Predicting The Energy Output Of Wind Turbine Based On Weather Condition

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1.INTRODUCTION

1.1 Project Overview:

Renewable energy such as wind and solar energy plays an increasing role in the supply of energy world-wide. This trend will continue because the global energy demand is increasing and the use of nuclear power and traditional sources of energy such as coal and oil is either considered as non-safe or leads to a large amount of CO2 emission. Wind energy is a key-player in the field of renewable energy. The capacity of wind energy production was increased drastically during the last years. In Europe for example, the capacity of wind energy production has doubled since 2005. However, the production of wind energy is hard to predict as it relies on the rather unstable weather conditions present at the wind farm. In particular, the wind speed is crucial for energy production based on wind and the wind speed may vary drastically during different periods of time. Energy suppliers are interested in accurate predictions, as they can avoid overproductions by coordinating the collaborative production of traditional power plants and weather dependent energy sources

1.2 Purpose:

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 mode

2. LITERATURE SURVEY

2.1 Existing problem :

2.2 References:

1) Manitoba Hydro, **Sources of Energy: Wind**, https://www.hydro.mb.ca/environment/energy_sources/wind.shtml

2) National Wind Coordinating Committee, **Wind Turbine Interactions With Birds And Bats: A Summary Of Research Results And Remaining Questions**, November 2004, http://www.laneaudubon.org/library-sub/maloney_wind-and-birds.pdf

3) John Laumer, Common Eco-Myth: **Wind Turbines Kill Birds**, Philadelphia,2006,http://www.treehugger.com/files/2006/04/common_misconce.php

4) Henry Seifert, Annette Westerhellweg, Jürgen Kröning, **Risk Analysis Of Ice Throw From Wind Turbines**, Paper presented at BOREAS 6, 9 to 11 April 2003, Pyhä, Finland, http://web1.msue.msu.edu/cdnr/icethrowseifertb.pdf

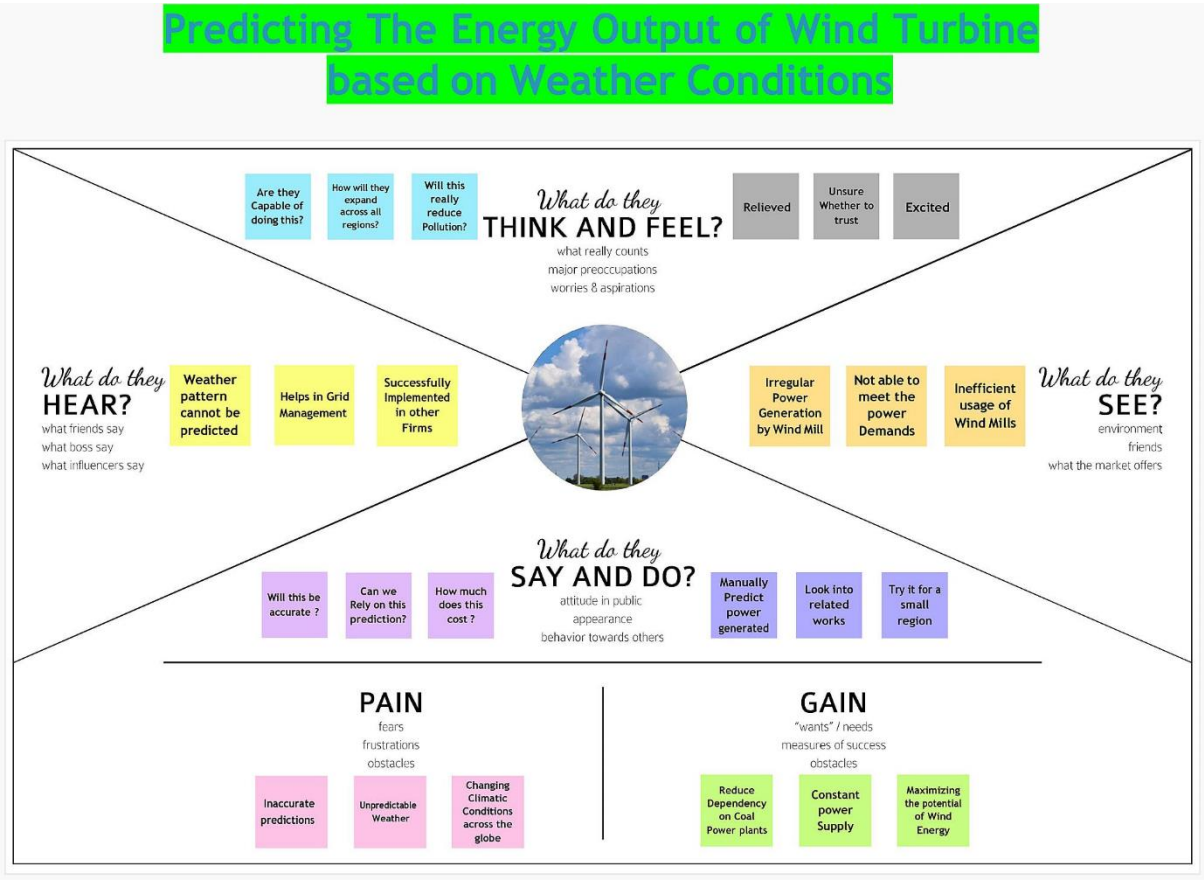
5) Province of Manitoba, **Harvesting the Wind in St. Leon Manitoba**: A new opportunity for renewable energy in Manitoba

2.3 ProblemStatement Definition:

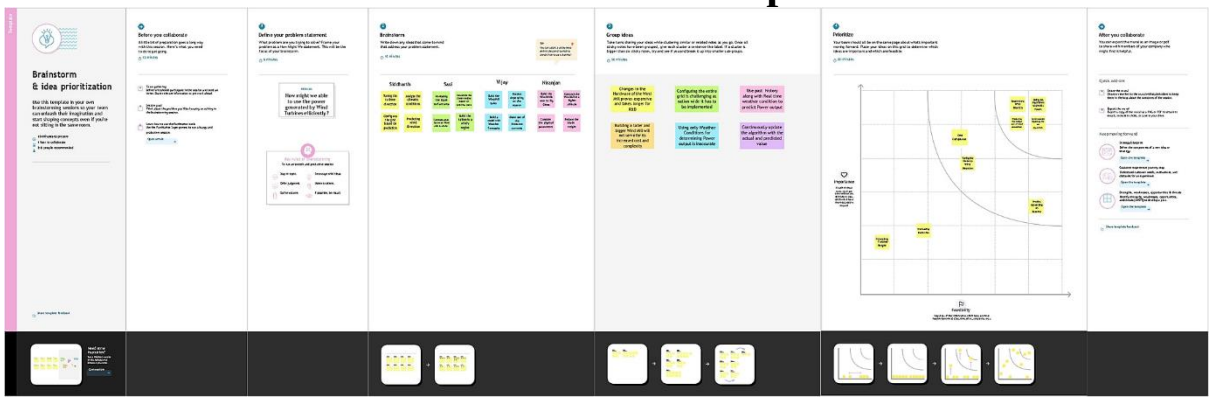
During the development of generator part for wind turbine, the analysis of eachelement need to be criticized so that the specific component used can be known. Thedetails of type of material used also must consider in order determining the productionof generator part of wind turbine experiment. Therefore, analysis must be done in orderto know the strength and weakness of making the generator part in order to produce theoutput voltage.

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas:



3.2 Brainstorm & Idea Prioritization Template:



3.3 Proposed Solution:

Problem Statement :

Wind power consistsof converting the energy producedby the movement of wind turbine blades driven by the wind into electrical energy.Wind power generation differs due to the stochastic nature of wind. The prediction of wind power plays an indispensable role inmaintaining the stability of the entire power grid. This solution aims to forecast the wind power values efficiently by correlating the parameters of weather conditions and wind turbines.

Idea / Solution Description :

Wind energy is a significant and eligible source that has the potential for producing energy in a continuous and sustainable manner among renewable energy sources. However, wind energy has several challenges, such as initial investment costs, the stationary property of wind plants, and the difficulty in finding wind-efficient energy areas. Hence, long-term wind power forecasting is to be performed based on daily wind speed data using machine learning algorithms. With the process of applying machine learning models along with statistical models to historical wind speed data of a region, we can obtain long-term wind power values. This architecture integrated with a weather forecasting API, furthermore assists in the prediction in any location. The model is trained using IBM Watson's machine learning service and its scoringendpoint is fed to the application developed using the Flask framework to process the API's andenergyprediction requests from the user to render the resultson the UI.

Novelty / Uniqueness :

This solution is aimed to be architected in a way that makes it scalable and flexible in any kind of situations like unusual weather conditions, sudden influx of customers or users, analyzing in any type of location etc. This helps in dealing with the challenges of balancing supply and demand in any electricity system ,reducing the need for additional balancing energyand reserve power to integrate wind power by accurate wind power forecasting. Through statistical analysis combinedwith machine learningservice over cloud as SAAS, the mentioneduniquenesses are desiredto be achieved.

Social Impact / Customer Satisfaction :

By creating an effective machinelearning model we will be able to increase the power producedhence the num and a clean technology, and this is one of the main impacts that

makes it such an attractive and promising energy supply solution to predict the energy output ofwind turbines based on weather conditions.Main social and environmental benefits includes reduction in CO2 emissions and fossil fuels imports. In areas where wind energy is employed, job opportunities are providedto many families and hence increases the employment percentage providing regional development. The customer will be able to get an overall picture of the output hence will get a clear picture on whether to invest more in that particular region or to rectifyby investigation in another region.The customer will also be able t o analyze and make changesbased on the output to maximize the output makin ghim/her a happy customer.

Business Model (Financial Benefit) :

Opportunities to trade in the power produced are likely to expand significantly.Currently, it is possible for wind power producers to sell electricity to the grid, use it for captive consumption or sell it to thirdparties. With the emergence of independ ent power exchanges and with the likely liberalization and streamlining of power distribution across states, the opportunities to trade in power are likely to increase and become more lucrative.With the adventof the RPO/REC mechanism in India, there has been significant demand for non-solar (wind, small hydro, biomassetc.) over the past few months.

Scalability of Solution :

Energy trading in liberalized markets is particularly interesting from the perspective of wind energyproducers because of the non-dispatchable nature of wind. This means that wind energy producers need to forecast how much they will produce in the future in order to place their bids. Hence customerscan use our SAAS model to accomplish the t ask.

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 inbyentering t heirusername and password.	Registration through Form.
FR-2	User Confirmation by validatingthe username withrespect to the password	Confirmation via pop-up Message.
FR-3	Displaying the further information about theapplication.	By selecting the about buttonthe details ofthe application will be displayed.
FR-4	Validatingthe city name.	System checks whether the city entered by the user ispresent or not. If present it will col lectthefurther details else it will display the pop-up message as errorin the city.
FR-5	[illegible]	the user.
FR-6	Validating all required fields.	Before predicting the output the system checks whetherall the valuesa re entered bythe user and checks whether allvalues are correct.
FR-7	Displaying weather conditionsfor a g iven city.	It displays the weather of the citywhich haveb eenselected.
FR-8	Displaying predictedenergyoutp ut power.	The predicted output will be displayed asamount ofwind energypower gen erated.

4.2 Non-functional Requirements:

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

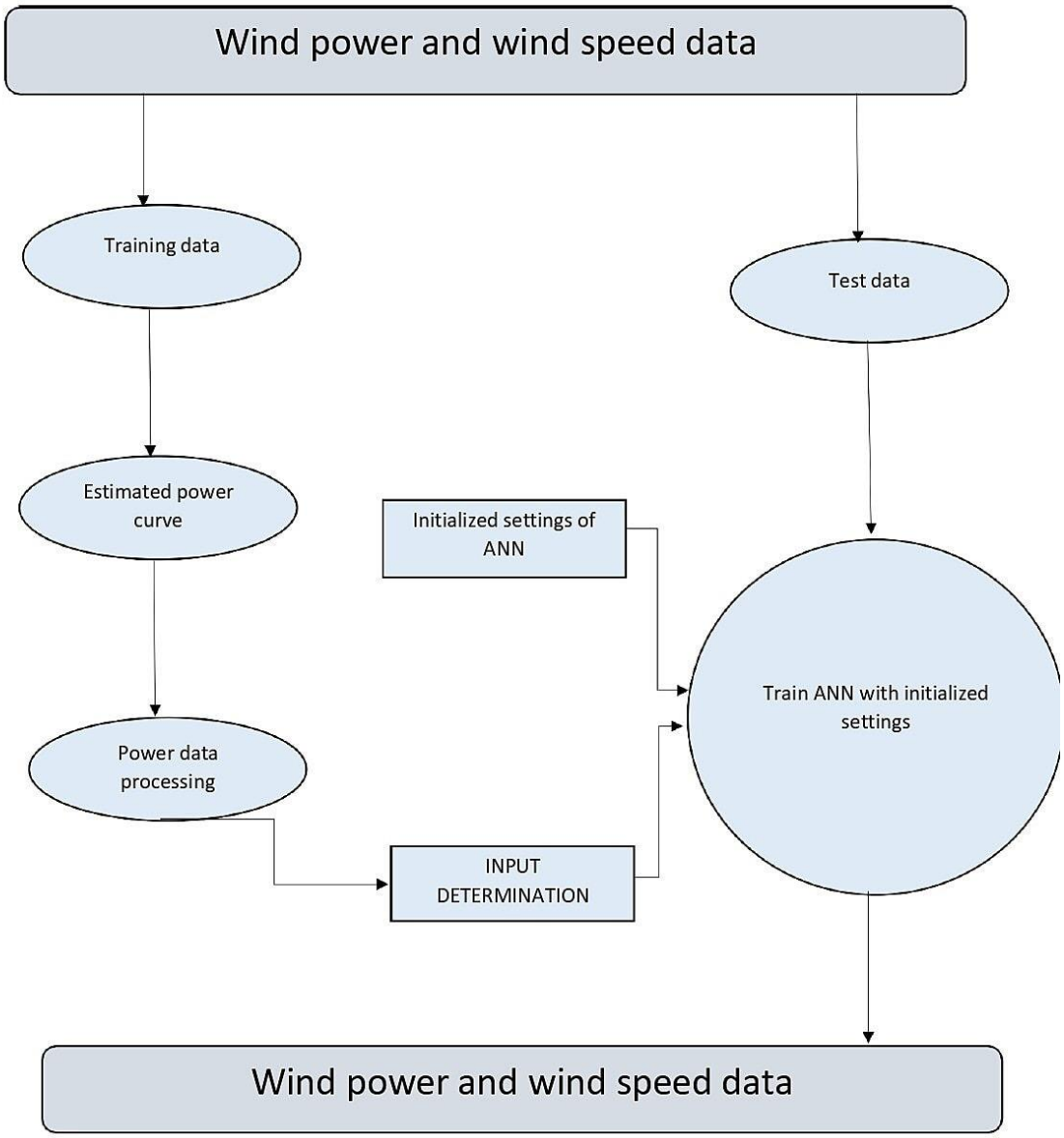
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	The system satisfies the user goalsand theapplication is easy to use.
NFR-2	Security	attacks andunauthorized access

NFR-3	Reliability	The system willprovide the consistency in outputwithout producing an error.
NFR-4	Performance	The performance willnever degrade eventheworkload is increased.
NFR-5	Availability	The application is available for 24*7
NFR-6	Scalability	The system can be used as web application aswellas mobile application with a sufficient internet availability.

5.PROJECT DESIGN

5.1 Flow Diagram:

FLOW DIAGRAM



5.2 Solution & Technical Architecture:

Solution Architecture:

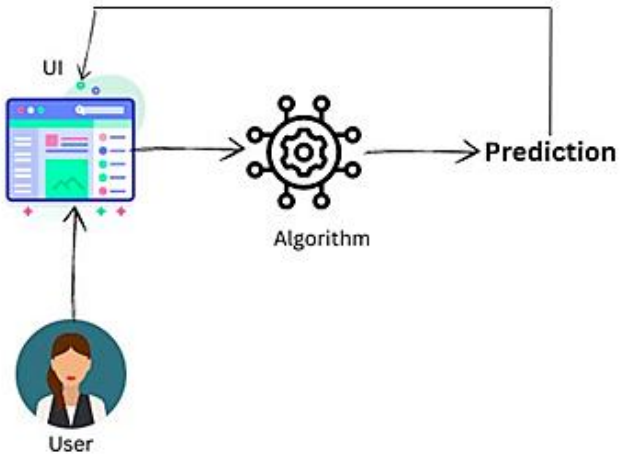
Problem Statement:

Wind power consistsof converting the energy producedby the movemen t of wind turbine blades driven by the wind into electrical energy.Wind power generation differs due to the stochastic nature of wind. The prediction of wind power plays an indispensable role inmaintaining the stability of the entire power grid. This solution aims to forecast the wind power values efficiently by correlating the parameters of weather conditions a nd wind turbines.

Proposed Solution:

Long-term wind power forecasting is to be performed based on daily wind speed data using machine learningalgorithms. A Minimal Viable Product is aimed to be built by integrating a machine learning algorithm with a front end UI to fetch the user inputs which will be evaluatedand the wind power results are fed back to the UI. This architecture is further enhanced as the customer base expands by integrating with a weather forecasting API which assists in the prediction from any geographical location and by training the model using IBM Watson'smachine learning service with its scoring endpoint fed to a Flask framework-built UI to process the API's and energyprediction requests from the user and rendering t he results back to the UI.

Block Diagram Of MVA:

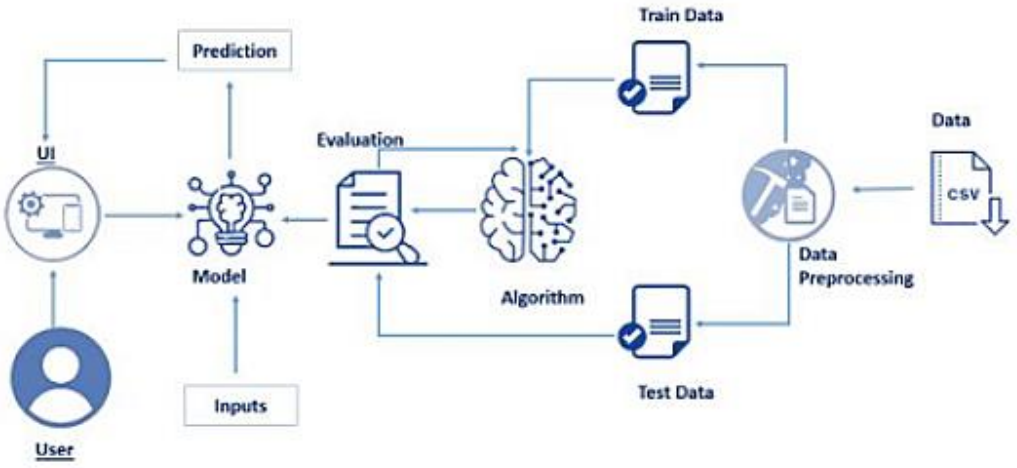


Block diagram

Conclusion:

The Minimal Viable Product is developed with basic features that provide the critical need of predicting wind power output based on weather conditions built with a simple UI powered by a regressor algorithm and statistical methods that can process the user's requests to predict the wind power values. The MVA is suitable for incremental development to augment the additional featuresor changes in the requirements to build a flexib le and scalable versionof the application architecture.

Technical Architecture:



5.3 User Stories

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my pa	2	High
Sprint-1		USN-2	As a user, I will receive confirmation email onceI have registered for the application	2	High
Sprint-4		USN-3	[illegible]	1	Medium
Sprint-4		USN-4	As a user, I can register for the applicationthrough LinkedIN	1	Medium
Sprint-1	Login	USN-5	As a user, I can log intothe application byentering email & password	2	High
Sprint-3		USN-6	As a user,I can change my password in case I forget it through the reset password option.	1	Medium
Sprint-2	Dashboard	USN-7	As a user,I can accessthe dashboard to View profile	3	Low

Sprint-2		USN-8	[illegible]	3	High

Sprint	[illegible]	[illegible]	User Story / Task	Story Points	Priority
Sprint-2		USN-9	As a user, I can view my previous Evaluations	2	High
Sprint-4	Profile	USN-10	As a user,I can editmy profile timeto time	1	Medium
Sprint-3	Requirements	USN-11	As a user, I can enterthe wind speedand otherinputs through a form	1	High
Sprint-3	Results	USN-12	[illegible]	1	High
Sprint-2	Downloads	USN-13	As a user I can download the results as animage	3	Medium
Sprint-2		USN-14	As a user,I can download the results as a pdf	3	High
Sprint-2		USN-15	As a user, I can download and share ther esultsthrough email	3	Low
Sprint-1	Login	USN-16	[illegible]	[illegible]	[illegible]
			entering email &password		
Sprint-3		USN-17	As an admin, I can changemy password in	3	Medium
			[illegible]		
			option		
Sprint-4	Website modification	USN-18	As an admin, I can addcontent and publis hthepages on the application assign by the super admin	3	Medium
Sprint-1	Login	USN-19	As a superadmin, I can log into the application by entering email &password	3	High

Sprint-3		USN-20	As a superadmin, I can log into the application by receiving a reset emailincase f orgotpassword	3	Medium
Sprint-3		USN-21		2	High

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 password, and confir	2	High	Siddharthan,Vijayakumar
Sprint-1		USN-2	As a user, I will receive confirmation email onceI have registered for the application	2	High	SiddharthanVijayakumar
Sprint-4		USN-3		1	Medium	
Sprint-4		USN-4	As a user, I can register for the applic ationthrough LinkedIN	1	Medium	Siddharthan,Surya
Sprint-1	Login	USN-5	As a user, I can log intothe applicatio n byentering email & password	2	High	Surya, S asibharathi
Sprint-3		USN-6	As a user,I can change my password in case I forget it through the reset password option.	1	Medium	Vijayakumar, Surya

Sprint-2	Dashboard	USN-7	As a user,I can accessthe dashboard to View profile	3	Low	Siddharthan, Surya
Sprint-2		USN-8		3	High	

Sprint			**User Story / Task**	**Story Points**	**Priority**	
Sprint-2		USN-9	As a user, I can view my previous Evaluations	2	High	Siddhartha , Vijayaku mar
Sprint-4	Profile	USN-10	As a user,I can editmy profile timet o time	1	Medium	
Sprint-3	Requirements	USN-11	As a user, I can enterthe wind sp eedand otherinputs through a form	1	High	Siddhartha n,Surya
Sprint-3	Results	USN-12		1	High	
Sprint-2	Downloads	USN-13	As a user I can download th e results as animage	3	Medium	Vijayaku m ar,Sasi bharathi
Sprint-2		USN-14	As a user,I can download the result s as a pdf	3	High	
Sprint-2		USN-15	As a user, I can download and sh are theresultsthrough email	3	Low	Surya, Sa sibharathi
Sprint-1	Login	USN-16				
			entering email &password			
Sprint-3		USN-17	As an admin, I can changemy pass word in	3	Medium	Siddharthan
			option			Sasibharath
Sprint-4	Website modific ation	USN-18	As an admin, I can addcontent a nd publishthepages on the application assign by the super admin	3	Medium	Vijayaku m ar, San mati

Sprint-1	Login	USN-19	As a superadmin, I can log into the application by entering email &password	3	High	Sasibharathi, Surya
Sprint-3		USN-20	As a superadmin, I can log into the application by receiving a reset emai lincase forgotpassword	3	Medium	Surya, Vijaya kumar
Sprint-3		USN-21		2	High	

Sprint			User Story / Task	Story Points	Priority	
Sprint-4	Website Modification	USN-22	As a super admin, I can add content and publish on all thepag es of the application	4	Low	Siddhartha n,Sasibhar athi
Sprint-4		USN-23	As a super admin,I can edi tthe design andlayout of th e website	4	Medium	

6.2 Sprint Delivery Schedule:

Sprint	Total StoryPoints	Duration	Sprint Start Date	Sprint End Date(Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	12	6 Days	24 Oct 2022	29 Oct 2022		
Sprint-2	17	6 Days	31 Oct 2022	05 Nov 2022		
Sprint-3	11	6 Days	07 Nov 2022	12 Nov 2022		
Sprint-4	14	6 Days	14 Nov 2022	19 Nov 2022		

6.3 Reports from JIRA:

https://pnt2022tmid53075.atlassian.net/

7.CODING & SOLUTIONING:

7.1 Feature 1:

Python Web Frame Works:

A Web framework is a collection of packages or modules which allow developers to write Web applications (see WebApplications) or services without having to handle such low-level details as protocols, sockets or process/thread management.

The majority of Web frameworks are exclusively server-side technology, although, with the increased prevalence of AJAX, some Web frameworks are beginning to include AJAX code that helps developers with the particularly tricky task of programming (client-side) the user's browser. At the extreme end of the client-side Web Frameworks is technology that can use the web browser as a full-blown application execution environment (a la gmail for example): see Web Browser Programming for details.

Python For Data Visualization:

The process of finding trends and correlations in our data by representing it pictorially is called Data Visualization. To perform data visualization in python, we can use various python data visualization modules such as Matplotlib, Seaborn, Plotly, etc. In this article, The Complete Guide to Data Visualization in Python, we will discuss how to work with some of these modules for data visualization in python and cover the following topics in detail.

7.2 Feature 2:

IBM Cloud:

In June 2013, IBM acquired SoftLayer, a public cloud platform, to serve as the foundation for its IaaS offering. Bluemix was announced for public beta in February 2014[18] after having been developed since early 2013.[19] Bluemix was based on the open source Cloud Foundry project and ran on SoftLayer infrastructure. IBM announced the general

availability of the Bluemix Platform-as-a-Service (PaaS) offering in July 2014.[20]

By April 2015, Bluemix included a suite of over 100 cloud-based development tools "including social, mobile, security, analytics, database, and IoT (internet of things).[21] Bluemix had grown to 83,000 users in India with growth of approximately 10,000 users each month.[21]

A year after announcement, Bluemix had made little headway in the cloud-computing platform space relative to its competition, and remained substantially behind market leaders Microsoft Azure and Amazon AWS.[22] By August 2016, little had changed in market acceptance of the Bluemix offering.[23] In February 2016,[24] IBM Bluemix includes IBM's Function as a Service (FaaS) system, or Serverless computing offering, that is built using open source[25] from the Apache OpenWhisk incubator project largely credited[26] to IBM for seeding. This system, equivalent to Amazon Lambda, Microsoft Azure Functions, Oracle Cloud Fn or Google Cloud Functions, allows calling of a specific function in response to an event without requiring any resource management from the developer.[27]

Python-Flask:

Flask is a micro web framework written in Python. It is classified as a microframework because it does not require particular tools or libraries.[2] It has no database abstraction layer, form validation, or any other components where pre-existing third-party libraries provide common functions. However, Flask supports extensions that can add application features as if they were implemented in Flask itself. Extensions exist for object-relational mappers, form validation, upload handling, various open authentication technologies and several common framework related tools.[3]

7.3 DatabaseSchema (if Applicable):

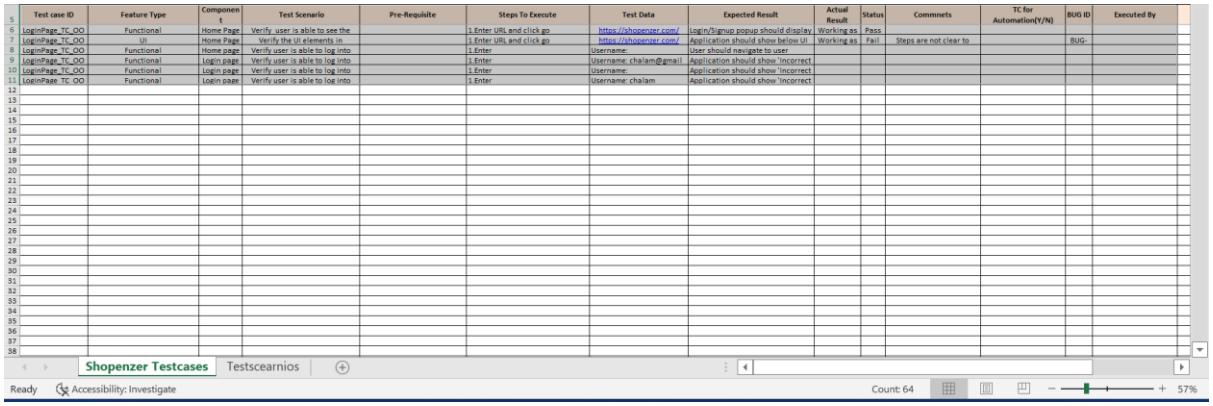
IBM Db2 is a family of data management products, including the Db2 relational database. The products feature AI-powered capabilities to help you modernize the management of both structured and unstructured data across on-premises and multicloud environments. By helping to make your data simple and accessible, the Db2 family positions your business to pursue the value of AI.

Most of the Db2 family is available on the IBM Cloud Pak® for Data platform, either as an add-on or an included data source service, making virtually all of your data available across hybrid or multicloud environments to fuel your AI applications. Easily converge your transactional data stores and rapidly derive insights through universal, intelligent querying of data across disparate sources.

Cut costs with the multimodel capability that eliminates the need for data replication and migration. Enhance agility by running Db2 on any cloud vendor.

8.TESTING:

8.1 Test Cases:



Test case ID	Feature Type	Componen t	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Commnets	TC for Automation(Y/N)	BUG ID	Executed By
LoginPage_TC_OO	Functional	Home Page	Verify user is able to see the		1.Enter URL and click go	https://shopenzer.com/	Login/Signup popup should display	Working as	Pass				
LoginPage_TC_OO	UI	Home Page	Verify the UI elements in		1.Enter URL and click go	https://shopenzer.com/	Application should show below UI	Working as	Fail	Steps are not clear to		BUG-	
LoginPage_TC_OO	Functional	Home page	Verify user is able to log into		1.Enter	Username:	User should navigate to user						
LoginPage_TC_OO	Functional	Login page	Verify user is able to log into		1.Enter	Username: chalam@gmail	Application should show 'Incorrect						
LoginPage_TC_OO	Functional	Login page	Verify user is able to log into		1.Enter	Username:	Application should show 'Incorrect						
LoginPage_TC_OO	Functional	Login page	Verify user is able to log into		1.Enter	Username: chalam	Application should show 'Incorrect						

Shopenzer Testcases | Testscearnios

Ready | Accessibility: Investigate | Count: 64 | 57%

8.2 User Acceptance Testing:

1. Purpose of Document

Thepurpose of this document is to briefly explainthe test coverageand open issuesofthe Project - Predicting the energy output of windturbine based on weather conditions projectat the time of the release to User Acceptance Testing (UAT).

2. Defect Analysis

This report shows the number of resolved or closed bugs at each severity level,andhow they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8

Totals 24 14 13 26 77

1. Test Case Analysis

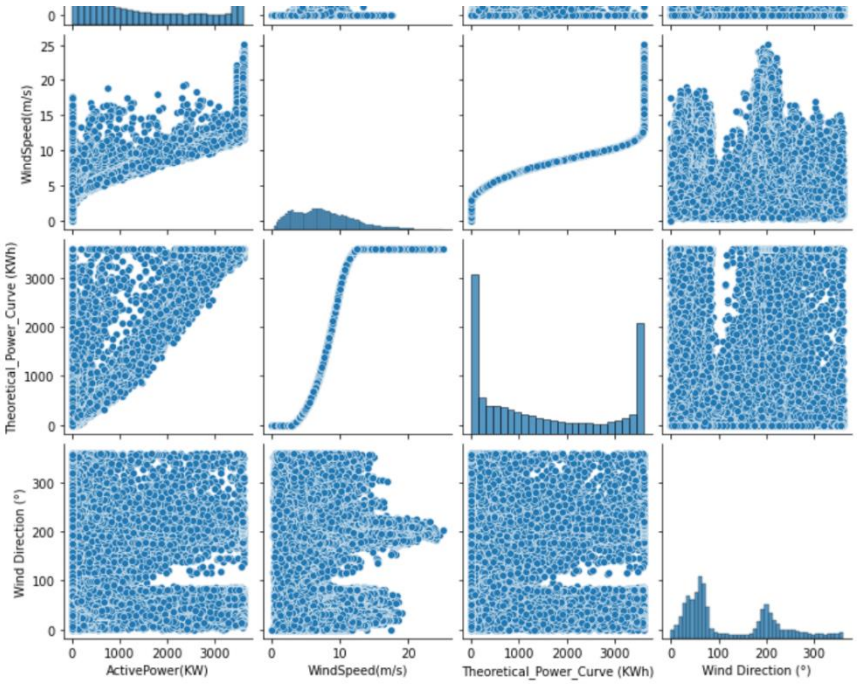
This report shows the number of test cases that have passed, failed,and untested

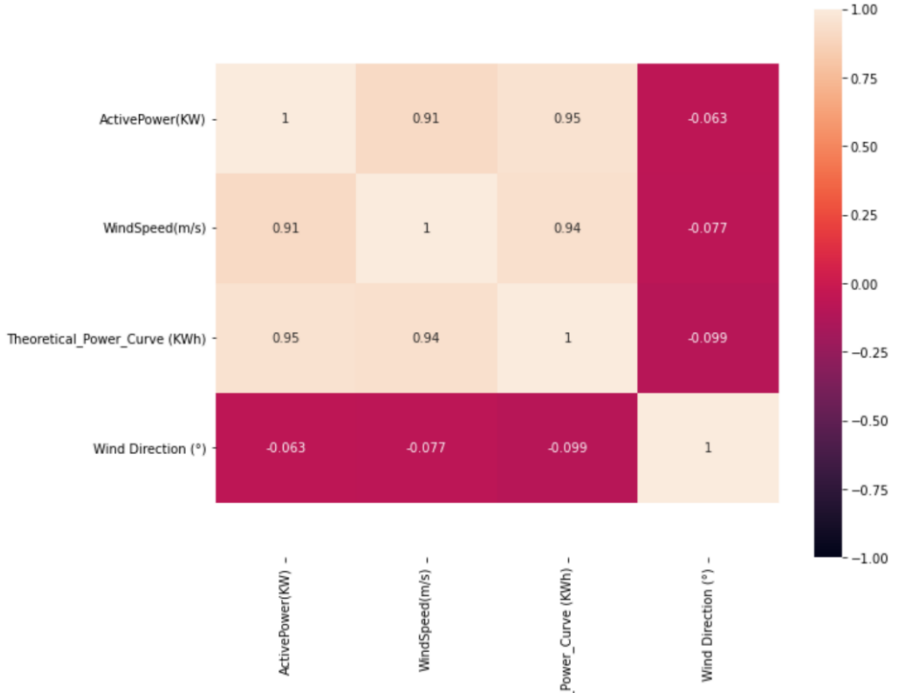
Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4

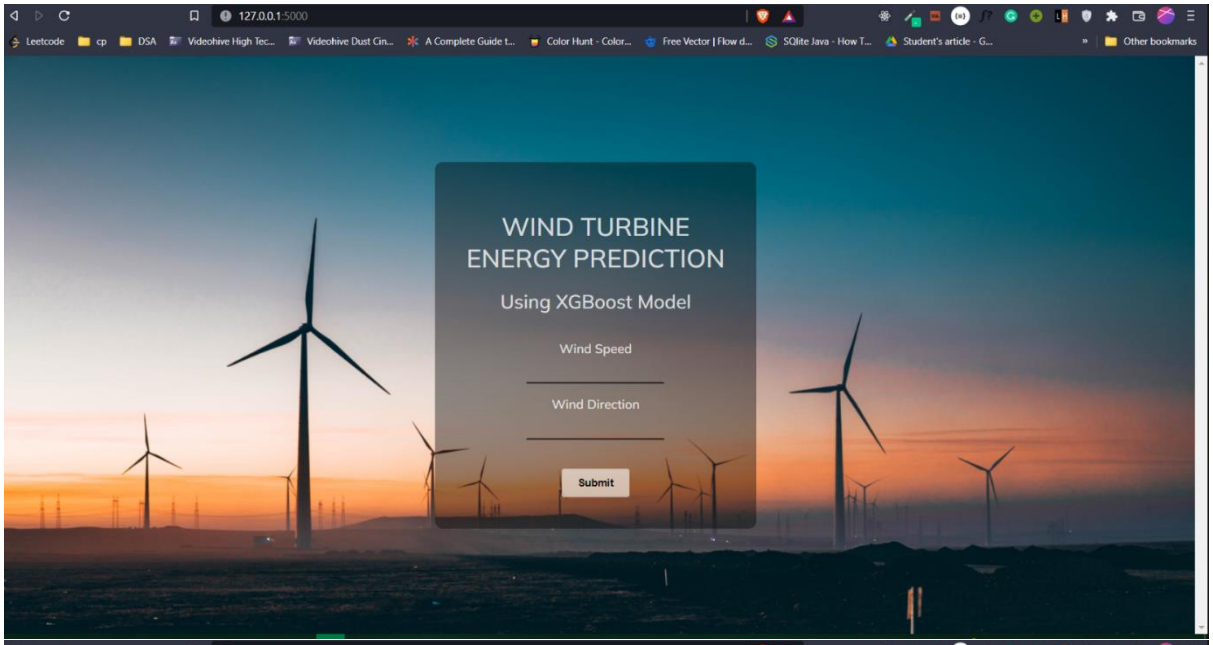
9.RESULTS:

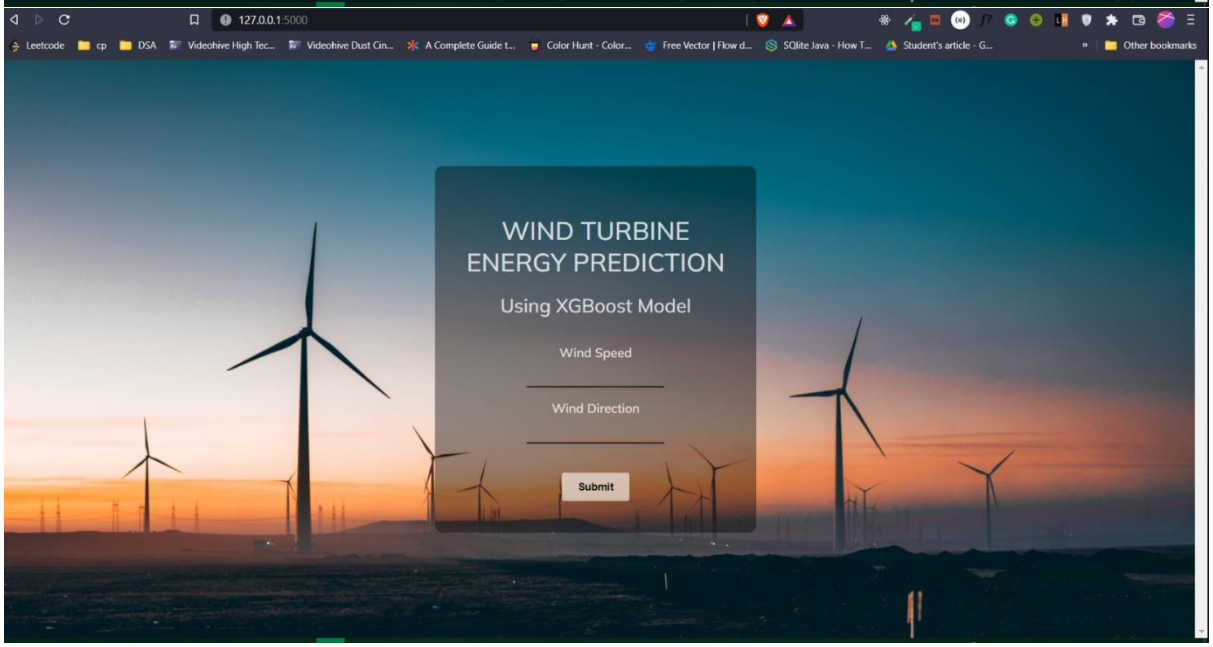
9.1 PERFORMANCE METRICS:

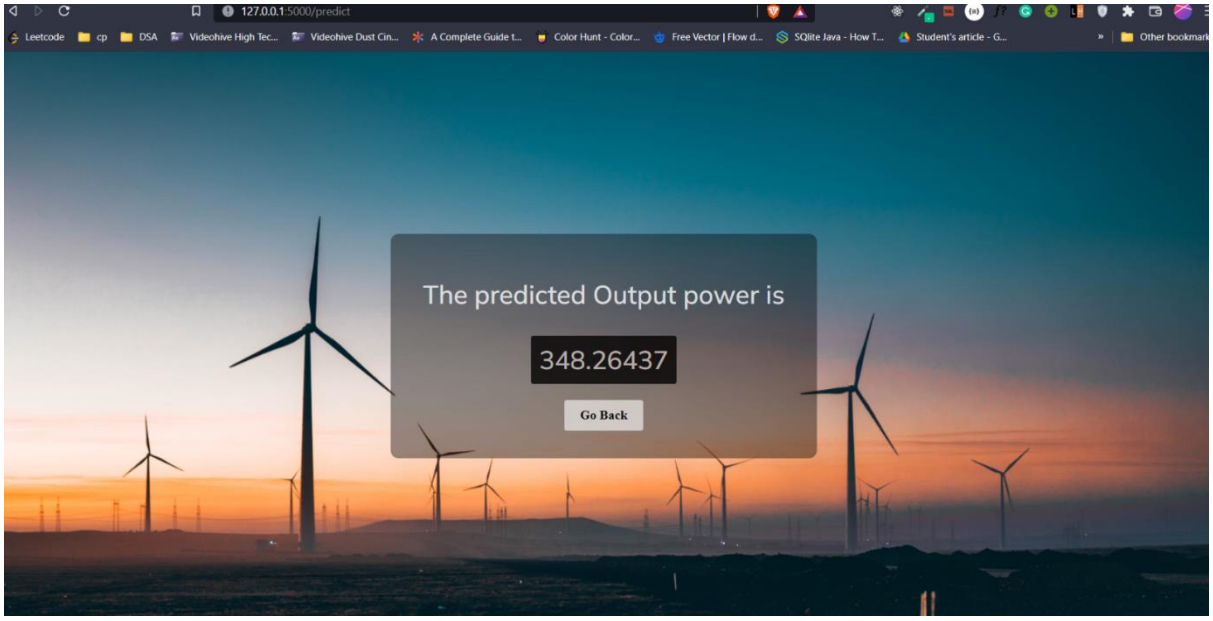
- Project metrics are used to track the progress and performance of a project.
- Monitoring parts of a project like **productivity, scheduling, and scope** make it easier for team leaders to see what's on track.
- As a project evolves, managers need access to changing deadlines or budgets to meet their client's expectations


WindSpeed(m/s)
Theoretical_Power_Curve (KWh)
Wind Direction (°)
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
ActivePower(KW)
WindSpeed(m/s)
Power_Curve (KWh)
Wind Direction (°)
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00


127.0.0.1:5000
WIND TURBINE
ENERGY PREDICTION
Using XGBoost Model
Wind Speed
Wind Direction
Submit


127.0.0.1:5000
WIND TURBINE
ENERGY PREDICTION
Using XGBoost Model
Wind Speed
Wind Direction
Submit



10. ADVANTAGES &DISADVANTAGES:

ADVANTAGES:

1) Free Fuel
2) One of the Cleanest Forms of Energy
3) Advances in Technology
4) Doesn’t Disrupt Farmland Operations
5) Reduces Our Dependence of Fossil Fuels

DISADVANTAGES:

1) Dangerous to Some Wildlife
2) Noisy
3) Expensive Upfront Cost
4) Unreliable/Unpredictable

11.CONCLUSION:

The use of appropriate features helps to improve the prediction. We used the absolute wind direction, wind speed and outdoor temperature to predictoutput power . We estimate the wind turbine performance by the capacity factor for realpower output and annual effected power output. Random forest regressor machine learning model to predict the output power. The estimated mean absolute error for our proposed model for the capacity factor 0.4 and 0.2 is 3.6% and 7.3 % respectively. These results are promising in uncertain and unpredictable wind forecast. The method offers an efficient and comfortable balancing of a preferably low prediction error. In future the problem of missing data can be solved using different imputation methods. The prediction model can be further extended to predict other parameter like fault in the wind turbine

12.FUTURE SCOPE:

Presently, the world economy is naturally subject to the viable methods of electrical force age, proper administration what's more, circulation. The regular methodologies of vitality creation have an enormous symptom on the worldwide atmosphere and atmosphere changes. As per as of late distributed reports by the International Energy Office (IEA) "Vitality related ozone depleting substance (GHG) outflows would lead to significant atmosphere debasement with a normal 6 °C worldwide warming". Thus, the perfect vitality is the achievable answer for make the world more secure. It is condition benevolent because of least CO2 sullying, which is the fundamental proportion of the nursery impact answerable for ecological corruption. Innovative work in the RE area on both the legislative also, open level will accomplish better proficiency and ensured repayment in future interest of vitality in light of the basic and minimal effort of support, solidness and the boundless sources.

13.APPENDIX:

13.1 Source Code:

INDEX.HTML

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-
scale=1.0" />
    <title>WIND TURBINE ENERGY PREDICTION</title>
    <link rel="stylesheet" href="{{ url_for('static',
filename='css/index.css') }}">
  </head>
  <body>
    <div class="container">
      <div class="glass">
        <h1 class="text" >WIND TURBINE <br>ENERGY
PREDICTION</h1>
      <h2 class="text">Using XGBoost Model</h2>
        <br>
      <form method="POST" action="/predict">
        <p class="text">Wind Speed</p>
        <input name="ws" required />
        <p class="text">Wind Direction</p>
        <input name="wd" required />
        <br />
        <br />
        <button type="submit" class="submit">Submit</button>
      </div>
    </div>
  </body>
</html>
```

PREDICT.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-
scale=1.0">
    <link rel="stylesheet" href="./css/index.css" />
    <title>Prediction</title>
</head>
<body>

    <div class="container">
        <div class="glassdoor">
            <h1 class="text">The predicted Output power is</h1>
            <h1 class="highlight">{{predict}}</h1>
            <a href="/" class="submit">Go Back</a>
        </div>
      </div>
</body>
</html>
```

APP.PY

```
import flask
from flask import request, render_template
from flask_cors import CORS
import joblib
import pandas as pd
from xgboost import XGBRegressor
app = flask.Flask(__name__, static_url_path='')
CORS(app)
```

```
@app.route('/', methods=['GET'])
def sendHomePage():
    return render_template('index.html')

@app.route('/predict', methods=['POST'])
def predictSpecies():
    ws = float(request.form['ws'])
    wd = float(request.form['wd'])

    X = [[ws,wd]]
    xgr=XGBRegressor()
    df = pd.DataFrame(X,
columns=['WindSpeed(m/s)','WindDirection'])
    xgr.load_model('static/model/test_model.bin')
    result = xgr.predict(df)[0]
    print(result)
    return render_template('predict.html',predict=result)

if __name__ == '__main__':
    app.run()
```

13.2 GITHUB LINK:
https://github.com/IBM-EPBL/IBM-Project-53704-1661489825