PREDICTING THE ENERGY OUTPUT OF WIND TURBINE BASED ON WEATHER CONDITION

1.INTRODUCTION

1.1 Project Overview

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 supplies can coordinate the collaborative production Of different energy sources more efficiently to avoid costly overproduction.

1.2 Purpose

The wind energy output can be predicted from available data with accuracy 95% by RANDOM FOREST REGRESSION ALGORITHM .By giving inputs like wind speed ,direction curve.

2.LITERATURE SURVEY

2.1 Existing problem

S.NO	TITLE	AUTHOR	YEAR	PROPOSED SYSTEM
1	A Multi-Step Prediction Method for Wind Power Based on Improved TCN to Correct Cumulative Error	Heifeng luo, Xun dou, Rong sun	2021	A Multi-step wind power prediction method was proposed by exploiting improved TCN to correct the cumulative error. First, multi-scale convolution (MSC) and self-attentiveness (SA) were adopted to optimize the problem that a single-scale convolution kernel of TCN is difficult to extract temporal and spatial features at different scales of the input sequence.
2	Remotely Sensed Winds and Wind Stresses for Marine Forecasting and Ocean Modeling	Mark A. Bourassa, Thomas Meissner, Ivana Cerovecki	2019	Remotely sensed surface winds (scalar winds and vector winds) with related material on surface stress, air-sea heat fluxes, currents, sea state, and precipitation.
3	Wind Generation Forecasting Methods and Proliferation of Artificial Neural Network	Muhammad Shahzad Nazir, Fahad Alturise, Sami Alshmrany	2020	Wind forecasting methods and the artificial neural network, The instrument used to measure wind assimilation is analyzed and discussed, accurately. The high forecasting accuracy could be achieved through proper handling and calibration of the wind-

4	Long term wind power forecast using adaptive wavelet neural network	Bhaskar-Kanna, Sn-Singh	2016	Mapping the NWP's wind speed and wind direction forecasts to wind power forecasts. Wind direction inheritantly being a circular variable, for better training and function approximation, a transformed version of wind direction variables are used as inputs.
5	Data mining for wind power forecasting	Lionel-Fugon, George-Kariniotakis, Jeremie-Juban	2008	Data Mining type of models for wind power forecasting. Models that are examined include neural networks, support vector machines, the recently proposed regression trees approach, and others. Evaluation results are presented for several real wind farms.

2.2 References

1. Luo H, Dou X, Sun R and Wu S (2021) A Multi-Step Prediction Method for Wind Power Based on Improved TCN to Correct Cumulative Error. Front. Energy Res. 9:723319. do i: 10.3389/fenrg.2021.723319.

2. Bourassa MA, Meissner T, Ostroveckij I, Chang PS, Dong X, De Chiara G, London C, Tchaikovsky DS, Elya J, Fore A, Viewings MR, Foster RC, Gille ST, Haus BK, Hristova-Veleva S, Holbach HM, Jelenak Z, Knaff JA, Kranz SA, Manaster A, Mazloff M, Mears C, Mouche A, Portabella M, Reul N, Ricciardulli L, Rodriguez E, Sampson C, Solis D, Stolen A, Stukel MR, Stiles B, Weissman D and Wentz F (2019) Remotely Sensed Winds and Wind Stresses for Marine Forecasting and Ocean Modeling. Front. Mar. Sci. 6:443. do i: 10.3389/fmars.2019.00443.

3. Nazir, Muhammad Shahzad, Fahad Alturise, Sami Alshmrany, Hafiz. M. J Nazir, Muhammad Bilal, Ahmad N. Abdalla, P. Sanjeevikumar, and Ziad M. Ali. 2020. "Wind Generation Forecasting Methods and Proliferation of Artificial Neural Network: A Review of Five Years Research Trend" Sustainability 12, no. 9: 3778. https://doi.org/10.3390/su12093778 .

4. Bhaskar-Kanna, Sn-Singh, Long term wind power forecast using adaptive wavelet neural network(2016), doi.org/10.1109/UPCON.2016.7894735.

5. Lionel-Fug on, George-Kariniotakis, Jeremie-Cuban, Data mining and wind power prediction(2008), Accepted 1 February 2012, Available online 29 March 2012. https://doi.org/10.1016/j.renene.2012.02.01

2.3 Problem Statement Definition

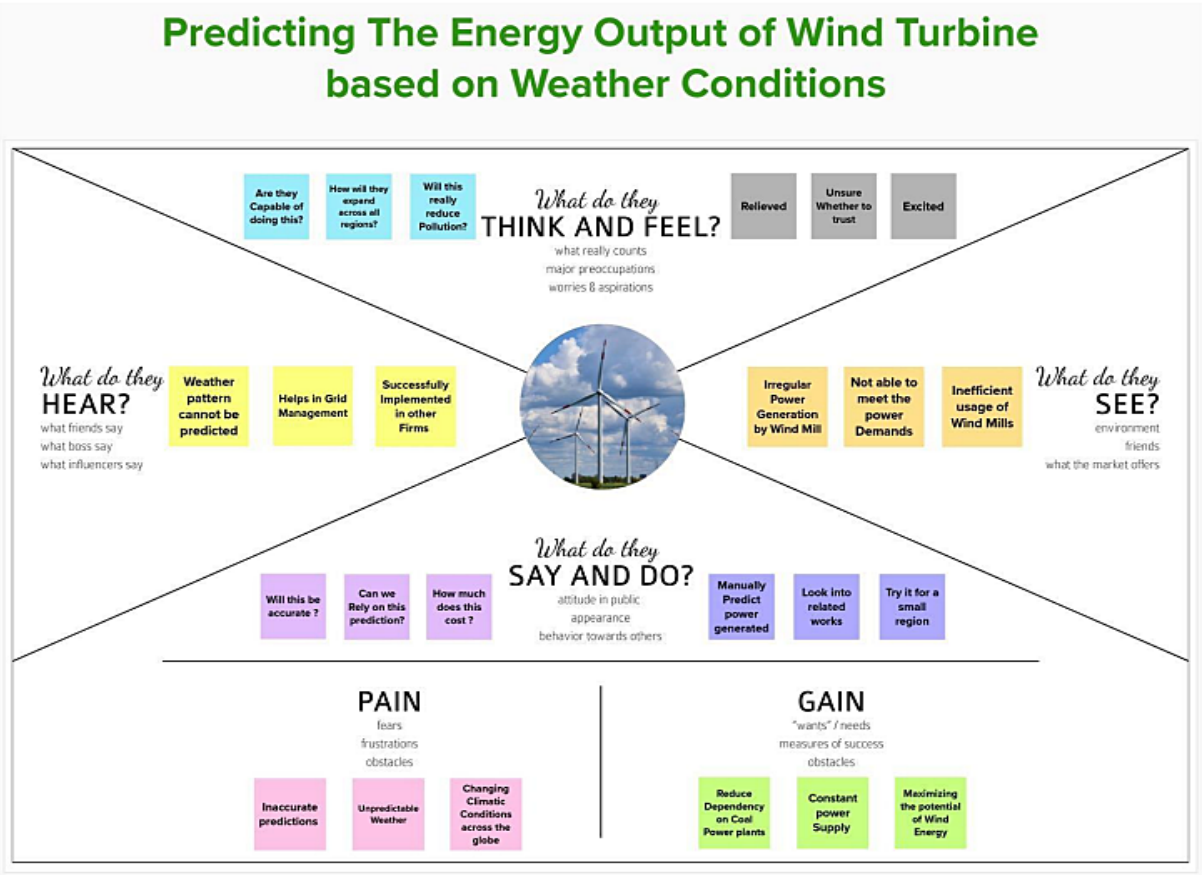
The prediction of wind power plays an indispensable role in maintaining the stability of the entire power grid. Due to its renewable resources and environmental friendliness, wind speed/power has gained increasing interest worldwide. The wind industry is rapidly expanding into a large-scale industry 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.

Problem Statement (PS)	**I am (Customer)**	**I'm trying to**	**But**	**Because**	**Which makes me feel**
PS-1	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
PS-2	user	Prevent power cuts and find a reliable energy resource	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
PS-3	organization	Produce wind energy	I face overproduction and high-cost issues	I can't accurately predict the wind energy	sad

3. IDEATION & PROPOSED SOLUTION

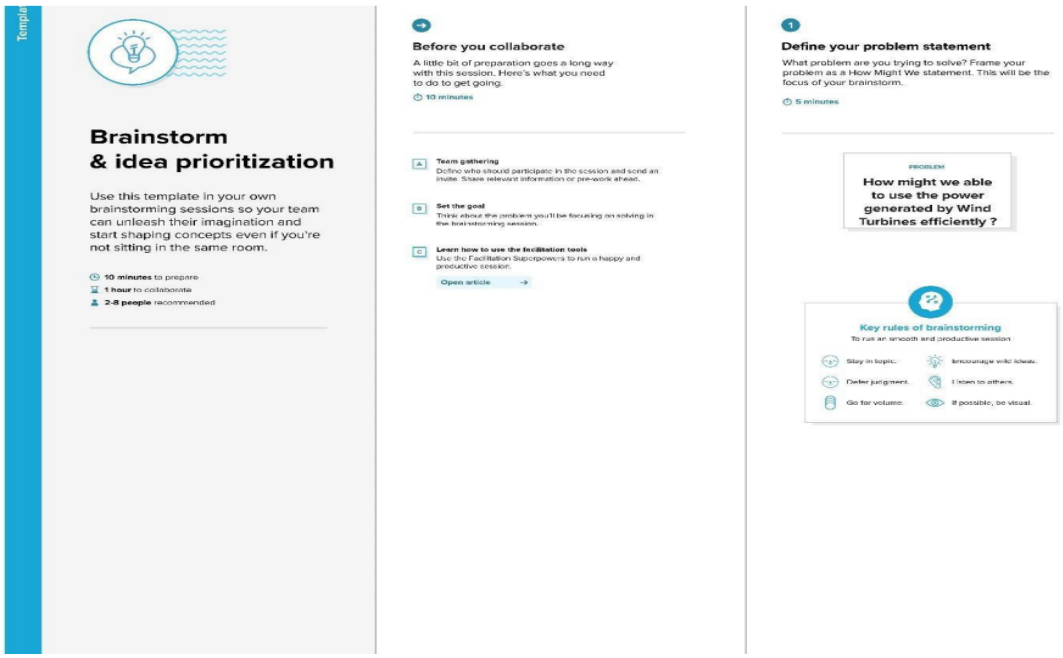
3.1 Empathy map

Empathy Map:

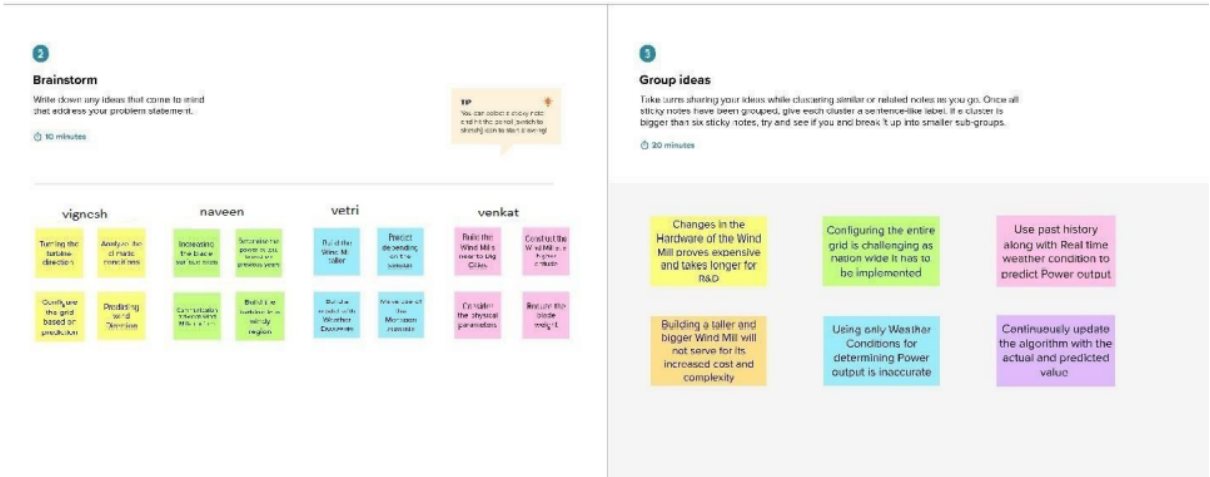


3.2 Ideation & Brainstorming

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



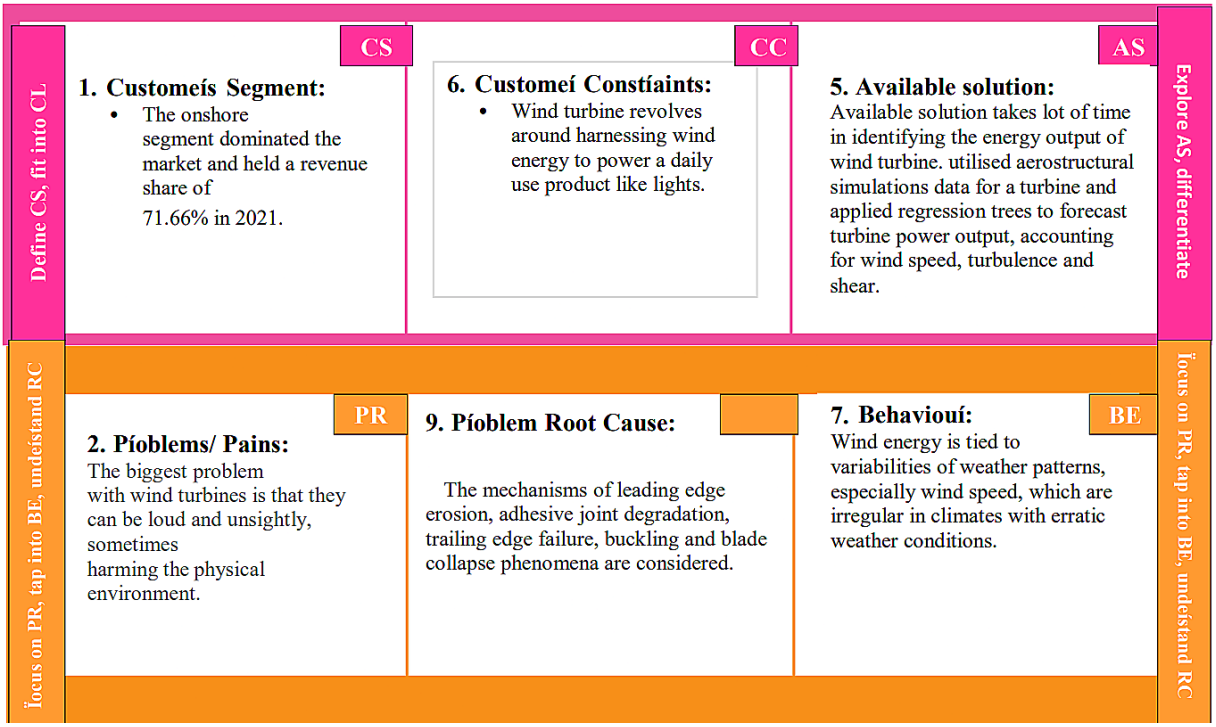
Step 2: Brainstorm, Idea listing and Grouping

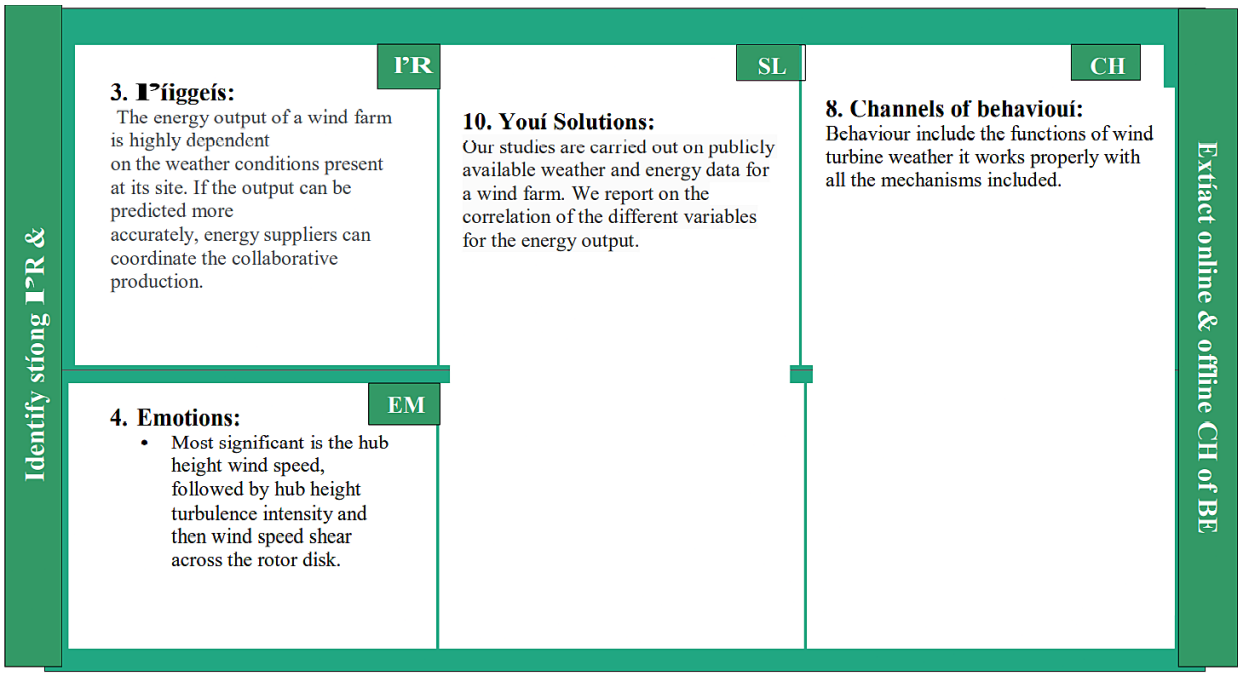


3.3 Proposed Solution

S.NO	Parameter	Description
1.	Problem Statement (Problem to be solved)	Our aim is to map weather data to energy production. The model prediction is then showcased on user interface to predict the energy output of wind turbine.
2.	Idea / Solution description	Our approach was to use a time series forecasting model that would generate point forecast of wind generation for the upcoming three days, for a wind turbine.
3.	Novelty / Uniqueness	It will be working on bad weather condition. Precise information on timing Fluctuation in weather conditions
4.	Social Impact / Customer Satisfaction	Wind energy jobs in rural communities in manufacturing, transportation and project construction.
5.	Business Model (Revenue Model)	• Identifying most significant features for wind power prediction. • Continuous learning and model improvement by hybrid ensemble with data and function perturbation. • Predicting best time for wind farm energy utilization. • Integrating weather conditions for predicting various time periods like per day, per week, per month, and annual reports for wind energy generation. • Graphical representations and reports to support various business decisions on improving wind energy generation. • Balancing production and utilization of the wind energy
6.	Scalability of the Solution	• To identify more environment parameters for testing their impact on wind energy generation. • To avail on-demand supply of wind energy. • To predict customer usage pattern and try to map with the wind energy generation for better business production

3.4 Problem Solution fit





4. REQUIREMENT ANALYSIS

4.1 Functional requirement

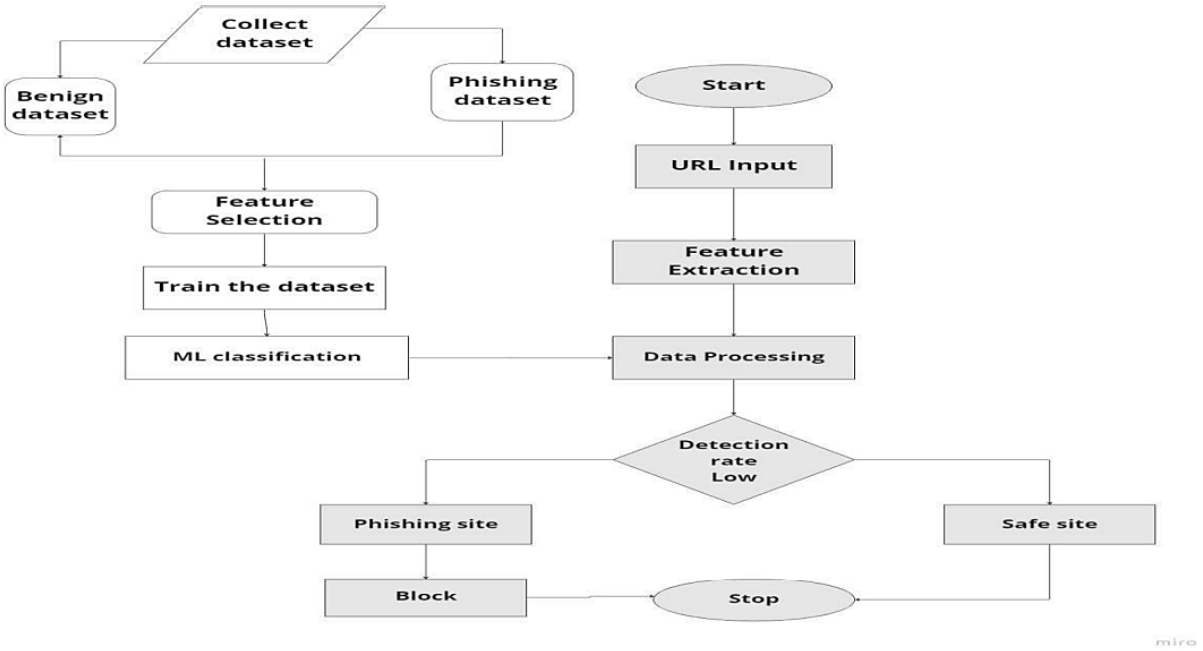
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration and logging in by entering their username and password.	Registration through Form.
FR-2	User Confirmation by validating the username with respect to the password	Confirmation via pop-up Message.
FR-3	Displaying the further information about the application.	By selecting the about button 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	It displays the weather of the city which have been

4.2 Non Functional Requirement

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 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.

5. PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture

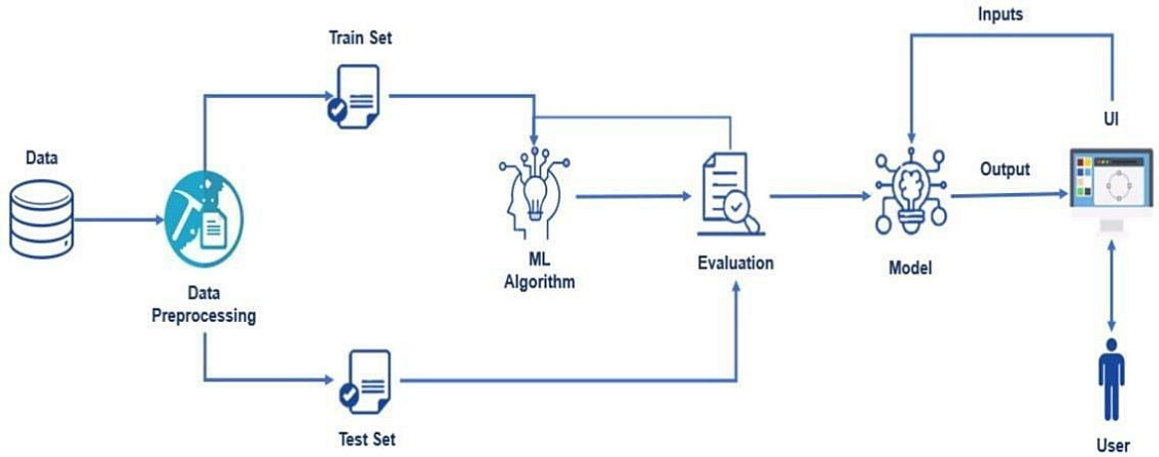


Table: Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g. Web UI, Mobile App, Chatbot etc.	HTML, CSS
2.	Application Logic	Logic for a process in the application	Python
3.	Cloud Database	Database Service on Cloud	IBM Cloud Storage
4.	File Storage	File storage requirements	Local Filesystem
5.	Machine Learning Model	Purpose of Machine Learning Model	Random Forest , Linear Regression

5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the website by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the website through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the website through Gmail	I can receive confirmation email.	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the website by entering email & password	I can receive confirmation email.	High	Sprint-1
	Dashboard	USN-6	As a user I can use a website through dashboard	I can access the dashboard	High	Sprint-1
Customer (Web user)	User input	USN-1	As a user, I can input the particular URL in the required field and wait for validation	I can access the website without any problem	High	Sprint-1
Customer Care Executive	Feature Extraction	USN-1	As a user, I can extract feature using heuristic and visual similarity approach	I can have comparison between website for security	High	Sprint-1
Administrator	Detection	USN-1	I will detect the URL using machine learning algorithm.	I can correctly detect on the particular algorithms	High	Sprint-1
	Classifier	USN-2	I will send the all output model to classifier in order to display final result.	I will find the correct classifier for producing the result.	Medium	Sprint-2

6. PROJECT PLANNING & SCHEDULING

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	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	5	High	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N
Sprint-1		USN-3	As a user, I can register for the application through mobile number.	3	Low	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N
Sprint-1		USN-4	As a user, I can register for the application through Gmail	2	Medium	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-5	As a user, I can log into the application by entering email & password	5	High	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N
Sprint-2	Dashboard	USN-6	Once logged in, I can access my dashboard	6	Medium	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N
Sprint-2	Web Access	USN-7	As a user, I can access the website to predict the turbine power	7	High	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N
Sprint-2	Prediction	USN-8	As a customer, when I enter the detail the website should predict the approximate turbine power	7	High	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N
Sprint-3	Analysis	USN-9	As a customer, I wish to store my predictions and make analysis	10	Medium	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N
Sprint-3	Security	USN-10	As a customer I expect my data to be secured	10	Medium	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-4	Database Access	USN-11	As an administrator, I should maintain the website and keep updating it regularly	20	Medium	Vignesh R Vetrivel murugan K Naveen M Venkatrajan N

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	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)	Average Velocity (AV)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022	3.333
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022	3.333
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022	3.333
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022	3.333

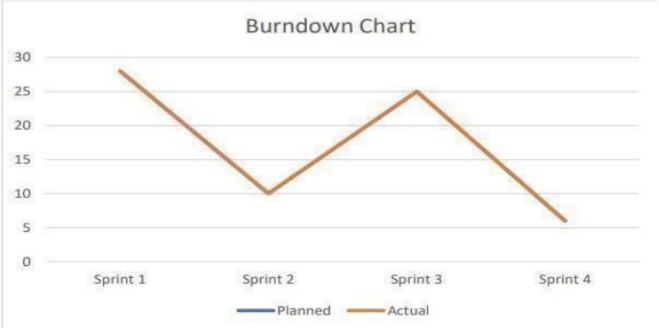
Total No of Days = 6 + 6 + 6 + 6 = 24 Days

Total Story Points = 20 + 20 + 20 + 20 = 80 Points

Average Velocity Per Sprint = 80 / 24 = 3.333

Burndown Chart:

A burndown chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies suchas Scrum. However, burn down charts can be applied to any project containing measurable progress over time.



7. CODING & SOLUTIONING

app.py

```
import numpy as np
from flask import Flask, request, jsonify, render_template
import joblib
import requests
from dotenv import load_dotenv
from os import getenv


load_dotenv()
apikey=getenv('API_KEY')

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')

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)
@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.predict(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)
```

locustfile.py

```
import time
from locust import HttpUser, task, between

class QuickstartUser(HttpUser):
    wait_time = between(1, 5)

    @task
    def hello_world(self):
        self.client.get("/")
        self.client.get("/predict")

    @task(3)
    def view_items(self):
        self.client.get("/")
        self.client.get("/predict")
```

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/c4d2f98e88a85b702f8ff
257d74714d8.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="http://localhost:5000/predict"><button type="button" class="myButton" >Click Here To Predict The wind Energy!</button></a>
      </div></div>
    </body>
</html>
```

predict.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/c4d2f98e88a85b702f8ff
257d74714d8.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="http://localhost:5000/predict"><button type="button" class="myButton" >Click Here To Predict The wind Energy!</button></a>
        </div>



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

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>
```

8. TESTING

Acceptence Testing

1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] project at 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, and how 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

3. 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

9. RESULTS

9.1 Performance Metrics

Locust Test Report

During: 11/18/2022, 11:46:18 AM - 11/18/2022, 11:48:35 AM

Target Host: http://localhost:5000

Script: locustfile.py

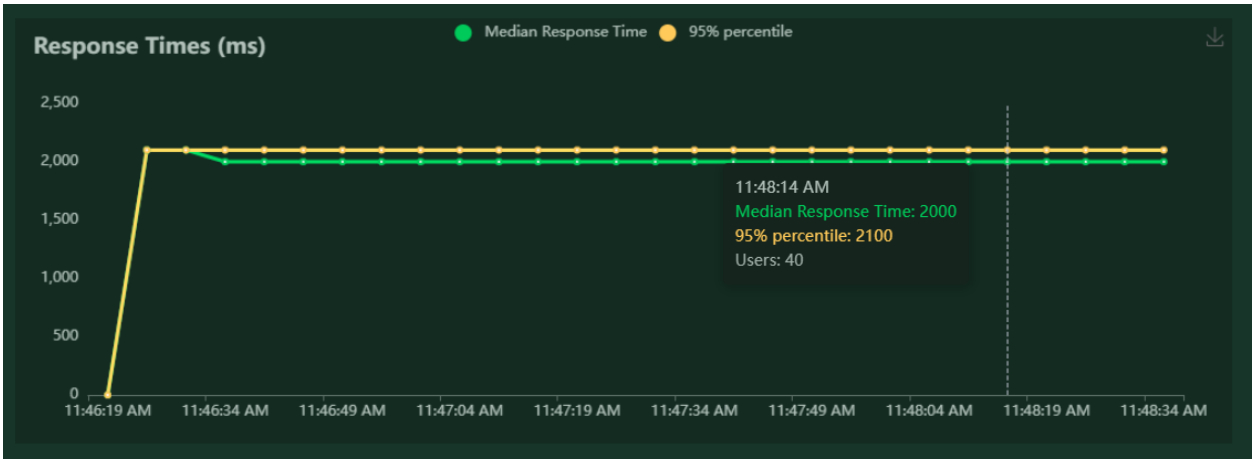
Request Statistics

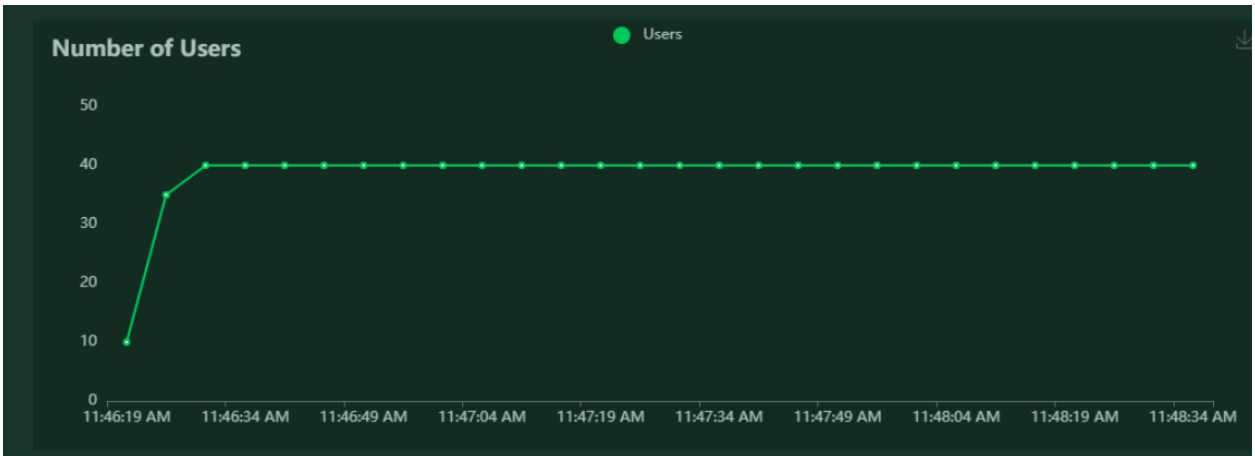
Method	Name	# Requests	# Fails	Average (ms)	Min (ms)	Max (ms)	Average size (bytes)	RPS	Failures/s
GET	/	764	0	2046	2014	2081	2244	5.6	0.0
GET	/predict	748	0	2046	2017	2080	7465	5.5	0.0
	Aggregated	**1512**	**0**	**2046**	**2014**	**2081**	**4826**	**11.1**	**0.0**

Response Time Statistics

Method	Name	50%ile (ms)	60%ile (ms)	70%ile (ms)	80%ile (ms)	90%ile (ms)	95%ile (ms)	99%ile (ms)	100%ile (ms)
GET	/	2000	2000	2100	2100	2100	2100	2100	2100
GET	/predict	2000	2000	2100	2100	2100	2100	2100	2100
	Aggregated	**2000**	**2000**	**2100**	**2100**	**2100**	**2100**	**2100**	**2100**

Charts





Final ratio

Ratio per User class

- 100.0% QuickstartUser
  - 25.0% hello_world
  - 75.0% view_items

Total ratio

- 100.0% QuickstartUser
  - 25.0% hello_world
  - 75.0% view_items

10. ADVANTAGES & DISADVANTAGES

Pros

- Accurate wind power forecasts are also important in reducing the occurrence or length of curtailments (which translate to cost savings). improved worker safety, and mitigating the physical impacts of extreme weather on wind power systems

- Wind speed forecasting naturally has greater value where balancing markets are part of a competitive trading system for electricity, because the balancing market provides financial incentives to the generators and retailers for accurate output predictions.

Cons

- The challenges to face when wind generation is injected in a power system depend on the share of that renewable energy.

- The unsteadiness and the turbulence of the wind may vary the wind speed predictions hence pose a threat to the wind turbine from cut-off speed

- The power output does not take into consideration the power loses due to wire cables or other resistance offering components.

- Wind gusts are not taken into the consideration while generating the predictions due to their unpredictability and lack of proper data.

- The model generates theoretical power forecasts close enough to the active power, thus the results cannot be taken as accurate point forecasts of the power values.

11. CONCLUSION

In this project, we have established the application to predict future windpower output values based on the regressor and deep learning models. The UI provides a great deal of information to anyone who would like to know about the future power output presented in theform of visualizations. Deploying it to the cloud makes it more scalable.

12. FUTURE SCOPE

- The results are quite promising, but there is still a room for further improvement. With the availability of daily wind turbine output data for a minimum of 3-4 years, we can use neural networks to understand the mapping of the calculated power into the active power due to the weather variables.

- Wind power generation is directly linked to weather conditions and thus the first aspect of wind power forecasting is the prediction of future values of the necessary weather variables at the level of the wind farm. However, even by better understanding and modelling both the meteorological and power conversion processes, there will always be an inherent and irreducible uncertainty in every prediction.

- This internal uncertainty corresponds to the incomplete knowledge one has of the processes that influence future events. Thus, rather than generating point forecasts of power outputs for consecutive hours, we should predict maximum power outputs for a day.

13. APPENDIX

SOURCE CODE

```
<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-
fnmOCqbTlWIlj8LyTjo7mOUStjsKC4pOpQbqyi7RrhN7udi9RwhKkMHpvLbHG9
Sr" crossorigin="anonymous" />
    <link href="https://fonts.googleapis.com/css?family=Dosis"
rel="stylesheet" />
    <link rel="stylesheet"
href="{{url_for('static',filename='css/main.css')}}"/>
    <link rel="stylesheet"
href="{{url_for('static',filename='css/media.css')}}"/>
    <link rel="stylesheet"
href="{{url_for('static',filename='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>
```

GITHUB LINK:

https://github.com/IBM-EPBL/IBM-Project-32667-1660211278

PROJECT DEMO LINK: