENT

Following are the non-functional requirements of the proposed solution.

NFR 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 protectedfrom 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 degradeeven the workload is increased.
NFR-5	Availability	The application is available for 24*7

NFR-6	Scalability	The system can be used as web application as well as mobile application with a sufficient internet availability.

Table: 4.2 - Non-Functional Requirement

CHAPTER 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAM

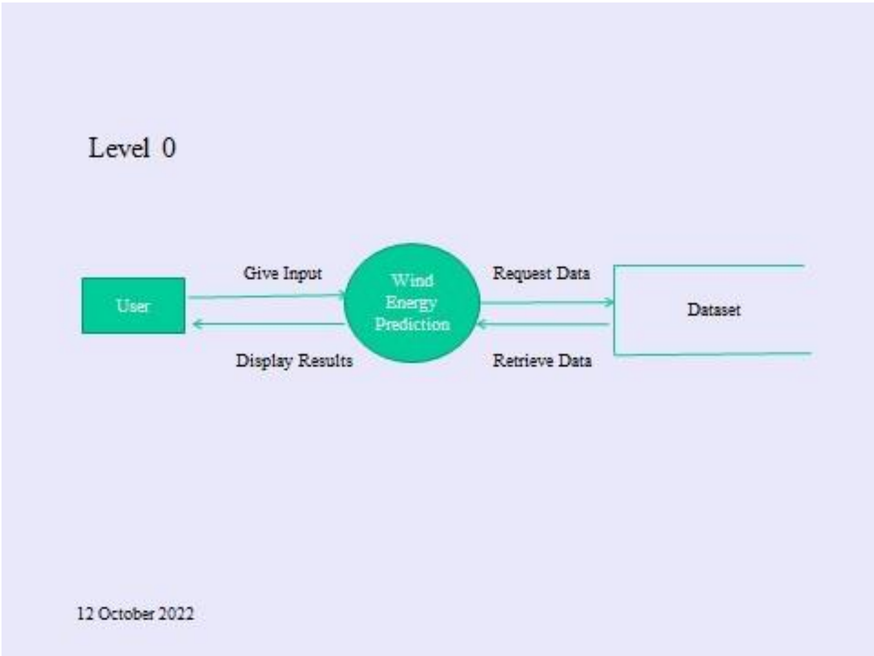


Figure: 5.1.1 - Data Flow Diagrams Level 0

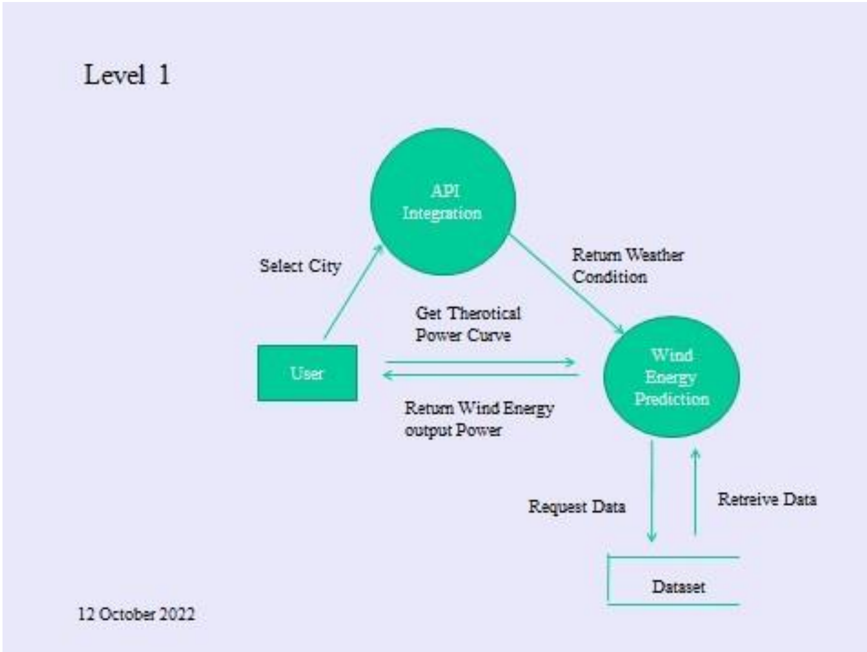


Figure: 5.1.2 - Data Flow Diagrams Level 1

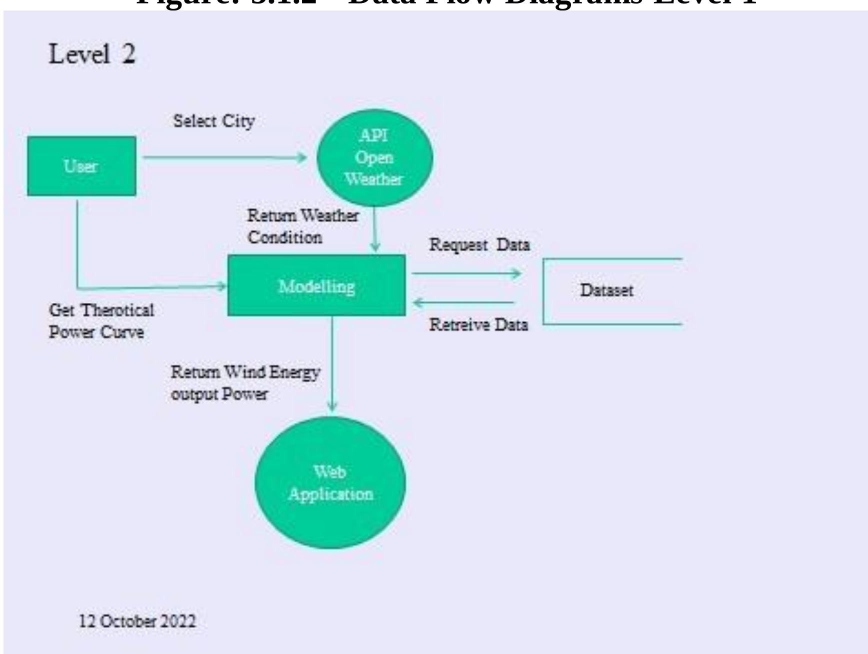


Figure: 5.1.3 - Data Flow Diagrams Level 2

5.2 SOLUTION & TECHNICAL ARCHITECTURE

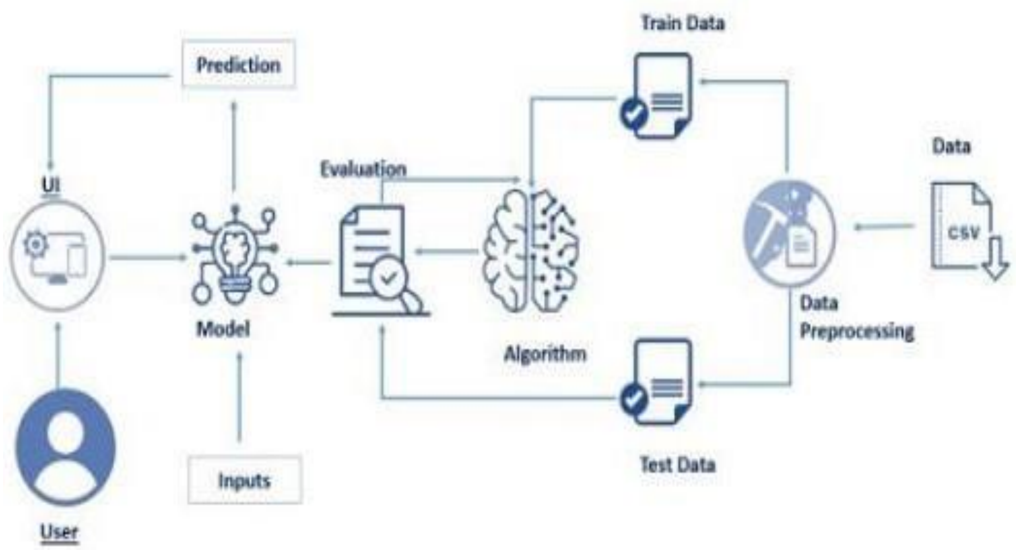


Figure: 5.2 - Solution & Technical Architecture

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	The open source framework used in this system is flexible and it includes R, python etc..	IBM Open source Tools and databases.
2.	Security Implementations	The data stored in the database when shared with industries are encrypted	Encryptions, IAM Controls, OWASP etc.

3	Scalable Architecture	The architecture used here is a 3tier architecture where a middleware is present	3tier architecture.

Table: 5.2 - Application characteristics

5.2 USER STORIES

User Type	Functional Requirements	User NumerStory	User Story/UserTask	Acceptance Criteria	Priority	Release
Customer	HomeHome (Application)	USN-1	As a user, I can view the guideline as well as the detailed information about the application	I can gain knowledge by practical method to use this application .	Low	Sprint-1
		USN-2	As a User, I can use this application by reading the instructions	I can use thisin user friendly method by reading the instruction.	Low	Sprint-1

		USN-3	As a User, I can login and by entering the correct username and password	If login is correctly entered,I can navigate to the next page.	**Low**	**Sprint-2**
		USN-4	As a user ,I am allowed to select the city and can get the weather of thecity.	I can select the city ,If the city is correct I can further enter the details.	**Medium**	**Sprint-3**
		USN-5	As a user I am allowedto viewthe weather of the selectedcity.	If correctcity selected the weather of the particulacity will be display ed	**Medium**	**Sprint-4**

Table: 5.3 - User Stories

CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	5	High	Aarthi Anshy Aruldeepan Hemaharsha vardhan
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	5	High	Aarthi Anshy Aruldeepan Hemaharsha vardhan
Sprint-1		USN-3	As a user, I can register for the application using phone number	2	Low	Aarthi Anshy Aruldeepan Hemaharsha vardhan
Sprint-1		USN-4	As a user, I can register for the application through Gmail	3	Medium	Aarthi Anshy Aruldeepan Hemaharsha vardhan
Sprint-1	Login	USN-5	As a user, I can log into the application by entering email & password	5	High	Aarthi Anshy Aruldeepan Hemaharshavardhan
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-2	Dashboard	USN-6	Once I have logged in, I can see my dashboard.	6	Medium	Aarthi Anshy Aruldeepan Hemaharsh avardhan
Sprint-2	Web Access	USN-7	As a customer I can access the website to predict the turbine power.	7	High	Aarthi Anshy Aruldeepan Hemaharshav ardhan
Sprint-2	Prediction	USN-8	As a customer when I enter the weather details the website should predict the approximate turbine power.	7	High	Aarthi Anshy Aruldeepan Hemaharshav ardhan
Sprint-3	Analysis	USN-9	As a customer, I wish to store my predictions and make analyses.	10	Medium	Aarthi Anshy Aruldeepan Hemaharsh avardhan
Sprint-3	Security	USN-10	As a customer I expect my data to be secured.	10	Medium	Aarthi Anshy Aruldeepan Hemaharshav ardhan
Sprint-4	Database Access	USN-11	As an administrator, I should maintain the website and update the website regularly.	20	Low	Aarthi Anshy Aruldeepan Hemaharsh avardhan

Table: 6.1 - Sprint Planning & Estimation table

6.2 SPRINT DELIVERY SCHEDULE

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date(Actual)
Sprint-1	20	6 Days	24-Oct-2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31-Oct-2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	7-Nov-2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14-Nov-2022	19 Nov 2022	20	19 Nov 2022

Table: 6.2 - Sprint Delivery Schedule table

Velocity:

We have a 6-day sprint duration, and the velocity of the team is 20 (points persprint). The team's average velocity (AV) per iteration unit (story points per day)

AV = Sprint duration / velocity= 20 / 6 = 3.33

6.3 REPORT FROM JIRA

Reporting helps you track and analyze your team's work throughout a project. Jira Software has a range of reports that you can use to show information about your project, versions, epics, sprints, and issues. A burnup chart highlightsthe work you've completed against your total project scope while a burn-downchart highlights the amount of work remaining in a project. A burnup chart contains a work completed line and a project scope line.

BURNDOWN CHART

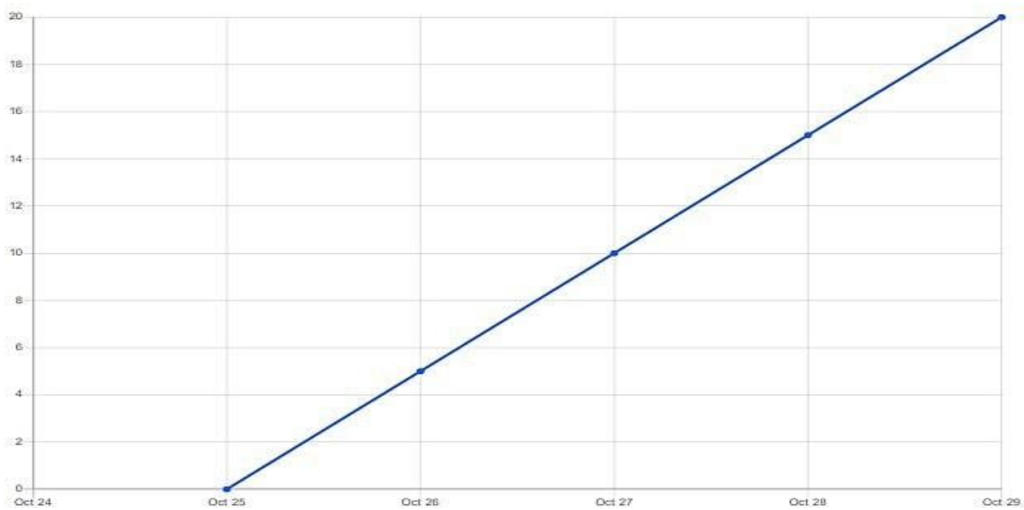


Figure: 6.1 - Burndown Chart

CHAPTER 7

CODING AND SOLUTION

7.1 FEATURE 1

Python flask is the first feature that helps to complete this project. It allows the user to create a local server and host the website on a local machine. Software programs are constructed using a framework as their foundation. It gives software developers a base upon which to build a range of apps for particular platforms. It is a collection of built-in classes and functions that link to the system software and manage inputs and outputs.

```
from flask import Flask,render_template,request,url_for,redirect.
```

Here we importall the necessary features of this project involvingin Python flask.

```
@app.route("/",methods=['POST','G
ET'])def index():
return render_template("index.html")
```

Here we created a local client’s own server which serves the .html pages to the users.

Here we use the inputs from the html pages which has to be get by using request method in Python Flask. By validating the values from the database, we allow the user to access the home page.

render_template : Used for rendering html pages on browser. url_for : Passing the control of the program to another function.session: Creates a separate session for the individual user.

7.2 FEATURE 2

Different types of python libraries such as pandas, Sklearn, NumPy, matplotlib are used for processing the algorithms. Using exploration data analysis technique data was analyses in junketeer notebook.10-fold cross validation technique is used for spitting the data set into training and testing data. Thenusing random forest algorithm dataset was processed.

COLLECTION OF DATASET

For the proposed study dataset was taken from Kaggle site. Then it was downloaded in excel file using comma separated format. Data has processed by python programming using Jupiter notebook.

```
data = pd.read_csv('wind_dataset.csv')
data.rename(columns = {'LV ActivePower (kW)':'ActivePower(kW)',
                       "Wind Speed (m/s)":"WindSpeed(m/s)",
                       "Wind Direction (°)":"WindDirection","Theoretical_Power_Curve (KWh)":"TheoreticalPowerCurve(KWh)"},
            inplace = True)
data.head()
```

	Date/Time	ActivePower(kW)	WindSpeed(m/s)	TheoreticalPowerCurve(KWh)	WindDirection
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	419.645905	5.659674	516.127569	271.258087
4	01 01 2018 00:40	380.650696	5.577941	491.702972	265.674286

Figure: 7.1 - Collection of datasets

PREPROCESSING - DATA CLEANINGCHECKING NULL ENTRIES

The most important step in EDA involving removing duplicate rows/columns,filling the void entries with values like mean/median of the data, dropping various values, removing null entries. Here we have check for null values and drop the entries which contains null values as the percentage of null values in dataset is very less.

```
data.isnull().any()
```

```
Date/Time                      False
ActivePower(kW)                False
WindSpeed(m/s)                 False
TheoreticalPowerCurve(KWh)     False
WindDirection                  False
dtype: bool
```

```
data.describe()
```

	ActivePower(kW)	WindSpeed(m/s)	TheoreticalPowerCurve(KWh)	WindDirection
count	50530.000000	50530.000000	50530.000000	50530.000000
mean	1307.684332	7.557952	1492.175463	123.687559
std	1312.459242	4.227166	1368.018238	93.443736
min	-2.471405	0.000000	0.000000	0.000000
25%	50.677890	4.201395	161.328167	49.315437
50%	825.838074	7.104594	1063.776283	73.712978
75%	2482.507568	10.300020	2964.972462	201.696720
max	3618.732910	25.206011	3600.000000	359.997589

Figure: 7.2 - Checking Null Entries

SPLITTING OF DATASET

```
In [10]: X=data[['WindSpeed(m/s)','WindDirection']]
         X.head()
```

Out[10]:

	WindSpeed(m/s)	WindDirection
0	5.311336	259.994904
1	5.672167	268.641113
2	5.216037	272.564789
3	5.659674	271.258087
4	5.577941	265.674286

Figure: 7.3 - Splitting of dataset

CHAPTER 8

TESTING

8.1 TEST CASES

In [1]:

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

In [2]:

```
data = pd.read_csv("T1.csv")
```

In [3]:

```
#head funtion and tail funtion
data.head()
```

Out[3]:

	Date/Time	LV ActivePower (kW)	Wind Speed (m/s)	Theoretical_Power_Curve (KWh)	Wind Direction (°)
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	419.645905	5.659674	516.127569	271.258087
4	01 01 2018 00:40	380.650696	5.577941	491.702972	265.674286

In [4]:

Figure: 8.1 - Test Cases

8.2 USER ACCEPTANCE

TESTINGHOME PAGE

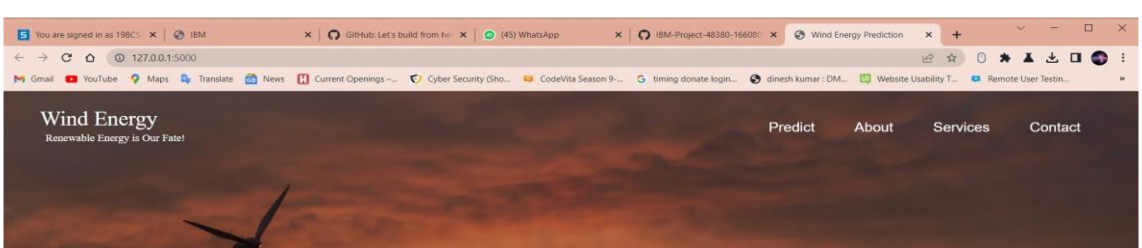


Figure: 8.2 - Home page

ABOUT PAGE

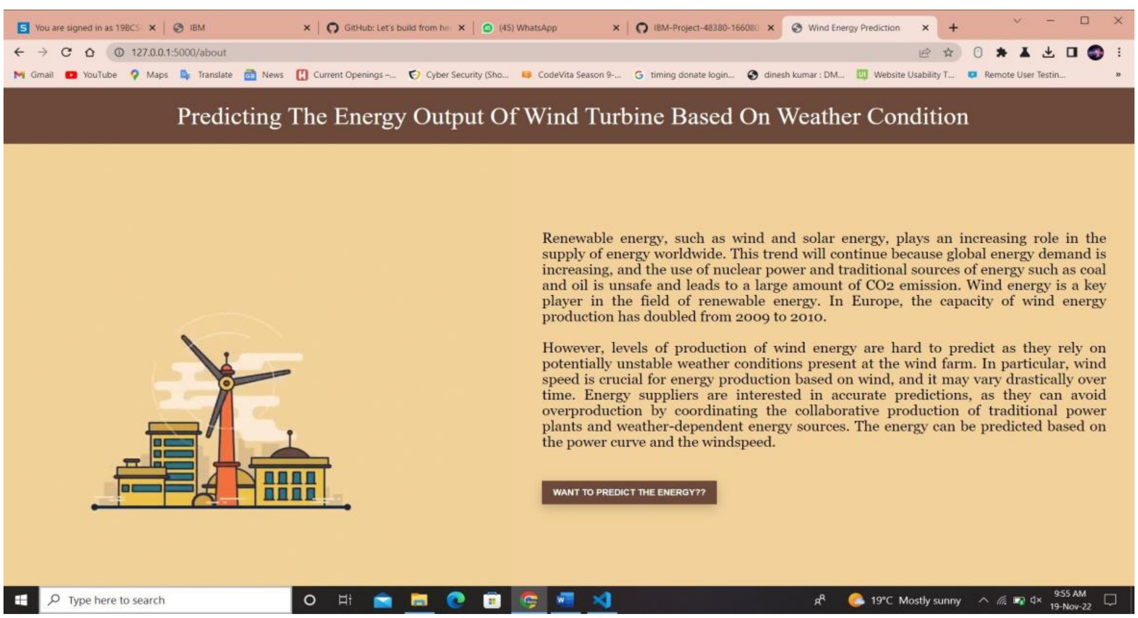


Figure: 8.3 - About Page

SERVICES PAGE

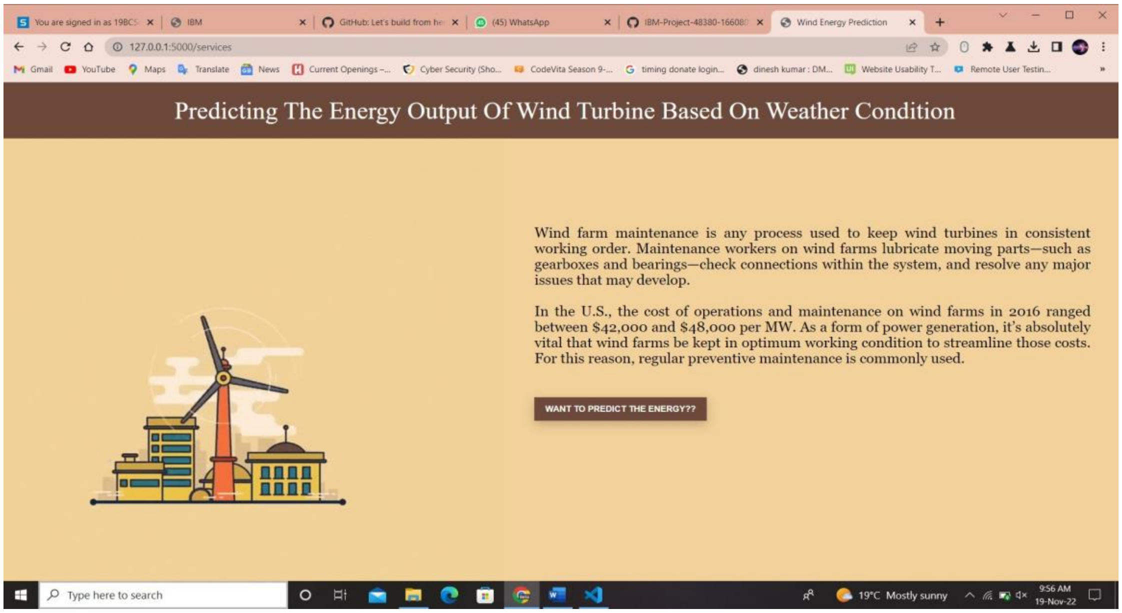


Figure: 8.4 - Services Page

CONTACT PAGE

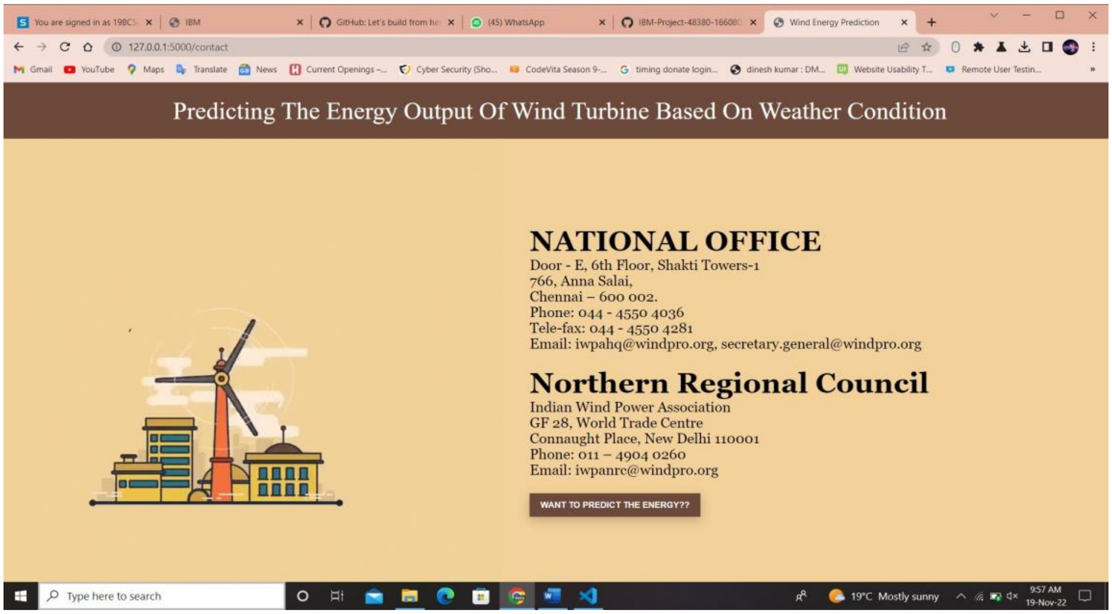


Figure: 8.5 - Contact Page

GETTING THE CITY NAME AS A INPUT FROM THE USER

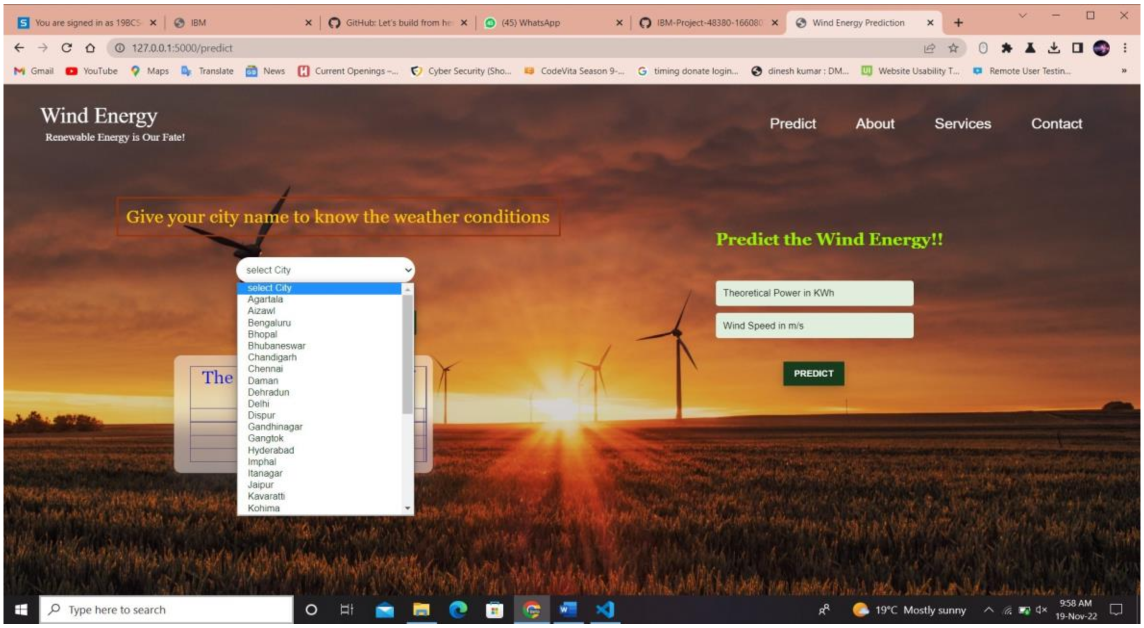


Figure: 8.6 - Input Page

GATHERING WEATHER REPORT FROM API

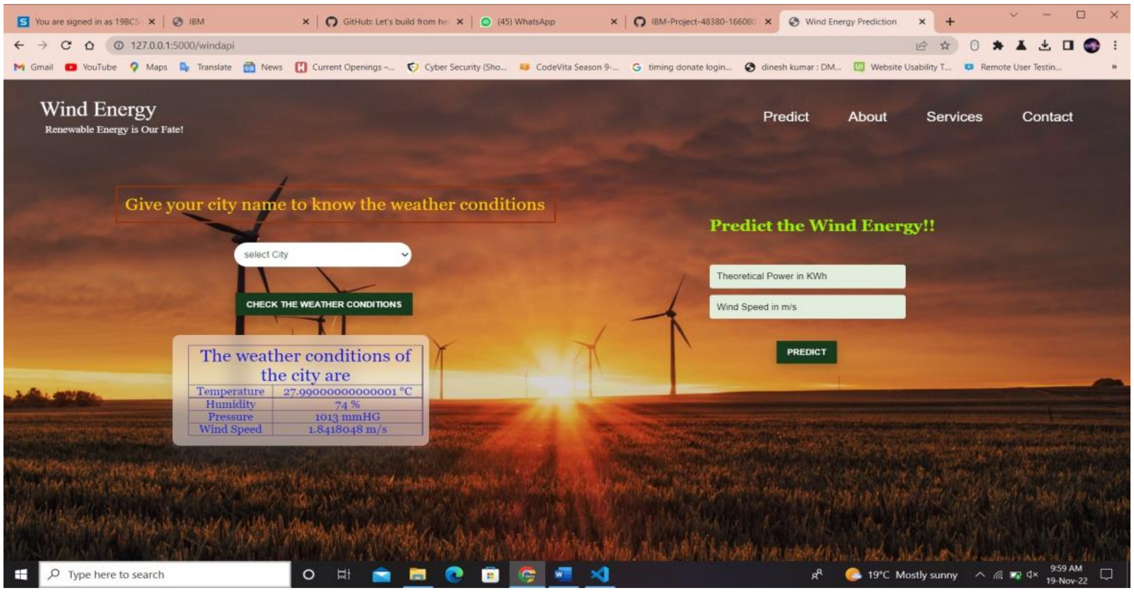


Figure: 8.7 - Weather Report From API

PREDICTING THE ENERGY OUTPUT OF WIND TURBINE

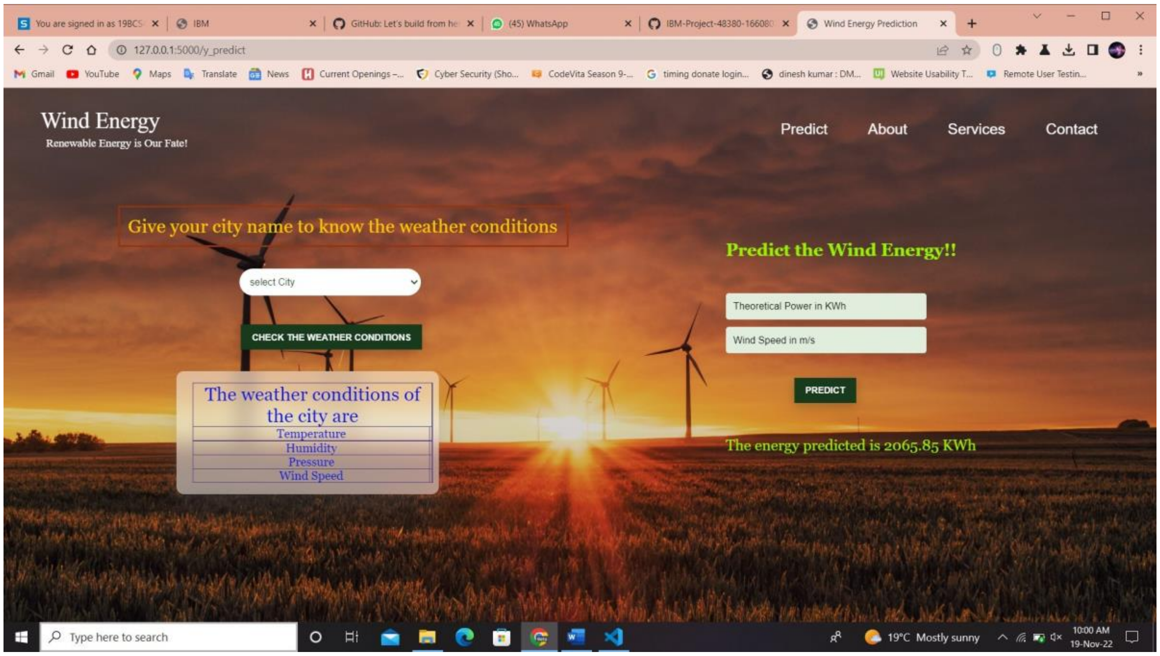


Figure: 8.8 - Predicting the Energy Output of Wind Turbine

CHAPTER 9
RESULTS

9.1 PERFORMANCE METRICS

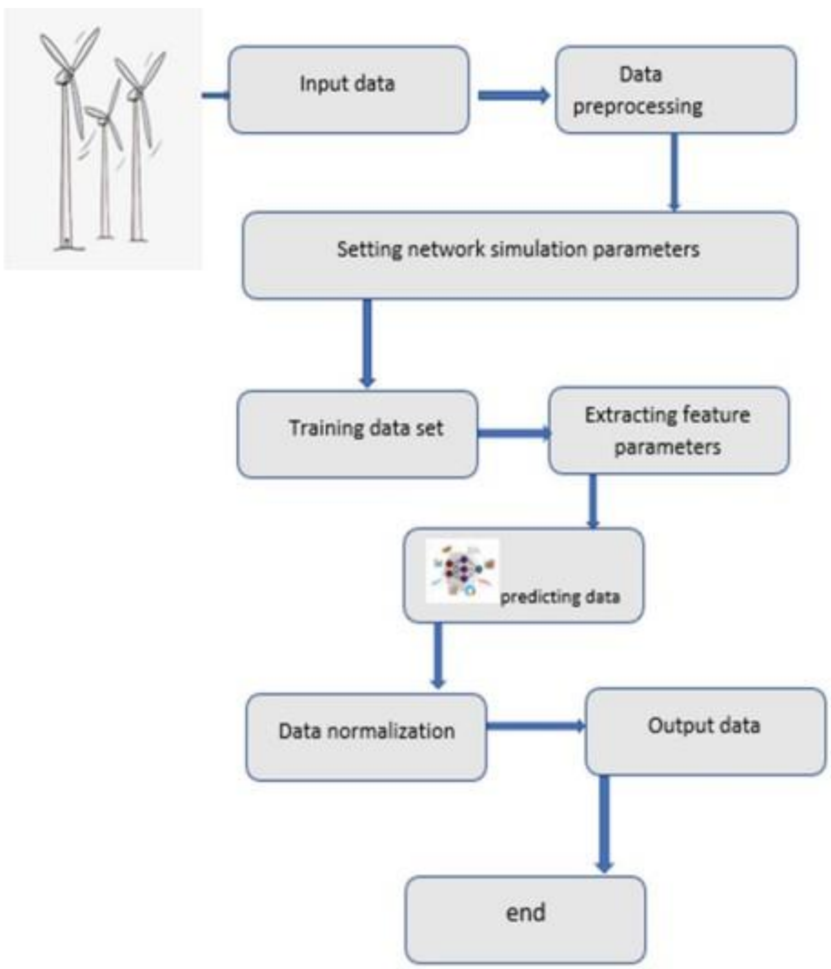


Figure: 9.1 - Performance Metrics

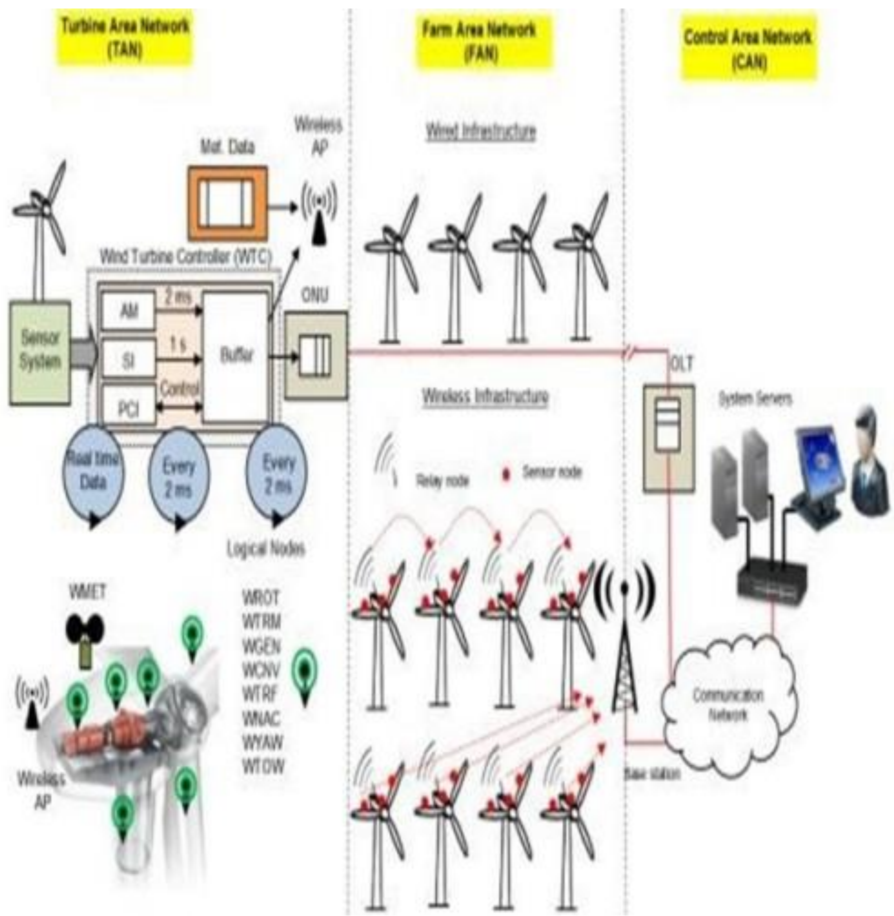


Figure: 9.2 - Network Function

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 where Level 1 is a sensor network in a single wind turbine, Level 2 is the wind turbine to-wind turbine interaction in the WPF, Level 3 is the local control centre to wind turbine interaction, and Level 4 is the farm-to-farm interaction to optimize grid operation.

CHAPTER 10

ADVANTAGES & DISADVANTAGES

ADVANTAGES

➤ 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.

➤ Predict the variation in the long-term wind speed over the site at the hub height of the machines, based on the long-term wind speeds at the mast locations.

➤ Predict the wake losses that arise as a result of one turbine operating behindanother – in other words in its wake; and calculate or estimate the other losses.

DISADVANTAGES

- In order to achieve better generalization for wind speed prediction, the input and output are to be model led and the hidden neuron number should be appropriatelyselected for the neural network design**.**

- In the current scenario many prediction research fields have been heuristic. While numerous researchers have developed prediction models for accurate wind speed prediction, no perfect model has been achieved.

CHAPTER 11

CONCLUSION

This seems natural as neural techniques are motivated by mechanisms of natural neural systems that have to cope with dynamic environments. Wind is a very dynamic system. An important aspect is to manage its volatile and dynamic nature.The integration of wind energy into smart grids affords balancing capabilities, and balancing affords understanding and forecasting. The examples presented in this work have shown how kernel techniques can help to cope with the dynamics of wind time series data. They turn out to be successful methods in modelling, forecastingand monitoring of wind energy time series data. Efficient implementations allowtheir application in real-time scenarios. It is subject to future projects to show the success of these and other kernel methods in real-world energy applications.

CHAPTER 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 wind power prediction, to improve regionalized wind power forecasting for on shore wind farms and to derive methods for wind power prediction for offshore wind farms. It is possible that the use of ensemble and combined weather prediction methods together may enhance forecasting. Offshore wind farms pose more of a challenge in terms of accurate wind power forecasting because the environment is typically flat and smooth with very few obstacles so changes in wind speed and thermal effects are felt more acutely than on land as weather fronts pass over the wind farm.

CHAPTER 13
APPENDIX

APP.PY

```
import flask
from flask import request,
render_templatefrom flask_cors
import CORS
import
joblib import
pandas as pd
```

```
from xgboost import
XGBRegressorimport requests
app = flask.Flask(_name_)
CORS(app)
# purposely kept API KEY since cuh is very less
API_KEY = "t1xJwH_pNvesyStso2tawTlpypHX0HEQJVMev99cmAtK"
token_response = requests.post('https://iam.cloud.ibm.com/identity/token',
data={"apikey":API_KEY, "grant_type": 'urn:ibm:params:oauth:grant-type:apikey'})
mltoken = token_response.json()["access_token"]
header = {'Content-Type': 'application/json', 'Authorization': 'Bearer ' + mltoken}
@app.route('/', methods=['GET'])
def home():
return
render_template('index.html')
@app.route('/about')
def about():
return
render_template('about.html')
@app.route('/predict')
def predict():
return render_template('predict.html')
@app.route('/services')
def services():
return render_template('services.html')
@app.route('/contact')
def contact():
return render_template('contact.html')
```

```
@app.route('/windapi',methods=['PO
ST']) def windapi():
city=request.form.get('city')
apikey="86b1a085e43cad23bfd9c45d5fd88fc3"
url="http://api.openweathermap.org/data/2.5/weather?q="+city+"&appid="+ap
ikey resp = requests.get(url)
resp=resp.json()
temp = str(float(resp["main"]["temp"])-273.15)+" °C"
humid = str(resp["main"]["humidity"])+" %"
pressure = str(resp["main"]["pressure"])+"
mmHG"
speed = str(float(resp["wind"]["speed"])*0.44704)+" m/s"
return render_template('predict.html', temp=temp, humid=humid, pressure=pressure,
speed=speed)
@app.route('/y_predict',methods=['POST'])

def y_predict():
ws =
float(request.form['theo'])
wd =
float(request.form['wind'])
X = [[ws, wd]]
xgr = XGBRegressor()
df = pd.DataFrame(X, columns=['WindSpeed(m/s)', 'WindDirection'])
payload_scoring = {"input_data": [{"field": [['ws', 'wd']], "values":X}]}
response_scoring = requests.post('https://us-
south.ml.cloud.ibm.com/ml/v4/deployments/0644c680-478f-475f-
bc23- 2a64fc6490a5/predictions?version=2022-10-24',
```

```
json=payload_scoring,headers={'Authorization': 'Bearer ' +
mltoken})

print(response_scoring)

predictions =

response_scoring.json()

print(predictions)

output = predictions['predictions'][0]['values'][0][0]

print("Final prediction :", predict)

return render_template('predict.html', prediction_text="The energy predicted is
{:.2f}

KWh".format(output))

if_name_== "_main__":

app.run()
```

INDEX.HTML

```
<!DOCTYPE html>

<html lang="en">

<head>
<meta charset="UTF-8">

<title>Wind Energy Prediction</title>

<link rel="stylesheet" href="{{ url_for('static', filename='css/style.css') }}">

<!----we had linked our css file---->

</head>

<body>

<div class="full-page">

<div class="navbar">

<div>
```

```
<a href="{{url_for('home')}}">Wind
Energy<br><label>  RenewableEnergy is Our Fate!</label></a>
</div>
<nav>
<ul id='MenuItems'>
<li><a href="{{url_for('predict')}}">Predict</a></li>
<li><a href="{{url_for('about')}}">About</a></li>
<li><a href={{url_for('services')}}>Services</a></li>
<li><a href={{url_for('contact')}}>Contact</a></li>
</ul>
</nav>
</div>
</div>
</body>
</html>
```

ABOUT.HTML

```
<html>
<head>
<title>Wind Energy Prediction</title>
<link rel="stylesheet" href="{{ url_for('static', filename='css/style.css') }}">
<style>
    .header
        {
        top:0
        px;
        margi
        n:0px
```

```
    ;left:
    0px;
    right:
    0px;
    position: fixed;
    background:
    #6c493a;color:
    white; overflow:
    hidden;
    padding-bottom:
    30px;font-size:
    2.25vw; width:
    100%;
    padding-
    left:10px;
    text-align:
    center;
    padding-
    top:20px;
}
.second
    {
    top:8
    0px;
    botto
    m:0p
    x;
```

```
    margi
    n:0px
    ;left:
    0px;
    right:
    0px;
    position:
    fixed;
    padding:
    0px; width:
    100%;
    background-
    image:url({{url_for('static',filename='/images/m123.gif')}});
    background-repeat:no-repeat;
    background-size: contain;
}
.inside{
    top:8
    0px;
    botto
    m:0p
    x;
    margi
    n:0px
    ;left:
    45%;
    right:   0%;
```

```
    position:
    fixed;
    padding-
    left: 40px;
    padding-
    top:8%;
    padding-right:40px;
    background-
    color:#F2D19A;
    font-family:Georgia, serif;
    color:black;
    font-
    size:20px;
    text-
    align:justif
    y;
}
.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:
#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>
<a href="{{url_for('home')}}">Wind
Energy<br><label>  RenewableEnergy is Our Fate!</label></a>
<div class="second">
<div class="inside">Renewable energy, such as wind and solar energy, plays
an increasing role in the supply of energy worldwide. This trend will continue
becauseglobal energy demand is increasing, and the use of nuclear power and
traditional sources of energy such as coal and oil is unsafe and leads to a large
amount of CO2emission. Wind energy is a key player in the field of
renewable energy. In Europe, the capacity of wind energy production has
doubled from 2009 to 2010. <br><br>
However, levels of production of wind energy are hard to predict as they rely
```

on potentially unstable weather conditions present at the wind farm. In particular, windspeed is crucial for energy production based on wind, and it may vary drastically over time. Energy suppliers are interested in accurate predictions, as they can avoid overproduction by coordinating the collaborative production of traditional power plants and weather-dependent energy sources. The energy can be predicted based onthe power curve and the windspeed.

```
<br><br><br>

<a href="{{url_for('predict')}}"><button type="button" class="myButton" >Want topredict the energy??</button></a>

</div>

</div>

</body>

</html>
```

Services.html

```
<html>

<head>

<title>Wind Energy Prediction</title>
<link rel="stylesheet" href="{{ url_for('static', filename='css/style.css') }}">

<style>

        .header

           {

           top:0

           px;

           margi

           n:0px

           ;left:

           0px;

           right:
```

```
    0px;
    position: fixed;
    background:
    #6c493a;color:
    white; overflow:
    hidden;
    padding-bottom:
    30px;font-size:
    2.25vw; width:
    100%;
    padding-
    left:10px;
    text-align:
    center;
    padding-
    top:20px;
}
.second
    {
    top:8
    0px;
    botto
    m:0p
    x;
    margi
    n:0px
    ;left:
```

```
    0px;
    right:
    0px;
    position:
    fixed;
    padding:
    0px; width:
    100%;
    background-
    image:url({{url_for('static',filename='/images/m123.gif')}});
    background-repeat:no-repeat;
    background-size: contain;
}
.inside{
    top:8
    0px;
    botto
    m:0p
    x;
    margi
    n:0px
    ;left:
    45%;
    right:   0%;
    position:
    fixed;
```

```
}
        padding-
        left: 40px;
        padding-
        top:8%;
        padding-right:40px;
        background-
        color:#F2D19A;font-
        family:Georgia, serif;
        color:black;
        font-
        size:20px;
        text-
        align:justif
        y;
      }
      .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: #6c493a;
padding: 10px 15px; margin: 0
auto;
box-shadow: 0 5px 15px rgba(0,0,0,0.20);
}
```

```
</style>

</head>
<body>

a href="{{url_for('home')}}">Wind
Energy<br><label>  RenewableEnergy is Our Fate!</label></a>

<div class="header">Predicting The Energy Output Of Wind Turbine Based
OnWeather Condition</div>

<div class="second">

<div class="inside">Wind farm maintenance is any process used to keep wind
turbines in consistent working order. Maintenance workers on wind farms
lubricatemoving parts—such as gearboxes and bearings—check connections
within the system, and resolve any major issues that may develop. <br><br>
In the U.S., the cost of operations and maintenance on wind farms in 2016
ranged between $42,000 and $48,000 per MW. As a form of power
generation, it’s absolutely vital that wind farms be kept in optimum working
condition to streamlinethose costs. For this reason, regular preventive
maintenance is commonly used.

<br><br><br>

<a href="{{url_for('predict')}}"><button type="button" class="myButton" >Want
topredict the energy??</button></a>

</div>

</div>

</body>

</html>
```

PREDICT.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.cs
s"

integrity="sha384-
fnmOCqbTlWIlj8LyTjo7mOUStjsKC4pOpQbqyi7RrhN7udi9RwhKkMHpvL
bHG9 Sr" crossorigin="anonymous" />

<link href="https://fonts.googleapis.com/css?family=Dosis" rel="stylesheet" />

<link rel="stylesheet" href="{{ url_for('static', filename='css/style.css') }}">

<title>Wind Energy Prediction</title>
<

s

t

y

l

e

>

t

a

b

l

e

{

    width: 100%;

    border-collapse: collapse;
```

}

.card {

}

```
margin-right: auto;
margin-left: 12%;
width: 350px;
box-shadow: 0 15px 25px rgba(129, 124, 124, 0.2);
border-radius: 10px;
backdrop-filter: blur(14px);
background-color: rgba(255, 255, 255, 0.5);padding:
15px;
text-align: center;
}
        .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: 60%;
 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;
 }
 .navbar
 {
    display: flex;
    align-items: center;
    padding: 20px;
    padding-left: 50px;
    padding-right: 30px;
    padding-top: 25px;
    line-height: 1.3;
 }
```

```
.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(255 204 0);;
            font-size:25px;
            align:center;
  }
    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: #000ff0;
}
@media screen and (max-width: 500px) {
 .left,
 .second,
 .third {
   width: 70%;
 }
}
</style>
</head>
<body>
<div class="full-page">
<div class="navbar">
<div>
<a href="{{url_for('home')}}">Wind Energy<br><label>  Renewable
Energy is Our Fate!</label></a>
</div>
<nav>
<ul id='MenuItems'>
<li><a href="{{url_for('predict')}}">Predict</a></li>
<li><a href="{{url_for('about')}}">About</a></li>

<li><a href={{url_for('services')}}>Services</a></li>
<li><a href={{url_for('contact')}}>Contact</a></li>
</ul>
</nav>
</div>
</div>
<div class="second">
<div class="left">
<p style="padding: 10px; border: 3px solid rgb(148, 53, 16); width: 600px;">Give
your city name to know the weather conditions</p>
<div style="margin-left:25%">
<br>
<form action="{{ url_for('windapi')}}"method="post" >
<select name="city" required >
<option value="" selected>select City</option>
<option value ="Agartala"  >  Agartala   </option>
<option value ="Aizawl" >  Aizawl  </option>
```

```
<option value ="Bengaluru"  >  Bengaluru   </option>
<option value ="Bhopal" >  Bhopal  </option>
<option value ="Bhubaneswar"    >  Bhubaneswar </option>
<option value ="Chandigarh" >  Chandigarh  </option>
<option value ="Chennai"    >  Chennai </option>
<option value ="Daman"  >  Daman   </option>
<option value ="Dehradun"   >   Dehradun    </option>

<option value ="Delhi"  >  Delhi   </option>
<option value ="Dispur" >  Dispur  </option>
<option value ="Gandhinagar"    >  Gandhinagar </option>
<option value ="Gangtok"    >  Gangtok </option>
<option value ="Hyderabad"  >  Hyderabad   </option>
<option value ="Imphal" >  Imphal  </option>
<option value ="Itanagar"   >   Itanagar    </option>
<option value ="Jaipur" >  Jaipur  </option>
<option value ="Kavaratti"  >  Kavaratti   </option>
<option value ="Kohima" >  Kohima  </option>
<option value ="Kolkata"    >  Kolkata </option>
<option value ="Lucknow"    >  Lucknow </option>
<option value ="Mumbai" >  Mumbai  </option>
<option value ="Panaji" >   Panaji  </option>
<option value ="Patna"  >   Patna   </option>
<option value ="Pondicherry"    >  Pondicherry </option>
<option value ="Port Blair" >  Port Blair  </option>
<option value ="Raipur" >  Raipur  </option>
<option value ="Ranchi" >  Ranchi  </option>
<option value ="Shillong"   >   Shillong    </option>
<option value ="Shimla" >  Shimla  </option>
<option value ="Silvassa"   >   Silvassa    </option>
<option value ="Srinagar"   >   Srinagar    </option>
<option value ="Thiruvananthapuram" >  Thiruvananthapuram  </option>
```

```
<option value ="Tirupati"   >   Tirupati    </option>
</select><br><br>
<div style="margin-left:-20%"><button type="submit" class="myButton" >Check
the Weather Conditions</button></div>
<div class="card">
<table style="margin-left:2%; text-align:center; border-spacing:25px;">
<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>
```

```html
<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>
```

GitHub & Project Demo Link

GitHub Link:

GitHub - IBM-EPBL/IBM-Project-14503-1659586348: Predicting the energy output of wind turbine based on weather condition

Project Demo Link:

https://1drv.ms/v/s!Asl_THNYI7I2g4t0WdYET4cBXfKBfQ?e=T1Fn6w