Predicting the energy output of wind turbine based on Weather Condition

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Joshua D

Jayakumar Y

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Chapter 1

INTRODUCTION

1.1 Project Overview

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 project, a prediction system is developed with a method of combining statistical models and physical models.

1.2 Purpose

Since the energy output of a wind farm is highly dependent on the weather conditions present at its site, if the output can be predicted more accurately, energy suppliers can coordinate the collaborative production of different energy sources more efficiently to avoid costly overproduction. This model can socially impact by increasing energy production as more power generation to the households, less power cuts. This model can also provide solutions by collaborating with the power suppliers and the government.

Chapter 2

LITERATURE REVIEW

2.1 Existing problem

Wind energy plays increasing role in the supply of energy world-wide. The energy - output of a wind farm is highly dependent on the weather conditionspresent at its site.

If the output is predicted more accurately, the energy suppliers can coordinate the collaborative production of different energy sources more efficiently to avoid costly overproduction. In this paper, we do energy prediction based on weather data and analyses the important parameters as well as their correlation on the energy output.

2.2 References

[1] Rashid, Haroon, Waqar Haider, and Canras Batunlu. "Forecasting of wind turbine output power using machine learning." *2020 10th International Conference on Advanced Computer Information Technologies (ACIT)*. IEEE, 2020.

[2] Webb, M., and S. Scuglia. "Wind power: A favoured climate change response." *Global Economic Research: Fiscal Pulse (Scotiabank)* (2007).

[3] “Vladislavleva, Ekaterina, et al. "Predicting the energy output of wind farms based on weather data: Important variables and their correlation." *Renewable energy* 50 (2013): 236-243..”

[4]Corchado, Emilio, Angel Arroyo, and Verónica Tricio. "Soft computing models to identify typical meteorological days." *Logic Journal of the IGPL* 19.2 (2011): 373-383.

[5]Kusiak, Andrew, Haiyang Zheng, and Zhe Song. "Short-term prediction of wind farm power: a data mining approach." *IEEE Transactions on energy conversion* 24.1 (2009): 125-136.

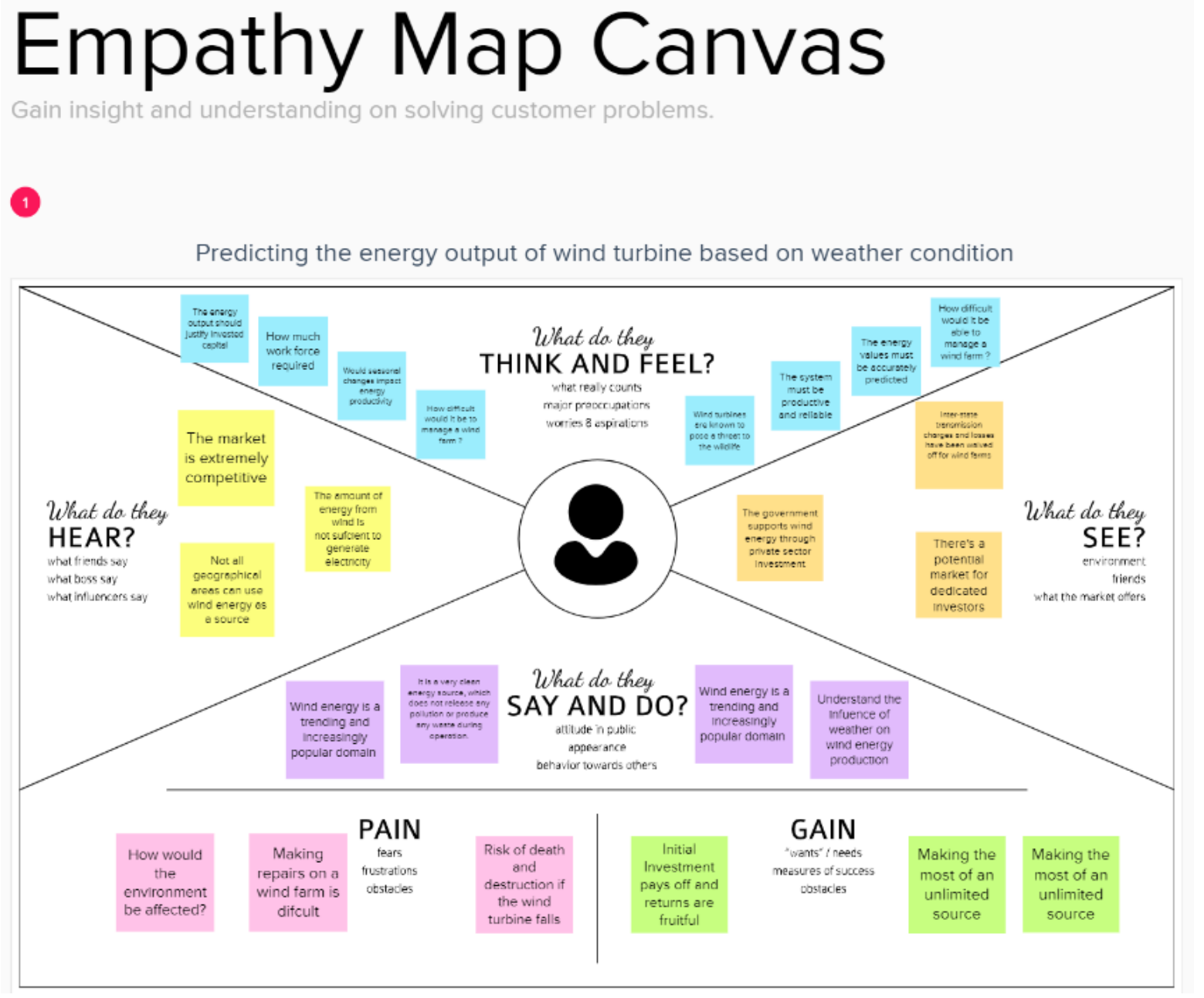
2.3 Problem Statement Definition

The manufacturer needs to find a way to analyze the weather conditions of a region so they can choose regions that produce high quality and quantities of wind energy. Overproduction and cost of production needs to be reduced. Wind energy should be utilized in a way to provide a steady supply of electricity.

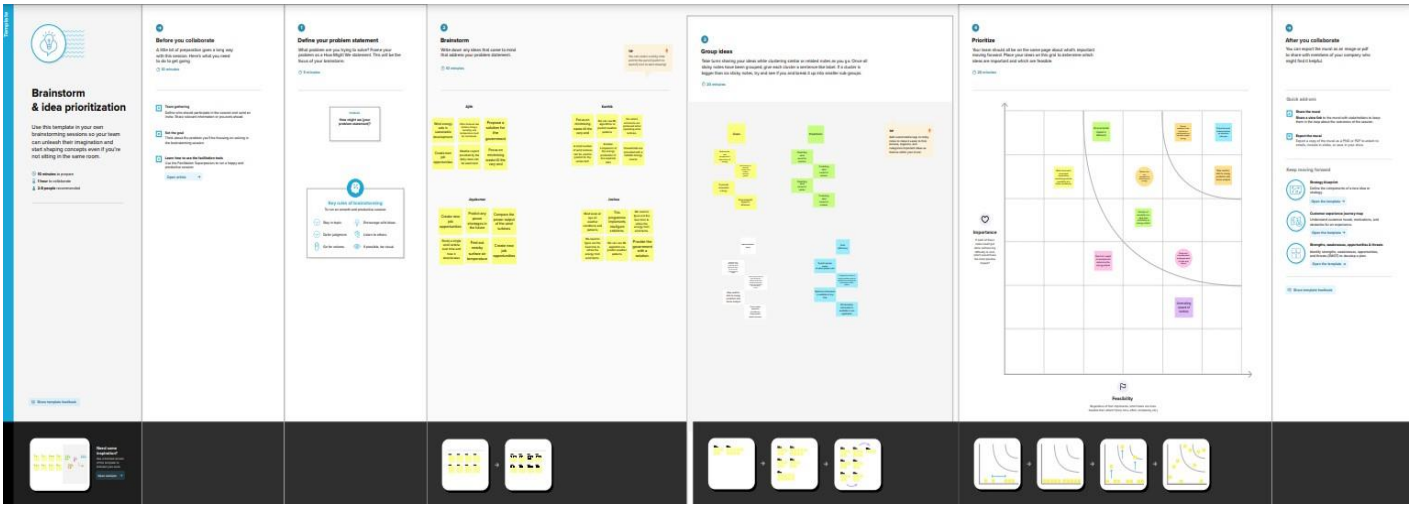
Chapter 3

IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming



3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	The manufacturer needs to find a way to analyze the weather conditions of a region so they can choose regions that produce high quality and quantities of wind energy. Overproduction and cost of production needs to be reduced. Wind energy should be utilized in a way to provide a steady supply of electricity.
2.	Idea / Solution Description	We examine the impact of different weather conditions on the energy output of wind farms. By accurately forecasting the wind-power, we reduce the need for additional balancing energy and reserve power to integrate wind power. A prediction system is developed with a method of combining statistical models and physical models. In this model, the inlet condition of the wind farm is forecasted by the auto regressive model.
3.	Novelty / Uniqueness	Currently, wind energy is not a primary source of electricity. Implementing our solution makes it possible to maximize energy output. This solution would make renewable energy sources more widely used. The user can upload their own data in real-time for forecasting.
4.	Social Impact / Customer Satisfaction	Local employment, better health, consumer choice, improvement of life standard, social bonds creation, income development, demographic impacts, and community development can be achieved by the proper usage of renewable energy system. Renewable energy improves human well-being and overall welfare well beyond GDP. Switching to clean sources of energy, thus helps address not only climate change but also air pollution and health.
5.	Business Model (Revenue Model)	Wind farm owners need a prediction model to predict the wind energy so they can provide a steady energy source. A subscription model would be efficient here, as the model will improve with time as it is used for forecasting using more and more data.
6.	Scalability of the Solution	This solution can be applied on a larger scale, to windfarms across the world.

3.4 Problem Solution fit

Define CS, fit into CC

1. CUSTOMER SEGMENT(S)

Who is your customer?

CS

Industrialist is the customer.

Wind energy producers.

6. CUSTOMER CONSTRAINTS

CC

What constraints prevent your customers from taking action or limit their choices of solutions?

Spending power, Budget, No cash, Risk factor of extent.

5. AVAILABLE SOLUTIONS

Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have?

AS

Predication based on the previous year energy output.

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS

Which jobs-to-be-done (or problems) do you address for your customers?

J&P

- Disaster or change of seasons
- Failures in machines
- Damages in Electronic devices

9. PROBLEM ROOT CAUSE

RC

What is the real reason that this problem exists? What is the back story behind the need to do this job?

- Less awareness about demands and troubles among the people.
- Unpredictable weather condition.
- High set-up cost.

7. BEHAVIOUR

What does your customer do to address the problem and get the job done?

BE

Directly related, Predict the weather and exact location of wind energy outcome by the application.

Indirectly related, Output power can be predicted in order to avoid damages.

Focus on J&P, tap into BE, understand RC

Identity strong TR & EM

3. TRIGGERS

What triggers customers to act?

TR

Analyze the weather patterns to predict wind energy

4. EMOTIONS: BEFORE / AFTER

How do customers feel when they face a problem or a job and afterwards?

EM

Before: Anger at improper energy flow
After: Satisfaction after optimized energy flow

10. YOUR SOLUTION

SL

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.
If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behavior.

- It reduces the need for additional balancing energy and reserve power to integrate wind power.
- The inlet condition of the wind farm is forecasted by a auto regressive model.

8. CHANNELS of BEHAVIOUR

CH

8.1 ONLINE

What kind of actions do customers take online? Extract online channels from #7

After uploading collected data, the projects predict the wind energy output.

8.2 OFFLINE

What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.

Data is collected by customer

Identity strong TR & EM

Chapter 4

REQUIREMENT ANALYSIS

4.1 Functional requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Essentiality	1) City name 2) Wind speed 3) Wind direction 4) Weather condition
FR-4	Output	Energy Predicated in KWh.

4.2 Non-functional requirements

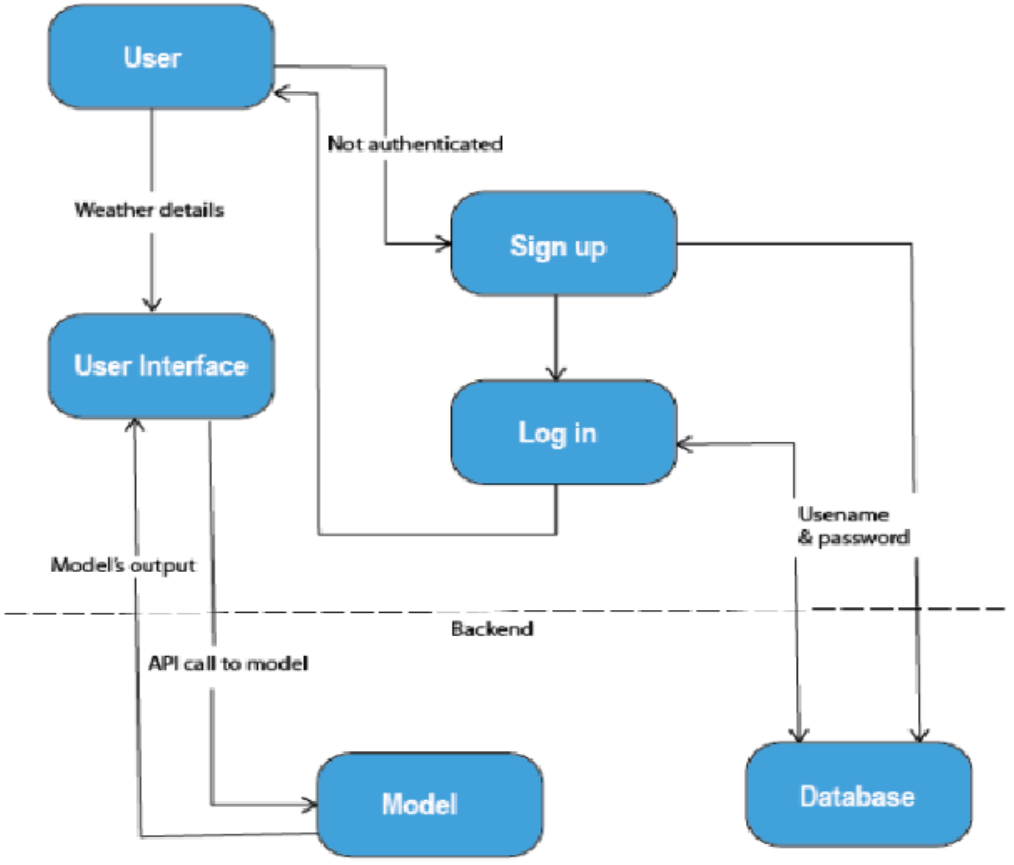
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	• Easy to learn • User friendly • Efficient
NFR-2	**Security**	Privacy - User can have Own accounts to secure their data.
NFR-3	**Reliability**	Wind Energy is reliable because it is both unlimited and domestic.
NFR-4	**Performance**	Accuracy is high due to combination of multiple ML models to predict the output.
NFR-5	**Availability**	This is a web-based application so we can access in any device that have a web browser with good Internet facility.
NFR-6	**Scalability**	It can be extended further to provide API which can be used by third party organisations such as industries, power suppliers, governmental, etc.

Chapter 5

PROJECT DESIGN

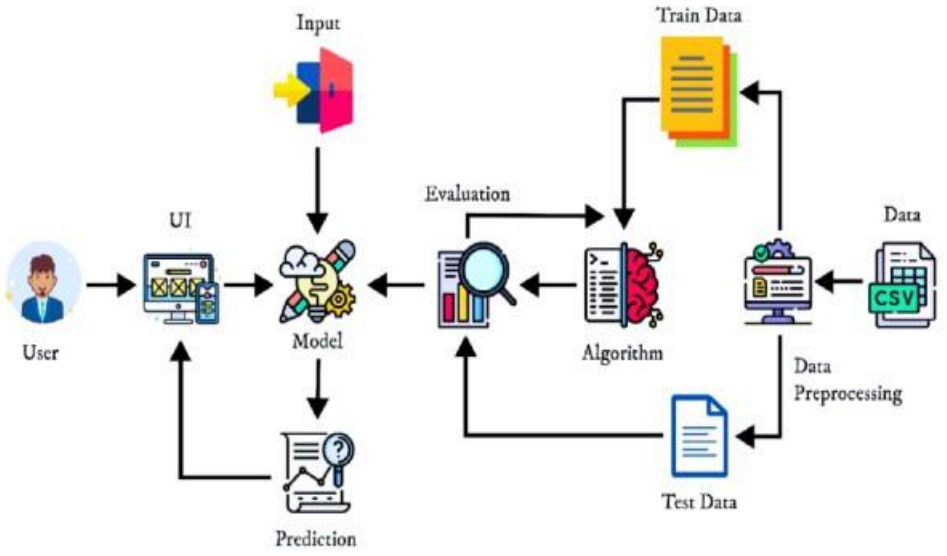
5.1 Data Flow Diagrams

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



5.2 Solution & Technical Architecture

Our aim is to map weather data to energy production. We wish to show that even data that is publicly available for weather stations close to wind farms can be used to give a good prediction of the energy output. Furthermore, we examine the impact of different weather conditions on the energy output of wind farms. We are building an IBM Watson AutoAI Machine Learning technique to predict the energy output of wind turbine. The model is deployed on IBM cloud to get scoring end point which can be used as API in mobile app or web app building. We are developing a web application which is built using node red service. We make use of the scoring end point to give user input values to the deployed model. The model prediction is then showcased on User Interface to predict the energy output of wind turbine.



5.3 User Stories

To list all the user stories for the product.

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 application 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 application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Sprint-1
	Dashboard	USN-6	Once I have logged in, I can see my dashboard		Medium	Sprint-2
Customer (Web user)	Web access	USN-7	As a customer I have the access the website to predict the turbine power	Customer can access the website once they logged in.	High	Sprint-2
	Prediction	USN-8	As a customer when I enter the weather details, the website should predict the approximate turbine power		High	Sprint-2
		USN-9	Customer can also provide the latitude and longitude of any location, and our web app will predict the wind power based on the wind speed and wind direction of the location given.		High	Sprint-2
	Forecasting	USN-10	Customer can enter latitude and longitude of any location, our website will forecast wind speed, wind direction and wind power for next 6 days.		Medium	Sprint-3

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
	Plotting	USN-11	Website provides various charts to make the customer understand the speed, direction and power visually.			
	Security	USN- 12	As a customer I expect my data to be secured	Data should be encrypted	Medium	Sprint-3
Administrator	Database Access	USN - 13	As an Administrator, I should maintain the website. And update the website regularly.	I can manage the website	Low	Sprint-4

Chapter 6

PROJECT PLANNING AND SCHEDULING

6.1 Sprint Planning & Estimation

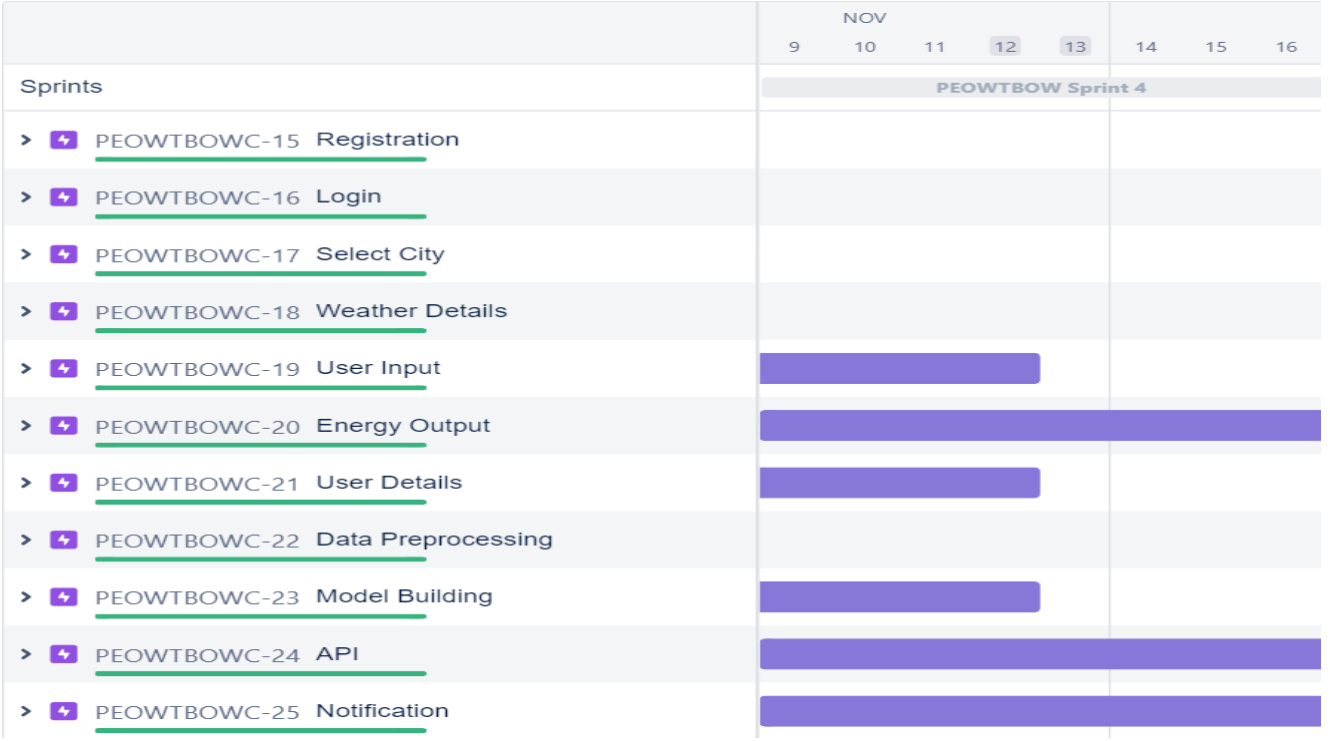
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	5	High	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	5	High	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-1		USN-3	User should verify the email once they have created their account.	2	Low	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-1		USN-4	As a user, I can register for the application through Gmail	3	Medium	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-1	Login	USN-5	As a user, I can log into the application by entering email & password	5	High	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-2	Dashboard	USN-6	Once I have logged in, I can see my dashboard.	6	Medium	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-2	Web access	USN-7	As a customer I can access the website to predict the turbine power	7	High	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-2	Prediction	USN-8	As a customer when I enter the weather details, the website should predict the approximate turbine power	7	High	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-3		USN-9	Customer can also provide the latitude and longitude of any location, and our web app will predict the wind power based on the wind speed and wind direction of the location given.	10	Medium	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-3	Forecasting	USN-10	Customer can enter latitude and longitude of any location; our website will forecast wind speed, wind direction and wind power for next 6 days.	5	Medium	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-3	Plotting	USN-11	Website provides various charts to make the customer understand the speed, direction and power visually.	3	Low	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-3	Security	USN-12	As a customer I expect my data to be secured	2	Low	Karthik D Ajith S Joshua D Jayakumar Y
Sprint-4	Database Access	USN-13	As an Administrator, I should maintain the website. And update the website regularly.	20	High	Karthik D Ajith S Joshua D Jayakumar Y

6.2 Sprint Delivery Schedule

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

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
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

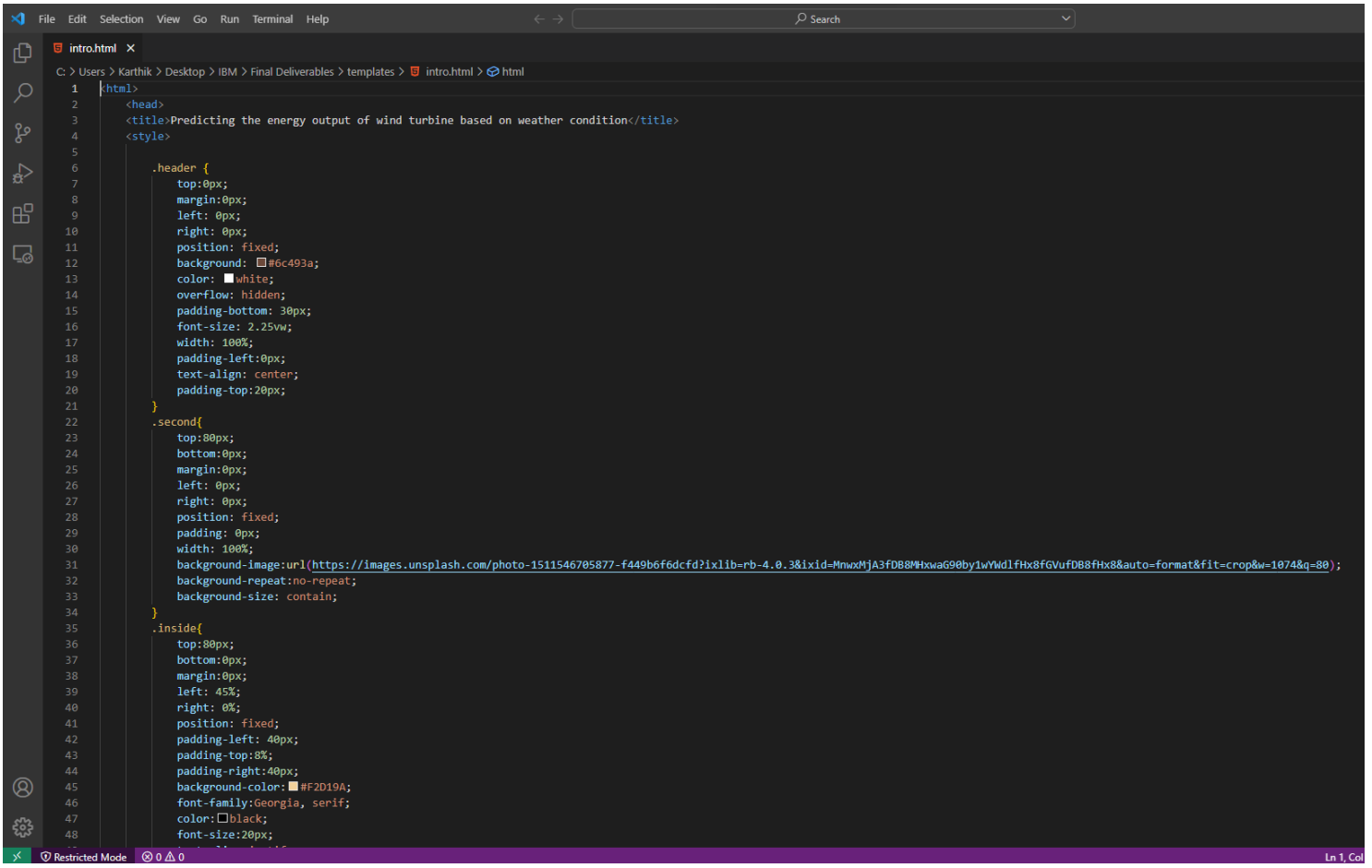
6.3 Reports from JIRA



CHAPTER 7

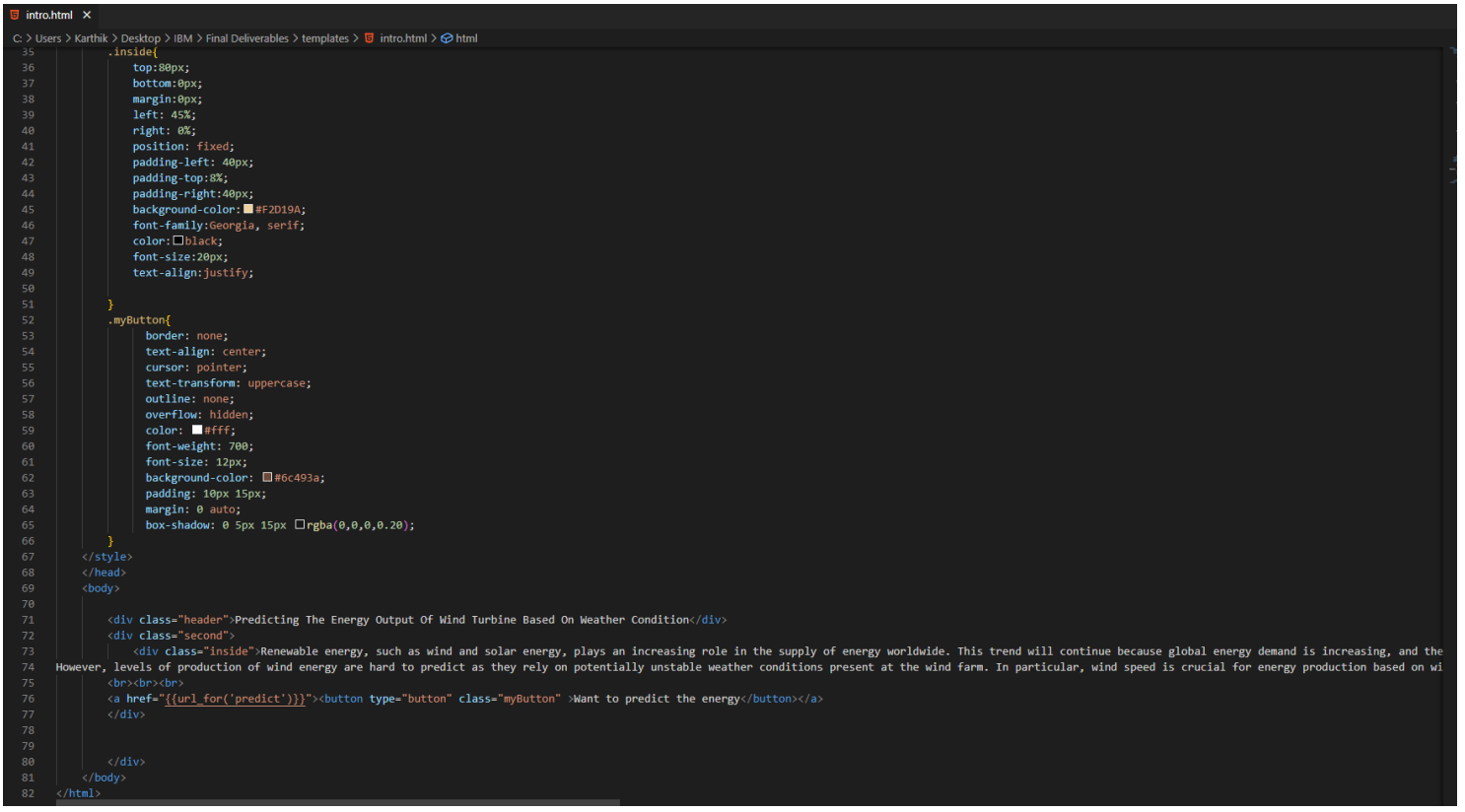
CODING & SOLUTIONING

Intro.html



```
<html>
    <head>
    <title>Predicting the energy output of wind turbine based on weather condition</title>
    <stryle>

        .header {
            top:0px;
            margin:0px;
            left: 0px;
            right: 0px;
            position: fixed;
            background: #6c493a;
            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%;
            background-image:url(https://images.unsplash.com/photo-1511546705877-f449b6f6dcfd?ixlib=rb-4.0.3&ixid=MnwxMjA3fDB8MHxwaG90by1wYWdlfHx8fGVufDB8fHx8&auto=format&fit=crop&w=1074&q=80);
            background-repeat:no-repeat;
            background-size: contain;
        }
        .inside{
            top:80px;
            bottom:0px;
            margin:0px;
            left: 45%;
            right: 0%;
            position: fixed;
            padding-left: 40px;
            padding-top:8%;
            padding-right:40px;
            background-color: #F2D19A;
            font-family:Georgia, serif;
            color:black;
            font-size:20px;
```



```
        .inside{
            top:80px;
            bottom:0px;
            margin:0px;
            left: 45%;
            right: 0%;
            position: fixed;
            padding-left: 40px;
            padding-top:8%;
            padding-right:40px;
            background-color: #F2D19A;
            font-family:Georgia, serif;
            color:black;
            font-size:20px;
            text-align: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: #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">Renewable energy, such as wind and solar energy, plays an increasing role in the supply of energy worldwide. This trend will continue because global energy demand is increasing, and the
However, levels of production of wind energy are hard to predict as they rely on potentially unstable weather conditions present at the wind farm. In particular, wind speed is crucial for energy production based on wi
        <br><br><br>
        <a href="{{url_for('predict')}}"><button type="button" class="myButton" >Want to predict the energy</button></a>
        </div>


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

Predict.html

predict.html 1

C: > Users > Karthik > Desktop > IBM > Final Deliverables > templates > predict.html > html

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



    <title>Predicting the energy output of wind turbine based on weather condition</title>
    <style>
#page {
  max-width: 80%;
  margin: auto;
}
body {
    background-image: url(https://images.unsplash.com/photo-1511546705877-f449b6f6dcfd?ixlib=rb-4.0.3&ixid=MnwxMjA3fDB8MHxwaG90by1wYWdlfHx8fGVufDB8fHx8&auto=format&fit=crop&w=1074&q=80);
    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: rgba(255, 255, 255, 0.2);
            padding: 15px;
            text-align: center;
        }
        .head {
```

```
.head {
        top:0px;
        margin:0px;
        left: 0px;
        right: 0px;
        position: fixed;
        background: #86521a;
        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:Arial, Helvetica, sans-serif;
        color:#f72727;
        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;
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            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;
```

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

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            color:rgb(36, 37, 37);;
            font-size:25px;
            align:center;

}
    select {
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    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, 0, 0); width: 575px;"> CITY NAME</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 ="Agartala">Agartala</option>
                    <option value ="Aizawl">Aizawl</option>
                    <option value ="Bangalore">Bangalore</option>
                    <option value ="Bhopal">Bhopal</option>
                    <option value ="Bhubaneswar">Bhubaneswar</option>
                    <option value ="Chandigarh">Chandigarh</option>
                    <option value ="Chennai">Chennai</option>
                    <option value ="Coimbatore">Coimbatore</option>
                    <option value ="Daman">Daman</option>
                    <option value ="Dehradun">Dehradun</option>
                    <option value ="Delhi">Delhi</option>
                    <option value ="Dindigul">Dindigul</option>
                    <option value ="Erode">Erode</option>
                    <option value ="Gandhinagar">Gandhinagar</option>
                    <option value ="Gangtok">Gangtok</option>
                    <option value ="Hyderabad">Hyderabad</option>
                    <option value ="Imphal">Imphal</option>
                    <option value ="Itanagar">Itanagar</option>
                    <option value ="Jaipur">Jaipur</option>
                    <option value ="Kavaratti">Kavaratti</option>
                    <option value ="Kohima">Kohima</option>
                    <option value ="Kolkata">Kolkata</option>
                    <option value ="Lucknow">Lucknow</option>
                    <option value ="Mumbai">Mumbai</option>
```

```
            <option value ="Panaji">Panaji</option>
            <option value ="Patna">Patna</option>
            <option value ="Pondicherry">Pondicherry</option>
            <option value ="Port Blair">Port Blair</option>
            <option value ="Raipur" >Raipur</option>
            <option value ="Ranchi" >Ranchi</option>
            <option value ="Shillong">Shillong</option>
            <option value ="Shimla">Shimla</option>
            <option value ="Silvassa">Silvassa</option>
            <option value ="Srinagar">Srinagar</option>
            <option value ="Thiruvananthapuram">Thiruvananthapuram</option>
            <option value ="Tirupati">Tirupati</option>

        </select><br><br>
        <div style="margin-left:-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 is</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;">Prediction of 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>
```

```
            <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 is</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;">Prediction of 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>
```

App.py

```
            <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 is</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;">Prediction of 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>
```

CHAPTER 8

TESTING

8.1 Performance Testing

				Date	17-Nov-22							
				Team ID	PNT2022TMID00784							
				Project Name	Predicting the energy output of							
				Maximum Marks	4 marks							
Test case ID	**Feature Type**	**Component**	**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_OO1	Functional	Home Page	User is able to study information about the wind energy and power prediction		1.Enter URL and click go 2.On the right side the the information about the wind energy is given.	http://127.0.0.1:5000/	The information about wind energy should display	Working as expected	Pass				
LoginPage_TC_OO2	UI	Home Page	User the can the design and picture that was		1.Enter URL and click go 2.Picture and Design and information is visible or not 3."To predict the energy output" box is present or not	http://127.0.0.1:5000/	Application should show below UI elements: a.Pictures b.Information about wind energy c."To predict energy output"	Working as expected	Fail	Pictures is not visible and showing blank white page		BUG-1234	
LoginPage_TC_OO3	Functional	Home page to Main Page	User able to click and navigate to main page		1.Enter URL and click go 2.Click on "Want to predict energy output" box 3.It takes to main page of the website	http://127.0.0.1:5000/predict	User should navigate to main page	Working as expected					
LoginPage_TC_OO4	Functional	Main Page	User can see two things in the main page		1.Enter URL(https://shopenzer.com/) and click go 2.After Click the "Want to predict energy output" box 3.It navigate to main page 4.Two function is present 5.User can use anything	http://127.0.0.1:5000/ http://127.0.0.1:5000/predict	Application should show 1. Left side - Weather condition 2. Right Side - Energy output prediction	Working as expected					
LoginPage_TC_OO4	Functional	Main Page	User can able to check weather condition in the eft side		1.Enter URL and click go to main page 2.On the left side choose the state to check the weather condition 3.Four box with weather info will appear 4.Temperature, humidity, pressure, speed are key elements in weather checking.	http://127.0.0.1:5000/predict	Application should show Weather information about selected state	Working as expected					
LoginPage_TC_OO5	Functional	Main Page	User can able to energy output of wind turbine		1.Enter URL and click go 2.On the right side type the Power and speed value in the box 3.The website will predict the energy output of wind turbine.	http://127.0.0.1:5000/predict	Application should show Energy Output of Wind turbine	Working as expected	Fail	The Energy Output is not Predicting		BUG 12345	
LoginPage_TC_OO2	UI	Home Page	User the can the design and picture that was		1.Enter URL and click go 2.Picture and Design and information is visible or not 3."To predict the energy output" box is present or not	http://127.0.0.1:5000/	Application should show below UI elements: a.Pictures b.Information about wind energy c."To predict energy output"	Working as expected	Pass				
LoginPage_TC_OO5	Functional	Main Page	User can able to energy output of wind turbine		1.Enter URL and click go 2.On the right side type the Power and speed value in the box 3.The website will predict the energy output of wind turbine.	http://127.0.0.1:5000/predict	Application should show Energy Output of Wind turbine	Working as expected	Pass				

8.2 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 using weather condition 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	6	4	2	7	19
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	20	10	5	26	61
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	1	0	0	1
Totals	29	18	12	35	94

3. Test Case Analysis

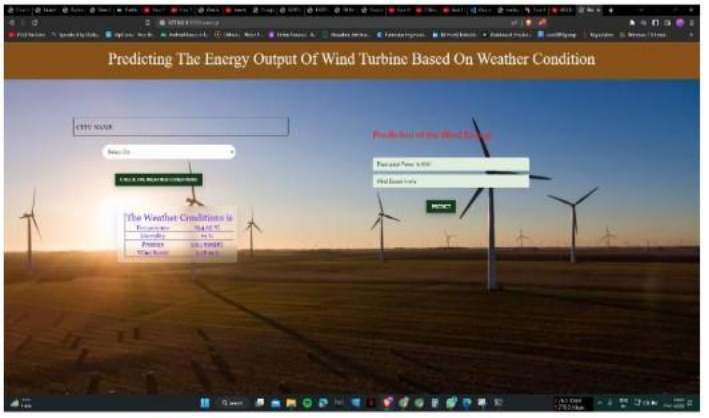
This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	2	5
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	6	0	0	6
Version Control	2	0	0	2

CHAPTER 9

RESULTS

9.1 Performance Metrics

S.No.	Parameter	Values	Screenshot
1.	Metrics	**Regression Model:** MAE – 0.6, MSE – 0.3, RMSE – 0.4, R2 score - 0.7 **Classification Model:** Confusion Matrix - 4, Accuracy Score- 85 & Classification Report -	
2.	Tune the Model	Hyperparameter Tuning – 0.6 Validation Method – 0.8	

CHAPTER 10

ADVANTAGES

&

DISADVANTAGES

Our system enables smoother and efficient prediction of wind energy from any turbine provided the necessary readings. Without having to manually predict the output for any weather condition our system is much easier.

Some **advantages** that can be listed are as follows:

1. Easy to input the wind parameters.
2. Computation of the wind energy in a short time using our machine learning model.
3. Simple method to create login for your account.
4. Security of your account and the data input is ensured.
5. Handles a large load of requests since we deploy our system in the cloud.

Some negligible **disadvantages** of our system are listed below:

1. Any user needs to create an account to use our system even if it's for once. Free trial needs to be created for anonymous users with certain limitations in accessing the features of our system.
2. User needs to manually input the wind parameters. They might feel it better to view just the prediction without having to input data. This can be achieved combining the direct access to the wind sensors with our system.
3. While registering in as a new user, the user needs to again enter their login credentials which shows redundancy.
4. Feedback from users isn't present, hence the user experience cannot be improved further.

CHAPTER 11

CONCLUSION

Wind Energy predicting systems are a very helpful system in the current world due to increasing needs for renewable energy and the unpredictable nature of the weather. With the aim of a better tomorrow, we have chosen this problem statement to create this system that predicts the energy that can be generated when we are supplied with the necessary values for the wind 48 parameters. In order to ensure the security of data of various wind energy suppliers we have created the account facility in the system. To improve the user experience without any delay we have deployed our system in the cloud. Our machine learning model also gives good performance over a wide range of the parameter values. We can now use this efficient system with a simple and easy to use user interface to predict the energy produced given a weather condition.

CHAPTER 12

FUTURE SCOPE

1. Predicting the power outputs in advance will result in the optimal utilization of energy resources to ensure maximum utilization of windmill energy.

2. By observing and predicting the power we can set up windmill farms on the location where there might be better wind energy resources by studying the average wind speed and direction of the wind.

3. Optimization of power distribution system so that the energy of windmill gets used up in synchronization with other energy resources like hydroelectricity and thermal electricity which would also help in minimizing the use of other non-renewable resources.

4. One day prediction is appropriate for interconnected power system operations such as unit commitment, conventional generators scheduling, as well as one day electricity markets.

APPENDIX

Github Link:

https://github.com/IBM-EPBL/IBM-Project-9641-1659062807

Video Link:

https://drive.google.com/file/d/1FCMc1HE9FGel4rskpancxirAGplTjzOt/view?usp=sharing