IBM NALAIYA THIRAN PROJECT REPORT

Predicting the Energy Output of Wind Turbine Based On Weather Condition

BY TEAM MEMBERS,

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INTRODUCTION

Project Overview:

Wind energy plays an increasing role in the supply of energy worldwide. The energy output of a wind farm is highly dependent on the weather conditions present at its site. We take energy prediction based on weather data and analyze the important parameters as well as their correlation on the energy output. To deal with the interaction of the different parameters, we use random forest regression of machine learning algorithms. The model obtained for energy prediction gives a very reliable prediction of the energy output for supplied weather data.

Purpose *:*

Machine learning (ML) is a field of inquiry devoted to understanding and building methods that 'learn', that is, methods that leverage data to improve performance on some set of tasks. Machine learning algorithms build a model based on sample data, known as training data, in order to make predictions or decisions without being explicitly programmed to do so. In statistical modeling, regression analysis is a set of statistical processes for estimating the relationships between a dependent variable and one or more independent variables. Regression analysis is primarily used for two conceptually distinct purposes.First, regression analysis is widely used for prediction and forecasting, where its use has substantial overlap with the field of machine learning.Second, in some situations regression analysis can be used to infer causal relationships between the independent and dependent variables.

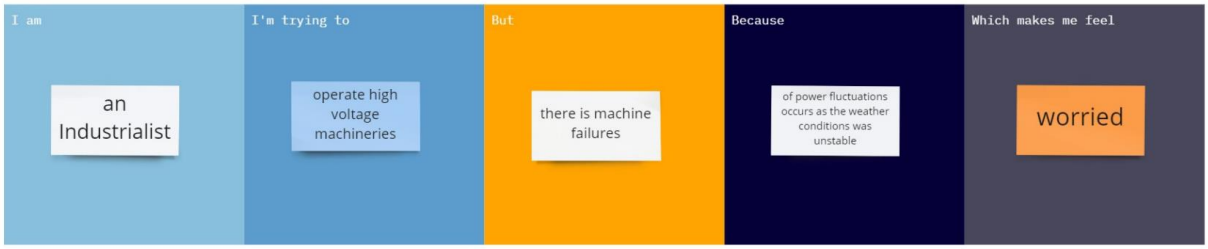
LITERATURE SURVEY

Existing problem :

Create a problem statement to understand your customer's point of view. The Customer Problem Statement template helps you focus on what matters to create experiences people will love.

A well-articulated customer problem statement allows you and your team to find the ideal solution for the challenges your customers face. Throughout the process, you'll also be able to empathize with your customers, which helps you better understand how they perceive your product or service.

Example



Reference:

(1.) The State-Of-The-Art in Short-Term Prediction of Wind Power

Author:Gregor Giebel

This report will give an overview over past and present attempts to predict wind power for single turbines or for whole regions, for a few minutes or a few days ahead. It has been produced for the ANEMOS project [1], which brings together many groups from Europe involved in the field, with up to 15 years of experience in short-term forecasting. The literature search involved has been extensive, and it is hoped that this report can serve as a reference for all further work. One of the largest problems of wind power, as compared to conventionally generated electricity, is its dependence on the volatility of the wind. therefore determined by the time constants in the grid (from minutes to weeks).

(2).Validations on wind power plant models

Authors: E Muljadi , A Ellis

Wind energy will continue to grow at a rapid pace and will provide an increasingly large portion of the total electricity generation. To achieve its full potential, the industry needs adequate wind-turbine generator (WTG) dynamic models to determine the impact of adding wind generation, and establish how the system needs to be upgraded .For the most part, WTG manufacturers have sponsored the development of WTG dynamic models. Models developed under this paradigm tend to be proprietary and specific to a particular WTG model.

(3).Forecasting of Wind Turbine Output Power Using Machine learning

Authors: Haroon Rashid, Waqar Haider, Canras Batunlu

Most of the countries around the world are facing huge environmental impact, and the most promising solution to mitigate these is the use of renewable energy, especially wind power. Though, the use of offshore wind energy is rapidly increasing to meet the elevating electricity demand. The researchers and policymakers have become aware of the importance of providing near accurate prediction of output power. Wind energy is tied to variabilities of weather patterns, especially wind speed, which are irregular in climates with erratic weather conditions. In this paper, we predicted the output power of the wind turbines using the random forest regressor algorithm.The SCADA data is collected for two years from a wind farm located in France. The model is trained using the data from 2017. The wind direction, wind speed and outdoor temperature are used as input parameters to predict output power. We test our model for two different capacity factorS.

(4).Integrative Density Forecast and Uncertainty Quantification of Wind Power Generation

Authors: Jingxing Wang, Abdullah Alshelahi, Mingdi You, Eunshin Byon, and Romesh Saigal

The volatile nature of wind power generation creates challenges in achieving secure power grid operations. It is, therefore, necessary to accurately predict wind power and its uncertainty quantification. Wind power forecasting usually depends on wind speed prediction and the wind-to-power conversion process. However, most current wind power prediction models only consider portions of the uncertainty. This paper develops an integrative framework for predicting wind power density, considering uncertainties arising from both wind speed prediction and the wind-to-power conversion process.

(5) Predicting The Energy Output Of Wind Turbine Based On Weather Condition:

Authors: S Preethi, H Prithika, M Pramila, S Birundha

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 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.

Problem Statement Definition:

A problem statement is important to a process improvement project because it helps clearly identify the goals of the project and outline the scope of a project. It also helps guide the activities and decisions of the people who are working on the project. The problem statement can help a business or organization gain support and buy-in for a process improvement project.

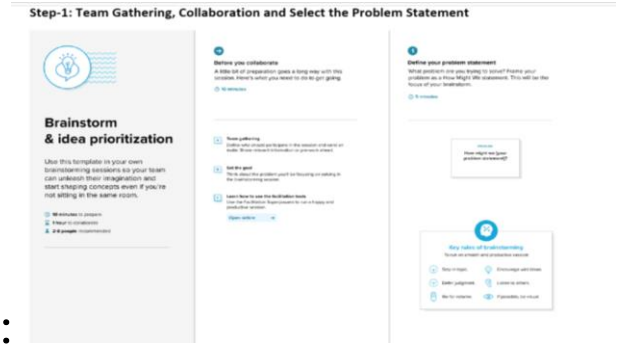
- ☞ The example used here will be an industrialist who's having a trouble in operating high voltage machines as there is a power fluctuations caused by weather condition which leads to machine failure.

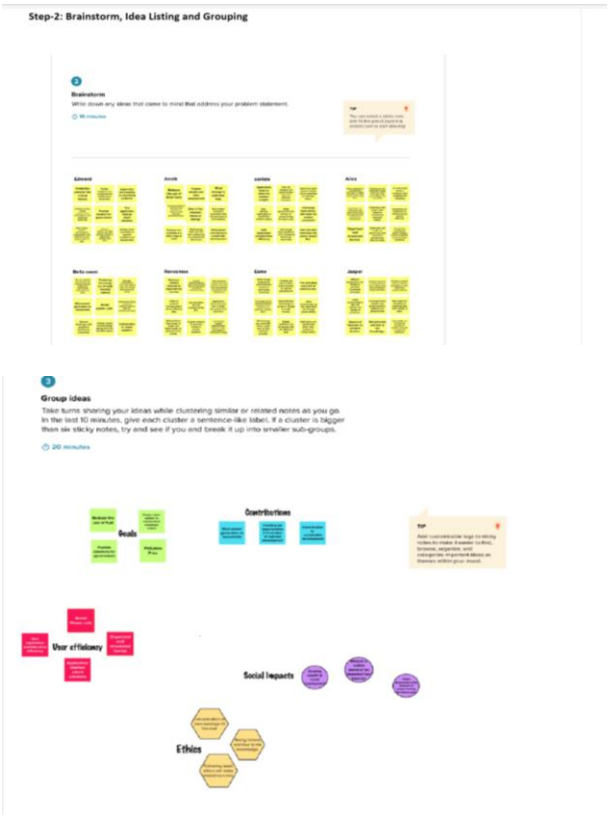
IDEATION & PROPOSED SOLUTION

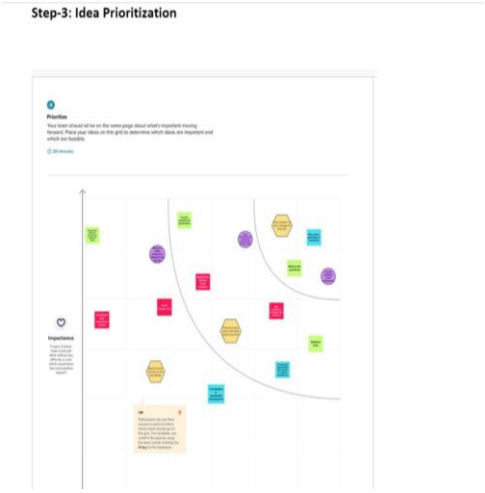
Empathy Map Canvas:

Ideation & Brainstorming:

:







ProposedSolution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	The example used here will be an industrialist who's having a trouble in operating high voltage machines as there is a power fluctuations caused by weather condition which leads to machine failure.
2.	Idea / Solution description	❖ According to the place (location) the parameters like temperature, air flow, pressure, etc... can be obtained. By this the energy produced from the wind turbines can be updated. ❖ From this information, the user (industrialist) Will get the notification on his/her connected device with the complete details of the energy produced.
3.	Novelty / Uniqueness	❖ Let it be the natural calamities like thunderstorm or rainfall, the information will reach the user by application. ❖ As the prior information about the weather reaching the user may reduce severe damages like turbine engines and machines

Problem Solution fit:

REQUIREMENT ANALYSIS

Functional requirement:

Energy Forecasting

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Registration	Registration through Application If customer wants to check their weather, temperature, Humidity they must be registered first.
FR-2	Login	After registration Confirmation were received via Email. • User received confirmation, He/ She can Login through valid user id and password you provide.
FR-3	Location	Turn on location service for getting better local search results and Detect location by GPS and network.
FR-4	Modify Location	• Search and Manage the Multiple location. • Customer can see weather in any places you like.
FR-5	Forecast for free	• This Application offers daily weather, hourly weather forecast . • Forecasts which includes atmospheric pressure, weather condition, visibility distance, relative humidity, wind speed and direction, in addition to 32 hourly future weather forecast.
FR-6	Predict the wind energy	From the output of the wind speed customer can easily predict the Energy outcome through the weather condition
FR-7	Store & Share	The report what are the customer get collected has option to save and share through email, messages, etc,..
FR-8	Reports	The Final report that customer should get , • Hourly and Daily forecast • Pressure, Temperature, Humidity, Wind Speed. • The prediction of energy.

Non-Functional requirements:

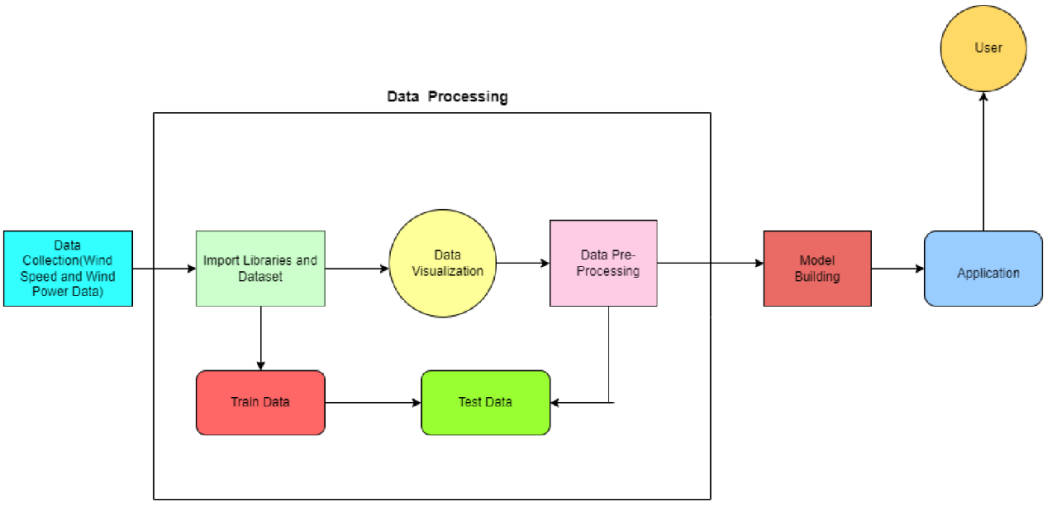
Non-functional Requirements:

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

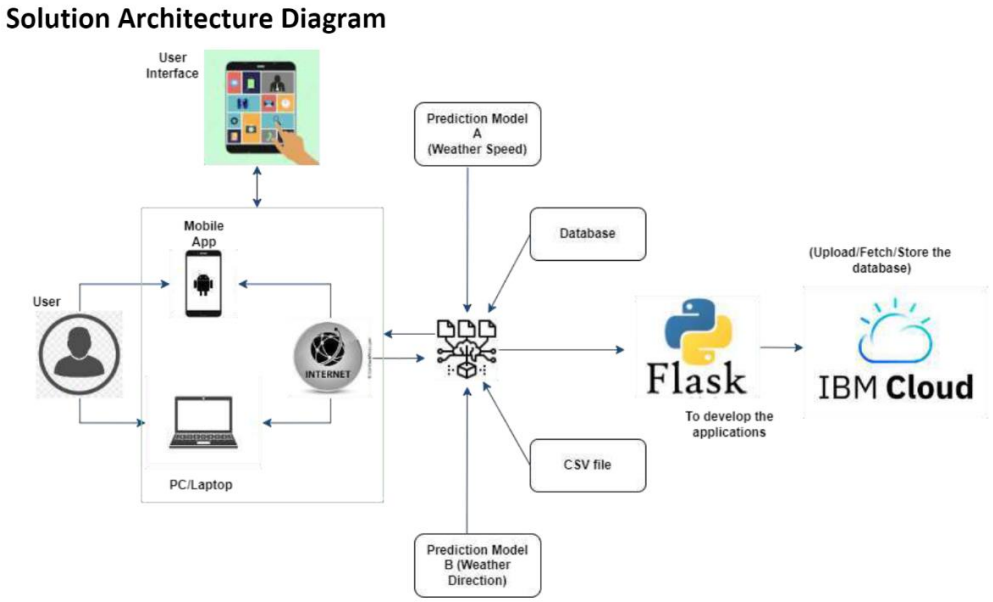
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Application should be easily used by the customer.
NFR-2	Security	• A web application firewall works by inspecting and, if necessary, blocking data packets that are considered harmful. • Application security enhance the security of an application by making it less vulnerable to threats
NFR-3	Reliability	The ability of the application working constantly in the way of user acceptable manner when working within the specified environment over a set duration of time.
NFR-4	Performance	• The application helps in predicting the energy produced by the wind turbine. • By selecting the location over the local area or world wide we can easily get the wind speed, Pressure, humidity and so on based on the location we selected. • Using this information customer can easily predict the energy produced by the wind turbine. • Performance should be very accurate and reliable.
NFR-5	Availability	This application forecast the live information and should be available at all times. The user can access the application by using a web browser, only restricted by the down time of the server on which system runs.
NFR-6	Scalability	Application scalability may depends upon the response time of the particular software and also based on the network usage and memory usage.

PROJECT DESIGN

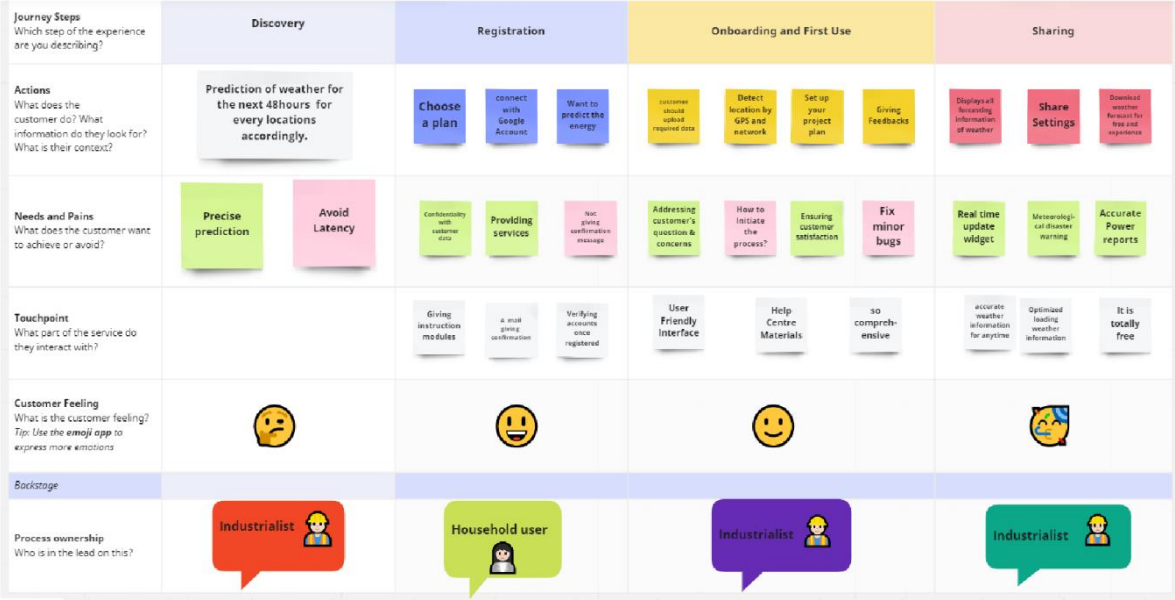
Data Flow Diagrams:

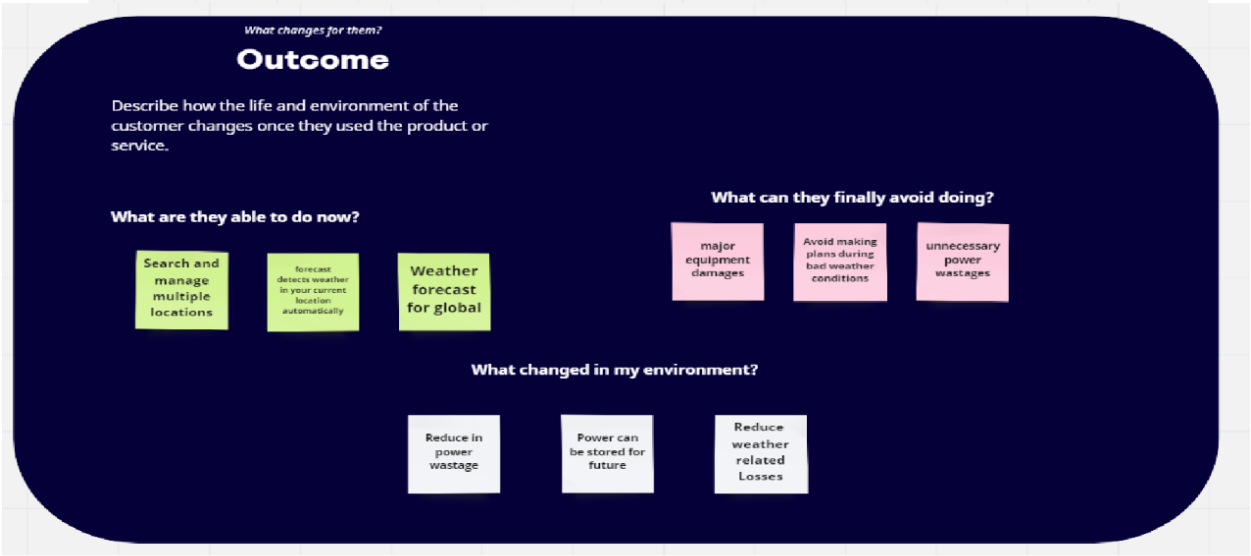


Solution & Technical Architecture:



User Stories:





Sprint Planning & Estimation:

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

Sprint Delivery Schedule:

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 giving email and password followed by a captcha	2	High	K. R. Sivasakthi R. Subashini R. Vaishnavi R. Vigneshwari
Sprint-1	Registration	USN-2	After the registration, I will get my confirmation mail	1	High	K. R. Sivasakthi R. Subashini R. Vaishnavi R. Vigneshwari
Sprint-1	Registration	USN-3	As a user , I can register through Google account	2	Medium	K. R. Sivasakthi R. Subashini R. Vaishnavi R. Vigneshwari
Sprint-2	Registration	USN-4	As a user , I can register through Facebook	1	Low	K. R. Sivasakthi R. Subashini R. Vaishnavi R. Vigneshwari
Sprint-1	Login	USN-5	As a user, I can login the application by email and password	2	High	K. R. Sivasakthi R. Subashini R. Vaishnavi R. Vigneshwari
Sprint-1	Dashboard	USN-6	As a user , I have an access to customer portal, predictions and measurements of data	2	High	K. R. Sivasakthi R. Subashini R. Vaishnavi R. Vigneshwari
Sprint-2	Dashboard	USN-7	As a user , I can visualize the graphs , maps , scatterplots through the application	1	Low	K. R. Sivasakthi R. Subashini R. Vaishnavi R. Vigneshwari
Sprint-1	Notifications	USN-8	As a user , I will be notified about the weather events and meteorological forecasts	2	High	K. R. Sivasakthi R. Subashini R. Vaishnavi R. Vigneshwari

CODING & SOLUTIONING

Intro.html:

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

                <div class="header">Predicting The Energy Output Of Wind Turbine Based On
Weather Condition</div>
                <div class="second">
                        <div class="inside">Renewable energy, such as wind and solar energy,
plays an increasing role in the supply of energy worldwide. 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>
                                The amount of electricity generated by wind increased by almost
273 TWh in 2021 (up 17%), 45% higher growth than that achieved in 2020 and the largest of all
power generation technologies. Wind remains the leading non-hydro renewable technology,
generating 1 870 TWh in 2021, almost as much as all the others combined.
                <br><br><br>
                <a href="{{url_for('predict')}}"><button type="button" class="myButton" >Click
Here To Predict The wind Energy!</button></a>
                </div>


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

Intro.css:

```
.header {
    top:0px;
    margin:0px;
    left: 0px;
    right: 0px;
    position: fixed;
    background-image: linear-gradient(to right,rgb(123, 231, 84) , rgb(140, 191, 220));
    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: 50%;
    background-image:url('https://i.gifer.com/79S2.gif');
    background-repeat:no-repeat;
    background-size: contain;
}
.inside{
    top:90px;
    bottom:0px;
    margin:0px;
    left: 50%;
    right: 0%;
    position: fixed;
    padding-left: 40px;
    padding-top:15%;
    padding-right:40px;
    background-color: white;
    opacity: 100%;
    font-family:Georgia, serif;
    color:black;
    font-size:30px;
    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-image: linear-gradient(to right, rgb(123, 231, 84) , rgb(140, 191, 220));;
    padding: 10px 15px;
    margin: 0 auto;
    box-shadow: 0 5px 15px rgba(0,0,0,0.20);
}
```

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.css"
                        integrity="sha384-
fnmOCqbTlWIlj8LyTjo7mOUStjsKC4pOpQbqyi7RrhN7udi9RwhKkMHpvLbHG9Sr"
crossorigin="anonymous" />
<link href="https://fonts.googleapis.com/css?family=Dosis" rel="stylesheet" />
<title>Wind Energy Prediction</title>
<link rel="stylesheet" href="{{ url_for('static',filename='predict.css') }}">
</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
KNOWTHE 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>
```

Predict.css:

```
#page {
   max-width: 80%;
   margin: auto;
 }
 body {
     background-
image:url('https://t4.ftcdn.net/jpg/02/98/49/11/360_F_298491126_NaWNrKTxN5RIlhfJo9j8ZdzaN0hQFzPS.jpg');
      width: 0px;
      height: 0px;
      background-repeat: no-repeat;
     background-attachment: fixed;
     background-size:contain;
     background-position:bottom;
     overflow: hidden;

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

 .card {
           margin-right: auto;
           margin-left: 15%;
           width: 300px;
```

```
    border-radius: 5px;
    backdrop-filter: blur(14px);
    background-image: linear-gradient(to right,rgb(219, 224, 217) , rgb(204, 240, 96));
    padding: 15px;
    text-align: center;
}
.head {
    top:0px;
    margin:0px;
    left: 0px;
    right: 0px;
    position: fixed;
    background-image: linear-gradient(to right,rgb(123, 231, 84) , rgb(140, 191, 220));
    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: rgb(102, 176, 219);
```

```
            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-image: linear-gradient(to right,rgb(123, 231, 84) , rgb(140, 191, 220));
            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(190, 199, 74);;
            font-size:25px;

  }
     select {
     width:50%;
     margin-bottom: 10px;
     background: rgb(145, 240, 140);
     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(121, 120, 123);
    border-collapse: collapse;
    color: #675f7d;
  }

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

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

Intergrate flask with Scoring end Point.py:

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

# NOTE: you must manually set API_KEY below using information retrieved from your IBM Cloud
account.
API_KEY = "NqfwMRhDq1weTZdyqDwUGt4qs1bFR0A5qtW7cCc_Hk9D"
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 = Flask(__name__)
#model = joblib.load('xg_RFR_forecast_model.sav')
#model = joblib.load('dec_model.sav')

@app.route('/')
def home():
    return render_template('intro.html')
@app.route('/predict')
def predict():
    return render_template('predict.html')
@app.route('/windapi',methods=['POST'])
def windapi():
    city=request.form.get('city')
    apikey="88d9c0f472a2dc46dc4a1f2d58f1d9d0"
    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/hr"
    direc = str((resp["wind"]["deg"]))+" deg"
    return render_template('predict.html', temp=temp, humid=humid,
pressure=pressure,speed=speed,direction = direc)
@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()]]
    print(x_test)
```

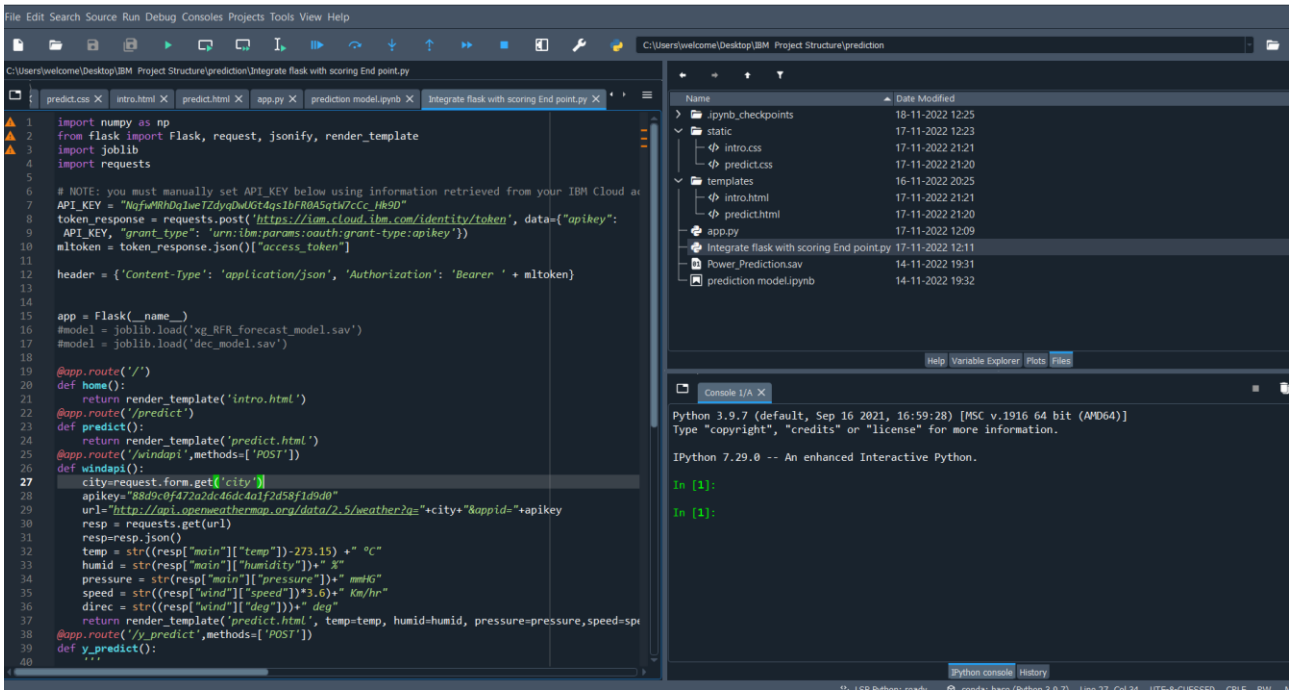
```
    # Deployed Link
    payload_scoring = {"input_data":
                               [{"field": [["Theoretical_Power", "Wind_Speed"]],
                               "values": x_test}]}

    response_scoring = requests.post('https://us-
south.ml.cloud.ibm.com/ml/v4/deployments/a5c5a088-a1bd-4beb-ab73-
700e0d864e14/predictions?version=2022-11-15', json=payload_scoring,
headers={'Authorization': 'Bearer ' + mltoken})
    print("Scoring response")
    predictions =response_scoring.json()
    print(predictions)
    print('Final Prediction Result',predictions['predictions'][0]['values'][0][0])


    pred =response_scoring.json()
    print(pred)
    #print('Final Prediction Result',predictions['predictions'][0]['values'][0][0])

   # prediction = model.predict(x_test)
    print(pred)
    output = pred['predictions'][0]['values'][0][0]
    return render_template('predict.html', prediction_text='The energy predicted is {:.2f}
KWh'.format(output))


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



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

# NOTE: you must manually set API_KEY below using information retrieved from your IBM Cloud ac
API_KEY = "NqfwMRhDq1weTZdyqDwUGt4qs1bFR0A5qtW7cCc_Hk9D"
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}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def predict():
    return render_template('predict.html')
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def windapi():
    city=request.form.get('city')
    apikey="88d9c0f472a2dc46dc4a1f2d58f1d9d0"
    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/hr"
    direc = str((resp["wind"]["deg"]))+" deg"
    return render_template('predict.html', temp=temp, humid=humid, pressure=pressure,speed=spe
@app.route('/y_predict',methods=['POST'])
def y_predict():
    '''
```
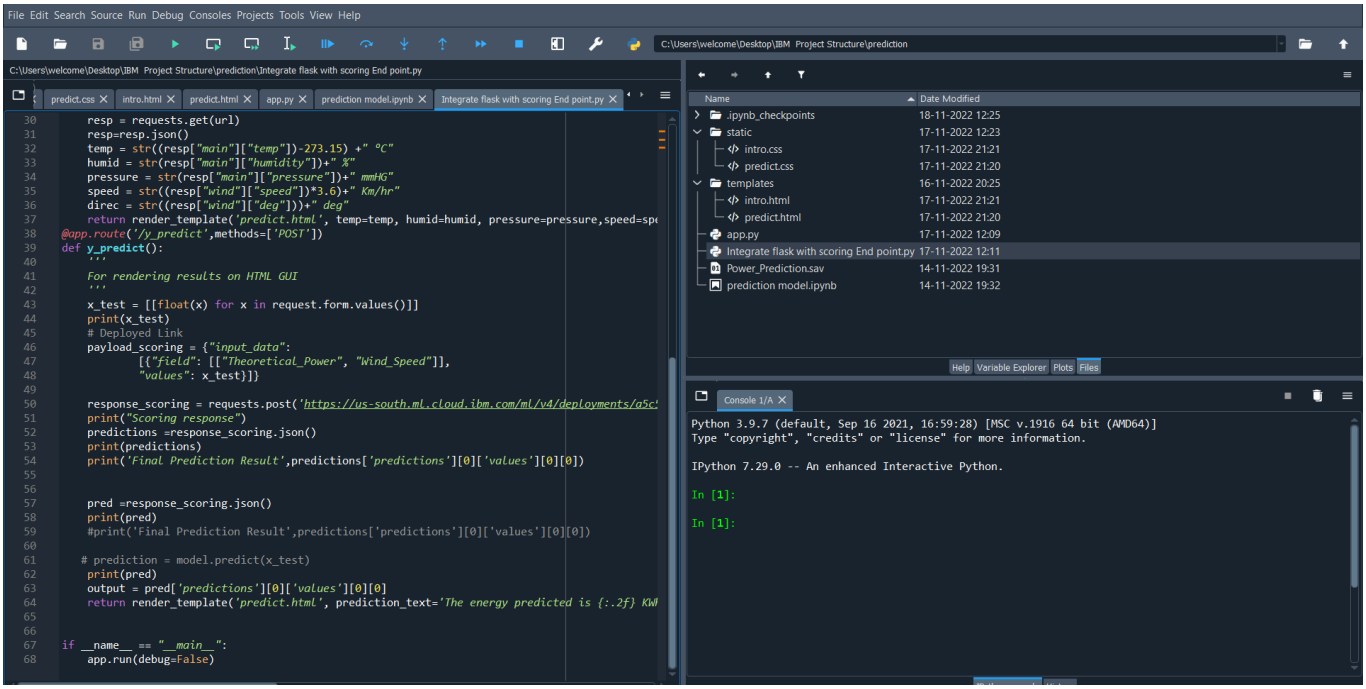

```
Python 3.9.7 (default, Sep 16 2021, 16:59:28) [MSC v.1916 64 bit (AMD64)]
Type "copyright", "credits" or "license" for more information.

IPython 7.29.0 -- An enhanced Interactive Python.

In [1]:

In [1]:
```



```
    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/hr"
    direc = str((resp["wind"]["deg"]))+" deg"
    return render_template('predict.html', temp=temp, humid=humid, pressure=pressure,speed=spe
@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()]]
    print(x_test)
    # Deployed Link
    payload_scoring = {"input_data":
            [{"field": [["Theoretical_Power", "Wind_Speed"]],
            "values": x_test}]}

    response_scoring = requests.post('https://us-south.ml.cloud.ibm.com/ml/v4/deployments/a5c
    print("Scoring response")
    predictions =response_scoring.json()
    print(predictions)
    print('Final Prediction Result',predictions['predictions'][0]['values'][0][0])


    pred =response_scoring.json()
    print(pred)
    #print('Final Prediction Result',predictions['predictions'][0]['values'][0][0])

   # prediction = model.predict(x_test)
    print(pred)
    output = pred['predictions'][0]['values'][0][0]
    return render_template('predict.html', prediction_text='The energy predicted is {:.2f} KW


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

```
Python 3.9.7 (default, Sep 16 2021, 16:59:28) [MSC v.1916 64 bit (AMD64)]
Type "copyright", "credits" or "license" for more information.

IPython 7.29.0 -- An enhanced Interactive Python.

In [1]:

In [1]:
```

TESTING

Test Cases:

				Date	03-Nov-22	
				Team ID	PNT2022TMID33022	
				Project Name	Project -Predicting the energy output of wind turbine based on weather condition	
				Maximum Marks	4 marks	
Test case ID	**Feature Type**	**Component**	**Test Scenario**	**Pre-Requisite**	**Steps To Execute**	**Test Data**
TC_OO1	Functional	Intro Page	The purpose of this test insure that the user can open the website.		1.Enter URL and click go 2.'Click the - 'CLICK HERE TO PREDICT THE ENERGY' To popoup to next page	http://127.0.0.1:5000/
TC_OO2	Functional	Predict page	The purpose of this page is to predict the energy by the uses of weather condition		1.Enter URL and click go 2.Click on the drop down button 3.User can select the location they like to check weather 4.Click the-'CHECK THE WEATHER CONDITION'	http://127.0.0.1:5000/predict
TC_OO3	Functional	Predict page	This page will show the Weather condition of the selected city		1.Enter URL(http://127.0.0.1:5000/windapi) and click go 2.Here user can the Weather details of the selected city. 3.Temperature,Humidity,Wind speen were shown. 4.Enter the Theoretical Value of the wind speed 5.Copy the Exact wind speed of the Wind speen Predict and Enter in the Wind speed column	http://127.0.0.1:5000/windapi
TC_OO4	Functional	Predict page	This page show the energy outcome		1.Enter URL(http://127.0.0.1:5000/y_predict) and click go 2.Click on "PREDICT" 3.Here the final outcome of the result will be obtained.	http://127.0.0.1:5000/y_predict

03-Nov-22						
PNT2022TMID33022						
Project -Predicting the energy output of wind turbine based on weather condition						
4 marks						
Steps To Execute	**Test Data**	**Expected Result**	**Actual Result**	**Status**	**Commnets**	**TC for Automat**
1.Enter URL and click go 2.'Click the - 'CLICK HERE TO PREDICT THE ENERGY' To popoup to next page	http://127.0.0.1:5000/	Intro page will be displayed	Working as expected	Pass		
1.Enter URL and click go 2.Click on the drop down button 3.User can select the location they like to check weather 4.Click the-'CHECK THE WEATHER CONDITION'	http://127.0.0.1:5000/predict	Prediction Page will open . Here user wants to select city.	Working as expected	pass		
1.Enter URL(http://127.0.0.1:5000/windapi) and click go 2.Here user can the Weather details of the selected city. 3.Temperature,Humidity,Wind speen were shown. 4.Enter the Theoretical Value of the wind speed 5.Copy the Exact wind speed of the Wind speen Predict and Enter in the Wind speed column	http://127.0.0.1:5000/windapi	Here While click Weather Condition page. Weather Details Have to Predicted	Working as expected	Pass		
1.Enter URL(http://127.0.0.1:5000/y_predict) and click go 2.Click on "PREDICT" 3.Here the final outcome of the result will be obtained.	http://127.0.0.1:5000/y_predict	Here the final prediction outcome should come. If we enter Values Km/speed error will occur	Working as expected	Pass		

User Acceptance Testing:

1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the [*Predicting the energy output of wind turbine based on weather condition*] 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	2	1	1	2	6
Duplicate	0	0	0	0	0
External	5	0	0	0	5
Fixed	2	0	0	0	2
Not Reproduced	0	0	1	0	1
Skipped	0	0	0	0	0
Won't Fix	0	0	0	0	0
Totals	9	1	2	2	14

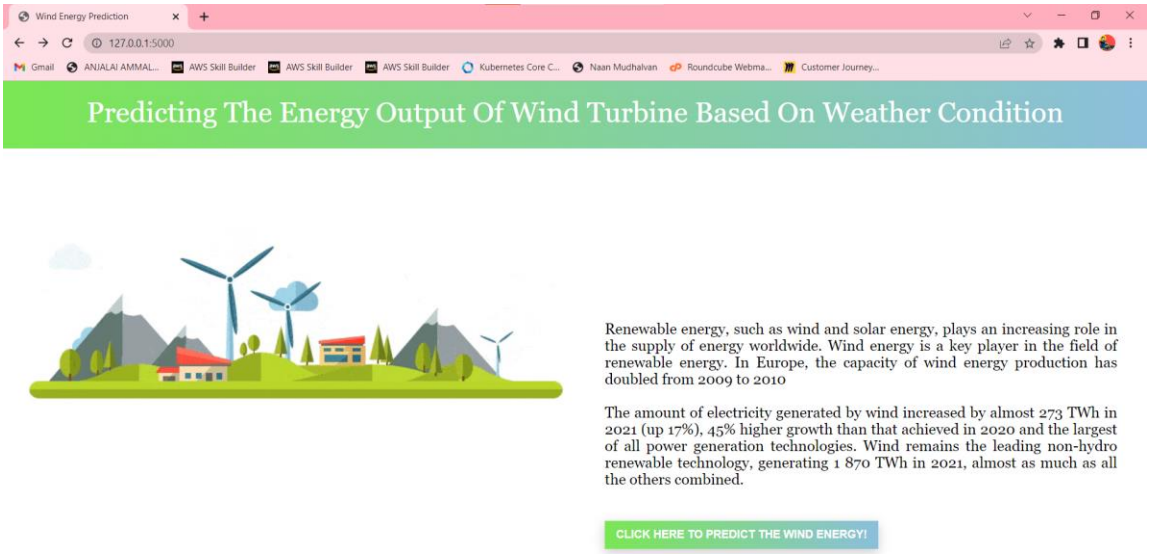
3.Test Case Analysis

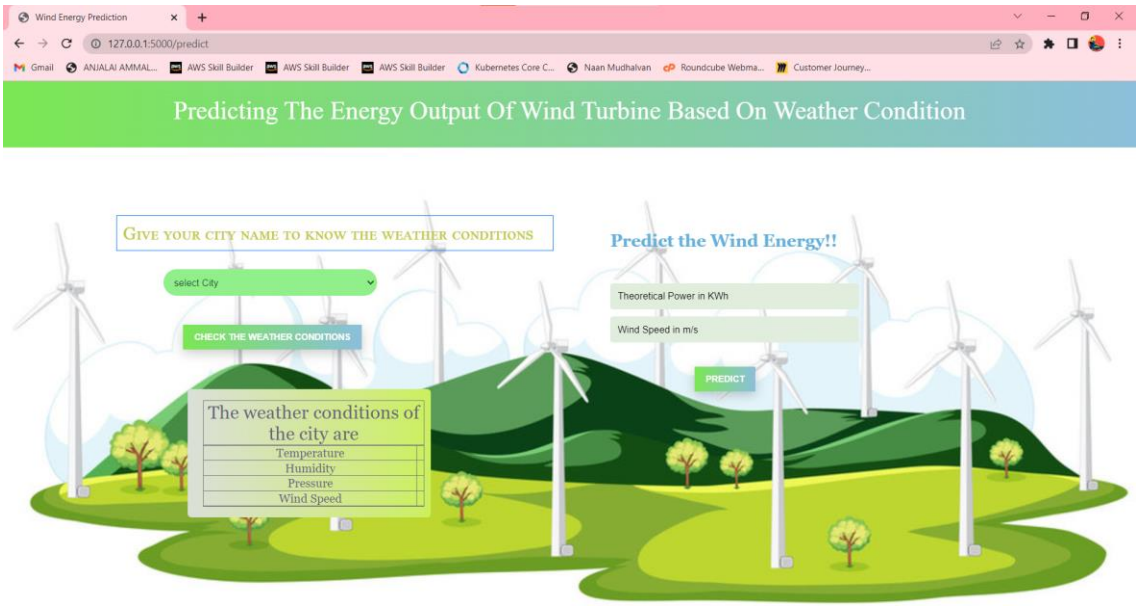
This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Intro Page	1	0	0	2
Weather Prediction	1	0	0	1
Area Inserted	20	0	0	20
Weather analysed on that area	1	0	0	1
Calculating power output	4	0	0	4
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4

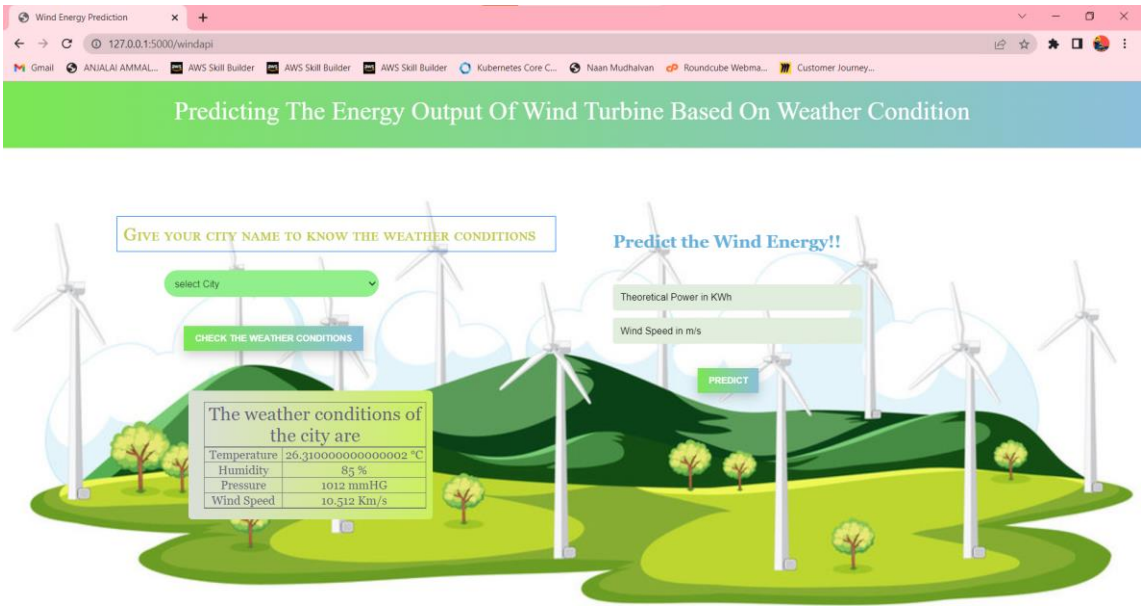
Results

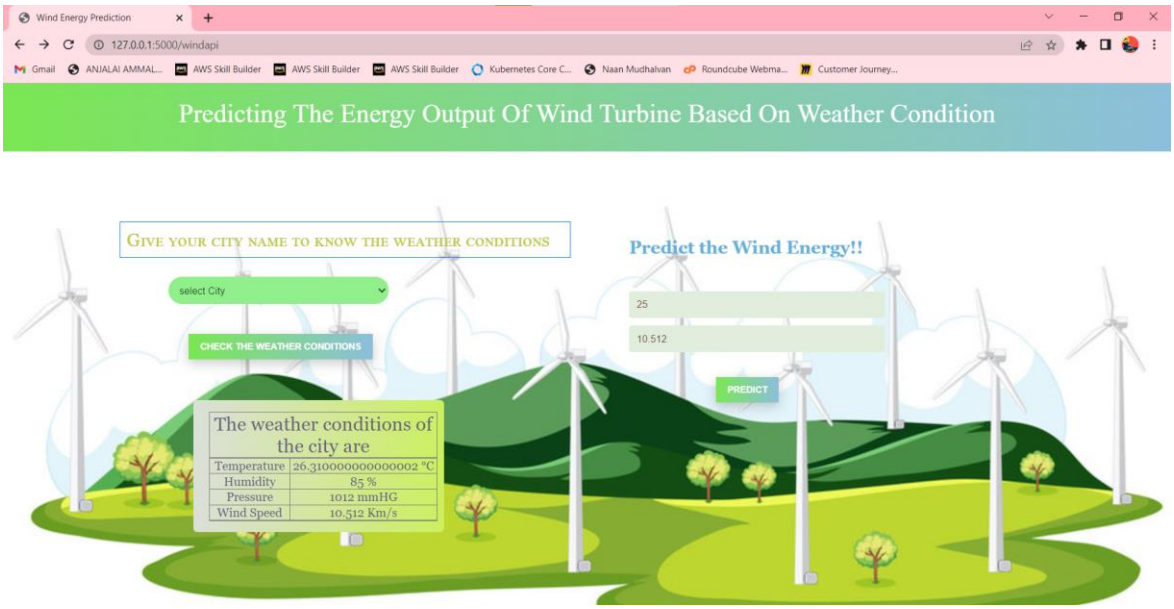
Performance Testing:

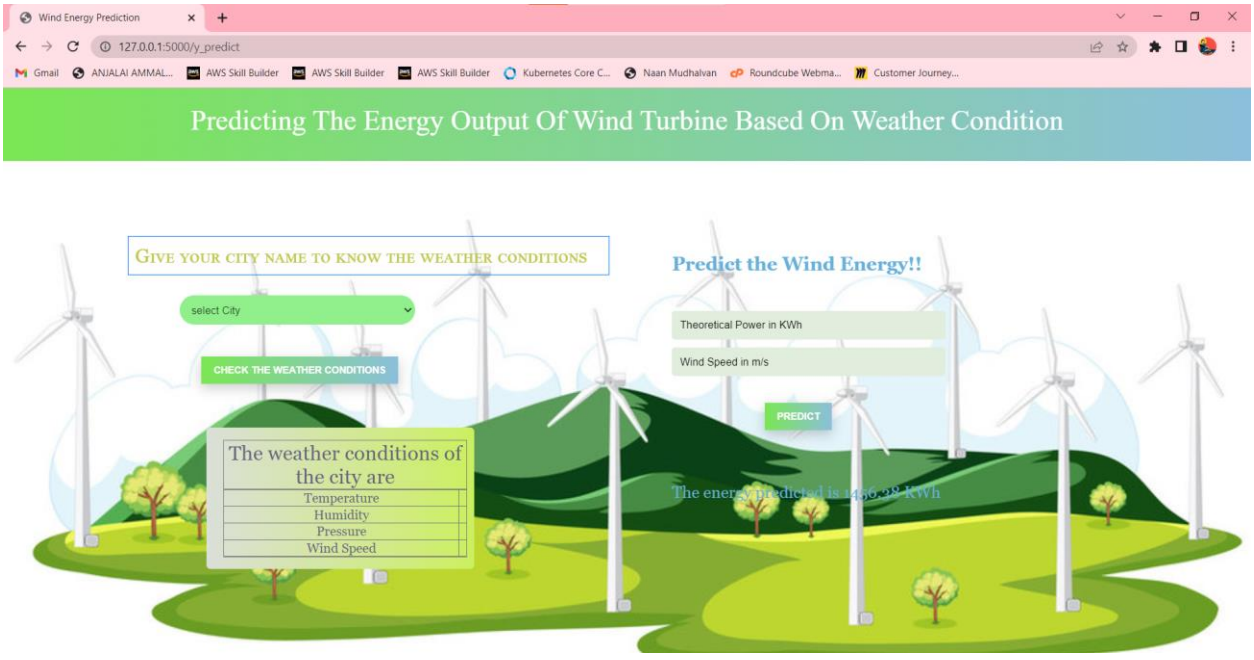





Wind Energy Prediction
127.0.0.1:5000/predict
Predicting The Energy Output Of Wind Turbine Based On Weather Condition
GIVE YOUR CITY NAME TO KNOW THE WEATHER CONDITIONS
select City
Pudukottai
Ramanathapuram
Ranipet
Salem
Sivagangai
Tenkasi
Thanjavur
Theni
Thiruvallur
Thiruvarur
Tuticorin
Trichirapalli
Thirunelveli
Tirupathur
Tiruppur
Tiruvannamalai
The Nilgiris
Vellore
Viluppuram
Virudhunagar
Predict the Wind Energy!!
Theoretical Power in KWh
Wind Speed in m/s
PREDICT


Wind Energy Prediction
127.0.0.1:5000/windapi
Predicting The Energy Output Of Wind Turbine Based On Weather Condition
GIVE YOUR CITY NAME TO KNOW THE WEATHER CONDITIONS
select City
CHECK THE WEATHER CONDITIONS
The weather conditions of the city are
Temperature 26.310000000000002 °C
Humidity 85 %
Pressure 1012 mmHG
Wind Speed 10.512 Km/s
Predict the Wind Energy!!
Theoretical Power in KWh
Wind Speed in m/s
PREDICT


Wind Energy Prediction
127.0.0.1:5000/windapi
Predicting The Energy Output Of Wind Turbine Based On Weather Condition
GIVE YOUR CITY NAME TO KNOW THE WEATHER CONDITIONS
select City
CHECK THE WEATHER CONDITIONS
The weather conditions of the city are
Temperature 26.310000000000002 °C
Humidity 85 %
Pressure 1012 mmHG
Wind Speed 10.512 Km/s
Predict the Wind Energy!!
25
10.512
PREDICT


Wind Energy Prediction
127.0.0.1:5000/y_predict
Predicting The Energy Output Of Wind Turbine Based On Weather Condition
GIVE YOUR CITY NAME TO KNOW THE WEATHER CONDITIONS
select City
CHECK THE WEATHER CONDITIONS
The weather conditions of the city are
Temperature
Humidity
Pressure
Wind Speed
Predict the Wind Energy!!
Theoretical Power in KWh
Wind Speed in m/s
PREDICT
The energy predicted is

ADVANTAGES & DISADVANTAGES

- Generating energy from the wind does not release any carbon emissions. Byreplacing electricity generated from other sources such as fossil fuel power stations,wind energy can lead to an overallreduction in carbonemissions.
- The energy used in manufacturing and installing wind turbines can also be paid back relatively quickly. For a large wind turbine on a good site this canbe as quick as six to eight months.
- It is a veryclean energy source,which does not release any pollutio
- orproduce any waste during operation.
- The energy output of a wind farm is highly dependent on the weather conditions present at its site. If the output can be predicted moreaccurately, energy supplierscan coordinate the collaborative production ofdifferent energysources more efficiently to avoid costly overproduction.

CONCLUSION:

- Thus accurate wind power forecasting plays a key role in dealing with the challengesof power system operation under uncertainties in an economical and technical way.
- This unique approach would surely open up new avenues and make wind farm datamore reliableand precise.
- In our application only weather parameters are considered.
- More updationscan be done in the future if theapplication needs requirements.
- Hopefully, the power of Machine Learning would boost the mass adoption of windpower and turn it into a popular alternative to traditional sources of electricity overthe years.

FUTURE SCOPE:

- Despite our model giving good results, we can add robustness to itby making it do the predictions for a greater time in the future.
- Our model can be scaled by governments by training our modelwith their data with better enhancements.
- Features like humidity and climatic changes should be consideredto achieve better predictions.

APPENDIX

GIT HUB LINK : IBM-Project-40991-1660638258

Demo Link : https://www.youtube.com/embed/SrUCXs_HMWM