PREDICTING THE ENERGY OUTPUT OF WIND TURBINE BASED ON WEATHER CONDITION

A Project Report

Submitted By

Team ID - PNT2022TMID45553

Team Details

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CONTENTS:

1. INTRODUCTION:

1.1 Project Overview

In Modern world the usage of the wind turbine is increasing day by day. Peoples are showing their interest on the Renewable Energy sources like Solar Energy and Wind Turbine. They are ready to adopt their self for renewable energy sources. The wind energy prediction is essential for Electric power supply for a country. If we predict and know the power generated by a wind turbine by weather condition the need of electric power for a country or state is partially satisfied the wind turbine. So we need to predict the energy output of wind turbine. It depends upon the wind speed and wind direction. Basically the output energy of wind turbines are directly depends on the wind speed. In a survey denotes that By 2050, wind energy could avoid the emission of 12.3 Giga Tones of Green house gases. Wind energy preserves water resources. By 2050, wind energy can save 260 billions of gallons of water – the equivalent to roughly 400,000 Olympic-size swimming pools that would have been saved by the electric power. If the output power can be predicted more accurately, the energy producers for a country, state, organization can co-ordinate the collaborative production of different energy sources to more efficiently to avoid costly overproductions. In this project we train the model by a dataset of wind turbines for the prediction. It helps us to build a model and split it into train and test data that we use that trained data to predict the energy output. We choose the model named Random Forest Regression for the Model Building. We also make a Web application (Flask App) to predict the output with the help of trained data. By using Watson Studio the model need to established throughout the world and whomever can access and predict the energy in this I give the cities within the Tamil Nadu. By using this model we can also know about the weather conditions like Temperature, Humidity, Wind speed.

1.2 Purpose

The wind energy plays a vital role on the renewable energy sources. The wind turbine usage increased very much in recently. The another energy power resources are far more dangerous and not be safe. The another sources are Nuclear, coal and oil it's all lead to the emission of CO2. The CO2 will be danger for the human beings and also leads to the acidic rain. It will collapse the Balance of nature. The wind energy is a free source it can be used by anyone for

energy production. The power generated by the wind turbines can reduce the amount of energy used by the non-renewable sources.

In our project first of all we collected a dataset and We preprocessed the dataset before split the dataset into train test split. After splitting the dataset We choose the appropriate model for model building. In this case we choose the Random Forest Regression for the model. It is one of the models available in machine learning and also a good accuracy estimator for predictions and it also provide better prediction among those. We use the IBM Watson Studio for high level Machine Learning and we use it to train our data. IBM cloud helps us to deploy our trained model into the web and whomever can use our web page or web application among the world. We use the flask Application it's a web based application. We made two html pages named index and predict. Index page consists of the basic details about wind turbine and one button is "CLICK HERE TO PREDICT THE ENERGY".

The next page named predict.html consists on city selection, weather details, inputs for Theoretical power and Wind speed. At last the button is named Predict. The output is shown as in KW/h.

2. LITERATURE SURVEY:

2.1 Existing problem

Renewable energy sources, especially wind energy, are to play a larger role in providing electricity to industrial and domestic consumers. This is already the case today for a number of European countries, closely followed by the US and high growth countries, for example, Brazil, India and China. There exist a number of technological, environmental and political challenges linked to supplementing existing electricity generation capacities with wind energy. Here, mathematicians and statisticians could make a substantial contribution at the interface of meteorology and decision-making, in connection with the generation of forecasts tailored to the various operational decision problems involved. Indeed, while wind energy may be seen as an environmentally friendly source of energy, full benefits from its usage can only be obtained if one is able to accommodate its variability and limited predictability. Based on a short presentation of its physical basics, the importance of considering wind power generation as a stochastic process is motivated. After describing representative operational decision-making problems for both market participants and system operators, it is underlined that forecasts should

be issued in a probabilistic framework. Even though, eventually, the forecaster may only communicate single-valued predictions. The existing approaches to wind power forecasting are subsequently described, with focus on single-valued predictions, predictive marginal densities and space–time trajectories. Upcoming challenges related to generating improved and new types of forecasts, as well as their verification and value to forecast users, are finally discussed.

2.2 References:

[1] Evolved Analytics LLC. DataModeler 8.0. Evolved Analytics LLC, 2010.

[2] A. M. Foleya, P. G. Leahya, A. Marvugliac, and E. J. McKeogha. Current methods and advances in forecasting of wind power generation. Renewable Energy, 37:1–8, 2012.

[3] R. Jursa and K. Rohrig. Short-term wind power forecasting using evolutionary algorithms for the automated specification of artificial intelligence models. International Journal of Forecasting, 24:694–709, 2008.

[4] M. Kotanchek, G. Smits, and E. Vladislavleva. Pursuing the pareto paradigm tournaments, algorithm variations & ordinal optimization. In Genetic Programming Theory and Practice IV, volume 5 of Genetic and Evolutionary Computation, chapter 12, pages 167–186. Springer, 11-13 May 2006.

[5] J. R. Koza. Genetic Programming II: Automatic Discovery of Reusable Programs. MIT Press, Cambridge Massachusetts, May 1994.

[6] O. Kramer and F. Gieseke. Analysis of wind energy time series with kernel methods and neural networks. In Seventh International Conference on Natural Computation, 2011. to appear.

[7] O. Kramer and F. Gieseke. Short-term wind energy forecasting using support vector regression. In International Conference on Soft Computing Models in Industrial and Environmental Applications, pages 271–280. Springer, 2011.

[8] A. Kusiak, H. Zheng, and Z. Song. Short-term prediction of wind farm power: A data mining approach. IEEE Transactions on Energy Conversion, 24(1):125 – 136, 2009.

[9] R. Poli, W. B. Langdon, and N. F. McPhee. A Field Guide to Genetic Programming. lulu.com, 2008.

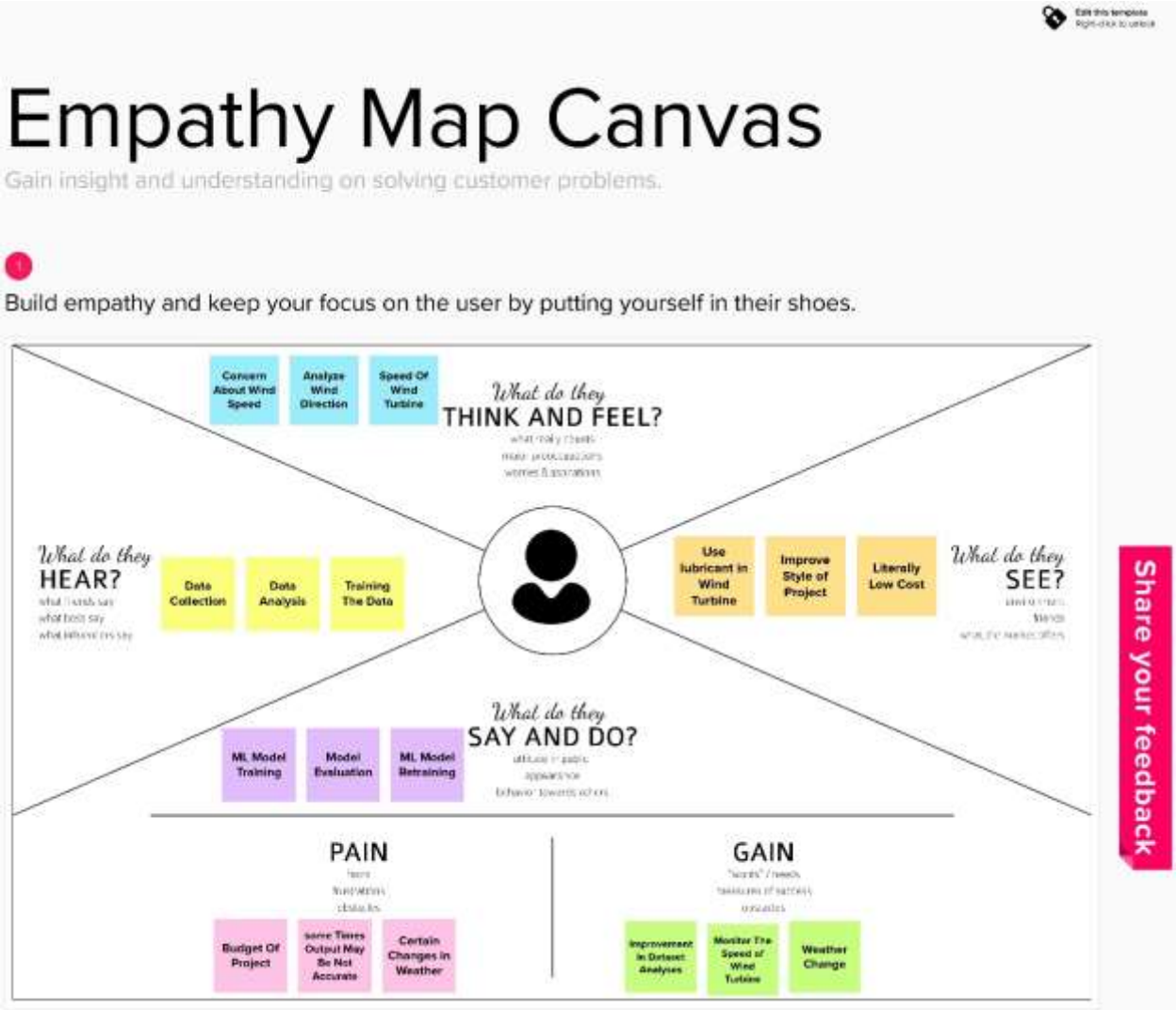
[10] M. Schmidt and H. Lipson. Age-fitness pareto optimization. In Genetic Programming Theory and Practice VIII, Genetic and Evolutionary Computation, chapter 8, pages 129– 146. Springer, 2010.

2.3 Problem Statement Definition:

Our aim is to predict the wind energy based on previous year dataset of energy output of wind turbine(windmill). 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.

3.IDEATION & PROPOSED SOLUTION:

3.1 Empathy Map Canvas



2.2 Ideation & Brainstorming

Template

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

Share template feedback

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

Team gathering
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

Set the goal
Think about the problem you'll be focusing on solving in the brainstorming session.

Learn how to use the facilitation tools
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

Predicting the energy output of wind turbine based on weather condition

PROBLEM :
Wind farms have different impacts on the environment compared to conventional power plants, but similar concerns exist over both the noise produced by the turbine blades and the visual impacts on the landscape

Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

BALASHANKAR M

- Use Tall and Small Towers in Shuffle
- Research about Wind Turbines
- Blade is Placed on Which Angle(Angle Based)
- Use Of Torque Generator High/low

SUREKA V

- Alterate Wind Speed of Box Fan
- Based on Gear Ratio
- No of Blades Used
- Material Type of Blades

POOVARASAN K

- Predicting wind current in summer
- Analysis on wind direction
- Mapping of wind tower
- Using larger rotor diameter

SAI RAKSHIT SB

- Wind Turbine Size
- installed cost
- estimated annual power production
- confidence in the estimated annual power

ELANGOVAN A

- Research
- Predict Energy Perfectly
- Exploration
- weather condition

3

Group ideas

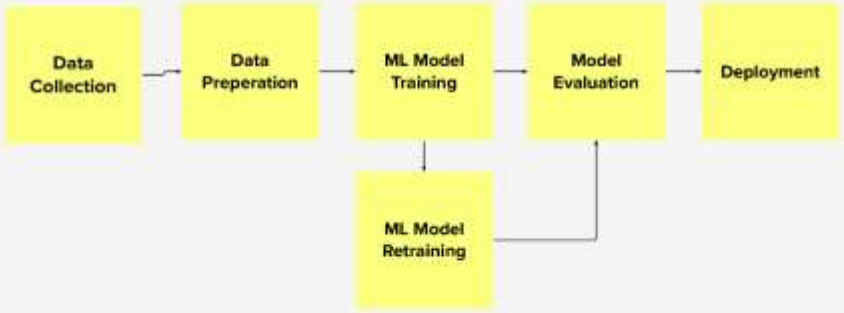
Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

TIP

Add custom/color tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

COMPLICATION :



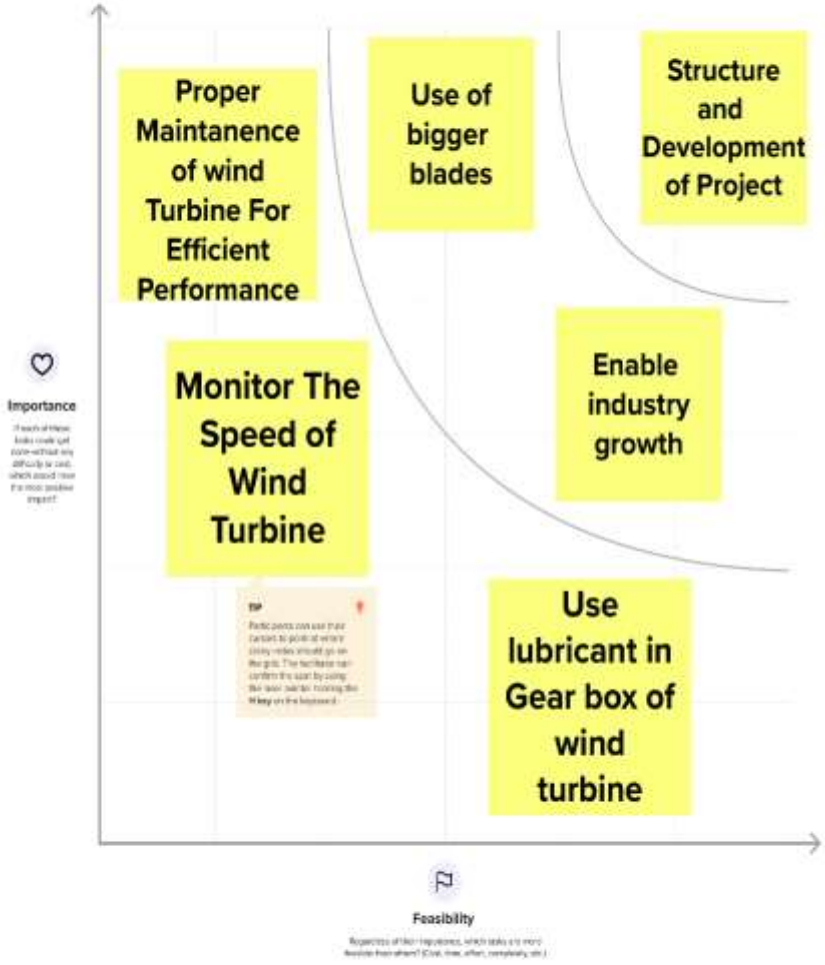
ANALYSIS :

4

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes



After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

Share the mural
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

Export the mural
Export a copy of this mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.
Open the template →

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template →

Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
Open the template →

Share template feedback

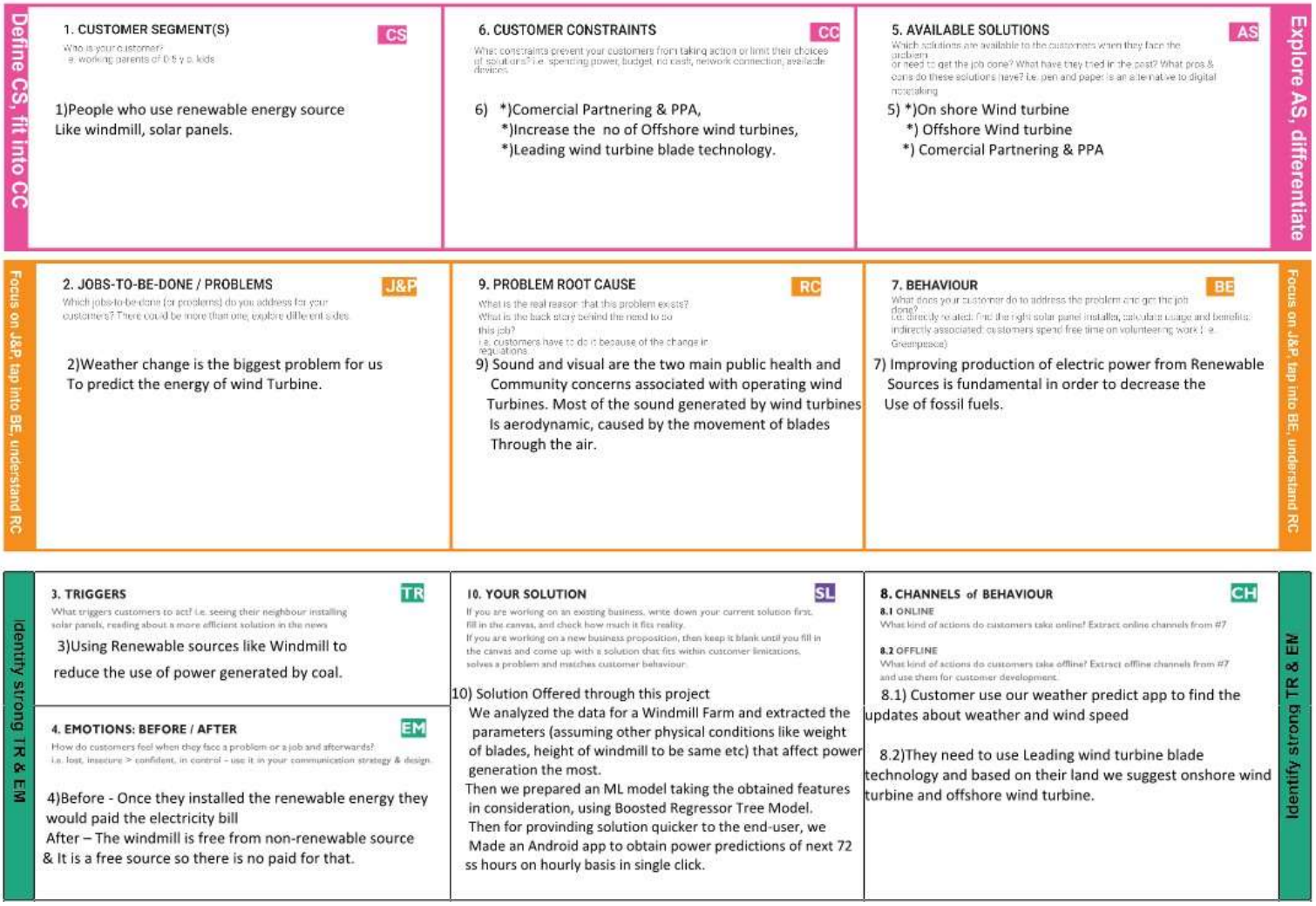
3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Our aim is to predict the wind energy based on previous year dataset of energy output of wind turbine(windmill). 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.
2.	Idea / Solution description	We analyzed the data for a Windmill Farm and extracted the parameters (assuming other physical conditions like weight of blades, height of windmill to be same etc) that affect power generation the most. Then we prepared an ML model taking the obtained features in consideration, using Boosted Regressor Tree Model. Then for providing solution quicker to the end-user, we Made an Android app to obtain power predictions of next 72 ss hours on hourly basis in single click.
3.	Novelty / Uniqueness	We create an Android app to predict the weather for our users to know about the weather for next 72 hrs. By using this they will know and use the another alternate method for inability of wind turbine during Bad weather. Because use of wind turbine in

		bad weather is not possible to get power.
4.	Social Impact / Customer Satisfaction	Sound and visual are the two main public health and Community concerns associated with operating wind turbines. Most of the sound generated by wind turbines Is aerodynamic, caused by the movement of blades through the air.
5.	Business Model (Revenue Model)	Wind energy has been the main resource of renewable energy in the China and European Union region for the last decade. We need to implement these models in the territories those who don't have max level of wind turbines and whom they don't have wind turbines. Making Available of wind turbines for those territories will reduce the use of non-renewable energy sources. Incase at a certain point there is no possible of having coal and crude oil we need to change ourself and adopt ourself to the renewable energy sources. So this can be the bigger business to the modern world.
6.	Scalability of the Solution	Our Aim is to improve the wind turbines as large as possible.

3.4 Problem Solution fit:

Project Title: Predicting the energy output of wind turbine based on weather condition. **Project Design Phase-I - Solution Fit Template** **Team ID: PNT2022TMID45553**



4. REQUIREMENT ANALYSIS

4.1 Functional requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration(For both app and webpage)	Registration through by your email or mobilenumber.
FR-2	User Confirmation	Confirmation will be sent to your registered mail id and msg via mobile number.
FR-3	Essentiality	• City name • Wind speed • Wind direction • Weather condition(temperature, humidity)
FR-4	Output	Predicated Energy will be show in KW/h

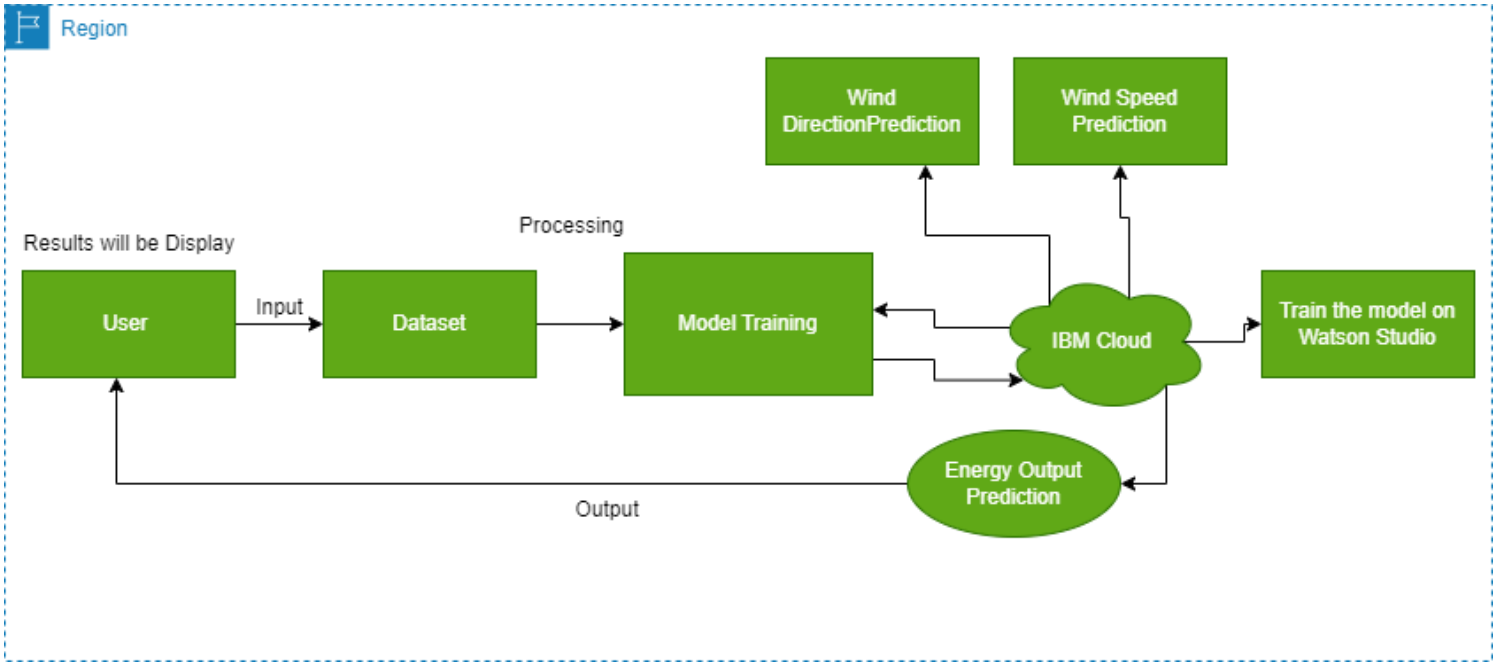
4.2 Non-functional Requirements:

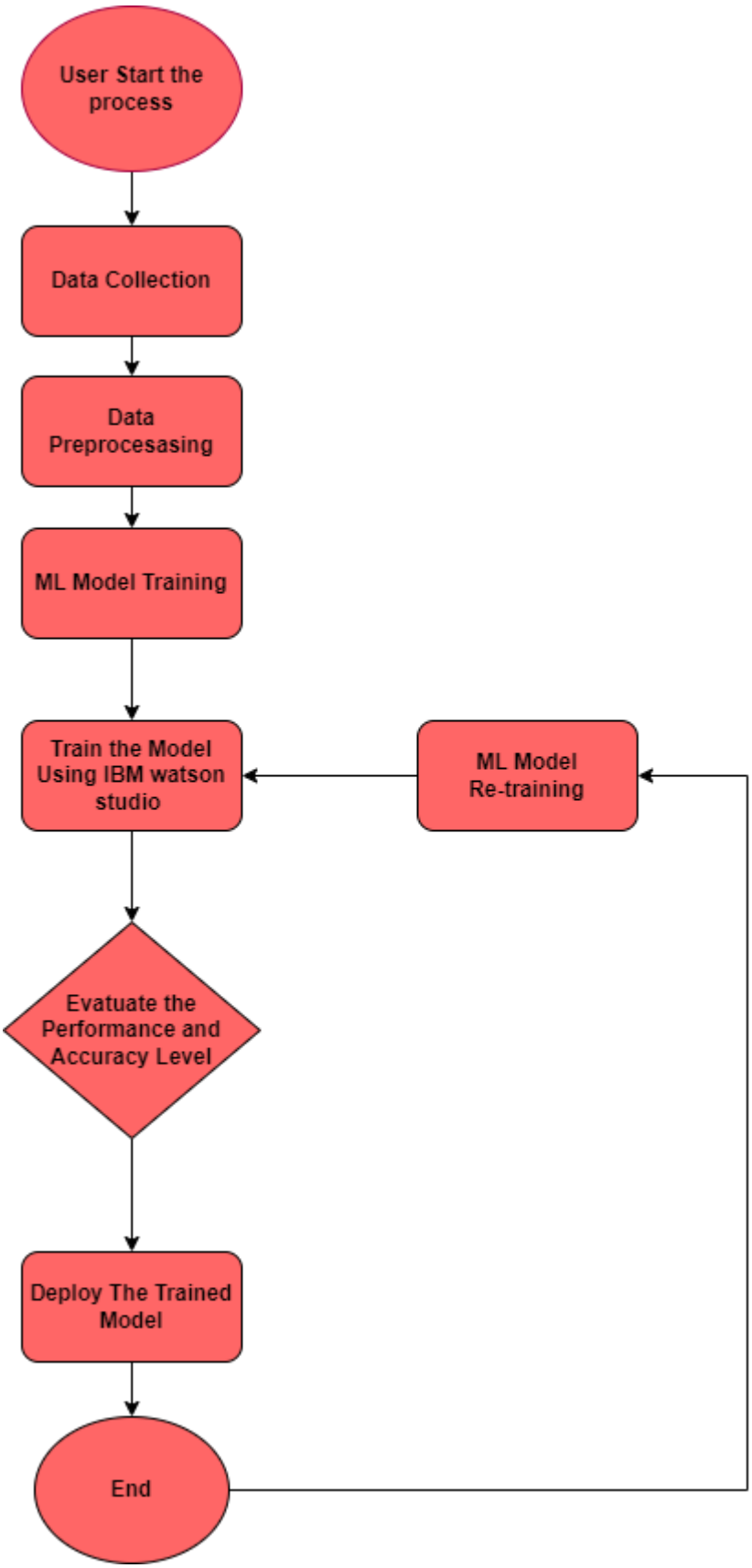
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	• Easy to use not need special knowledge • User friendly
NFR-2	**Security**	Privacy – User need to create their account their self not to share details to others for secure their data.
NFR-3	**Reliability**	Wind Energy is reliable because of it's a Renewable Energy source.
NFR-4	**Performance**	We use more than one model to ML Model training so The Accuracy is so good.,

NFR-5	**Availability**	This is to be a web based application so anyone can access it through any device with better internet connection.
NFR-6	**Scalability**	This app can be used to provide useful information to the user. The users maybe whomever like Organizations, Students, Government.

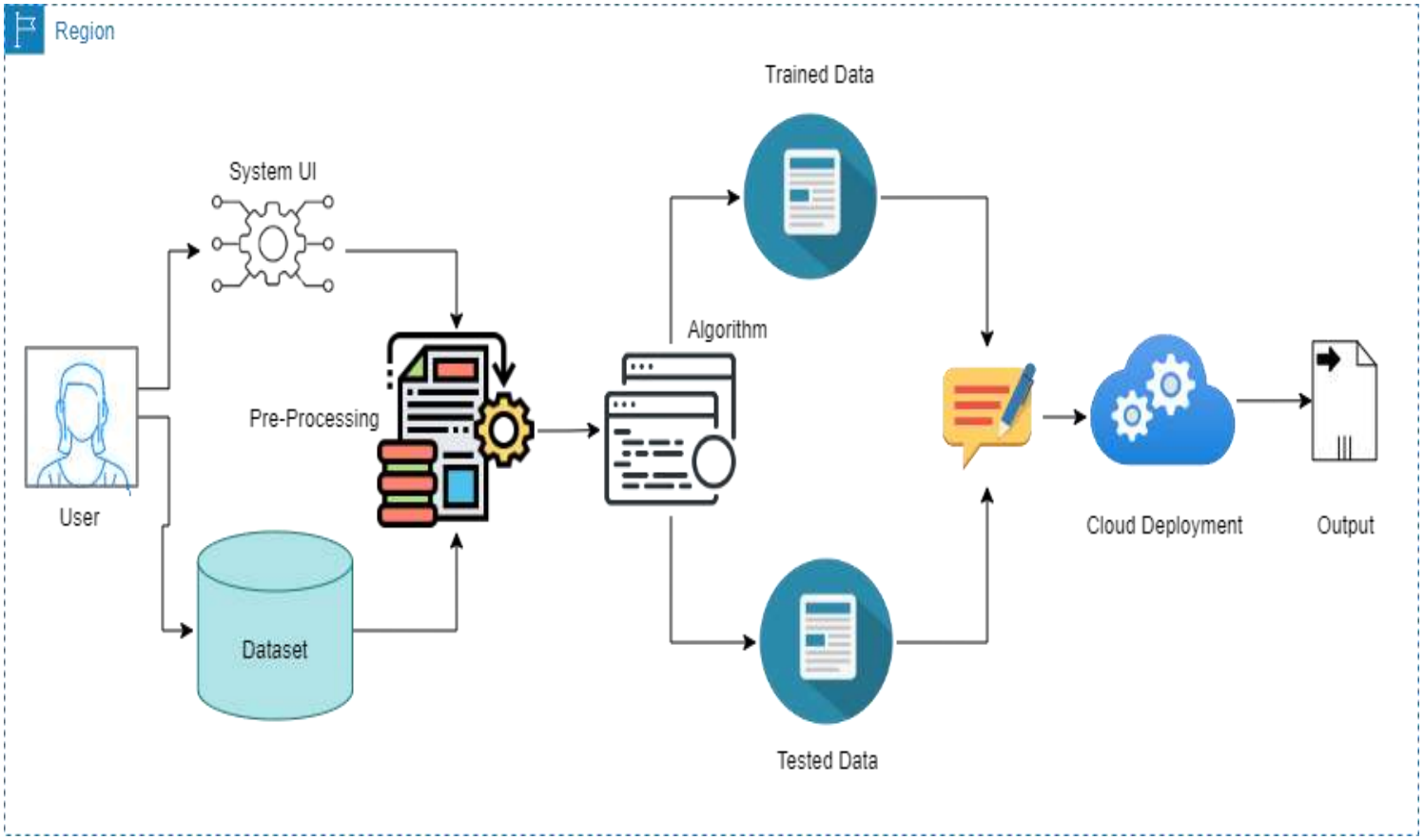
5. PROJECT DESIGN:

5.1 Data Flow Diagrams:




User Start the process
Data Collection
Data Preprocesasing
ML Model Training
Train the Model Using IBM watson studio
ML Model Re-training
Evatuate the Performance and Accuracy Level
Deploy The Trained Model
End

5.2 Solution & Technical Architecture:



5.3 User Stories:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Mobile	Registration	USN-1	As a user, I can Register the app for the first time with my mail id or phone number	I can access my account after registration by email or phone	High	Sprint-1

		USN-2	I will receive the confirmation mail	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	Once you receive the mail the registration is completed	The Acknowledgement will be sent to mail	Low	Sprint-1
		USN-4	Otherwise you can register the app through facebook also.	I can receive pop-up confirmation from facebook	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application byentering email & password	Once you log in with correct details it will show Login Successful	High	Sprint-1
	Homepage	USN-6	In the home page user can view the search bar for search the location	I can search the cities with the help of the search bar	Low	Sprint-1
		USN-7	As a user I can select the location by search	In this I can view	Low	

				the selected location		Sprint-2
	App Interfaces	USN-8	As a user I can see the weather conditions on it	In this I can see the weather conditions of selected city	Low	Sprint-2
			As a user I can also see the wind speed and humidity level to.	In this I can view the humidity and speed also	Medium	Sprint-3
Customer (Web user)	Login	USN-10	As a User I can register the same by the app users email and mobile number to.	I can register by mobile number and mail id on webpage	High	Sprint-3
Help line		USN-11	As a user I can contact the Helpline and ask the doubts about the use cases from any time.	I can contact helpline at any time for any queries	High	Sprint-4
Feedback (from User)		USN-12	As a User I can provide the feedback by the app or webpage.	I can send my feedback to the developer on the webpage	High	Sprint-4

6. PROJECT PLANNING & SCHEDULING:

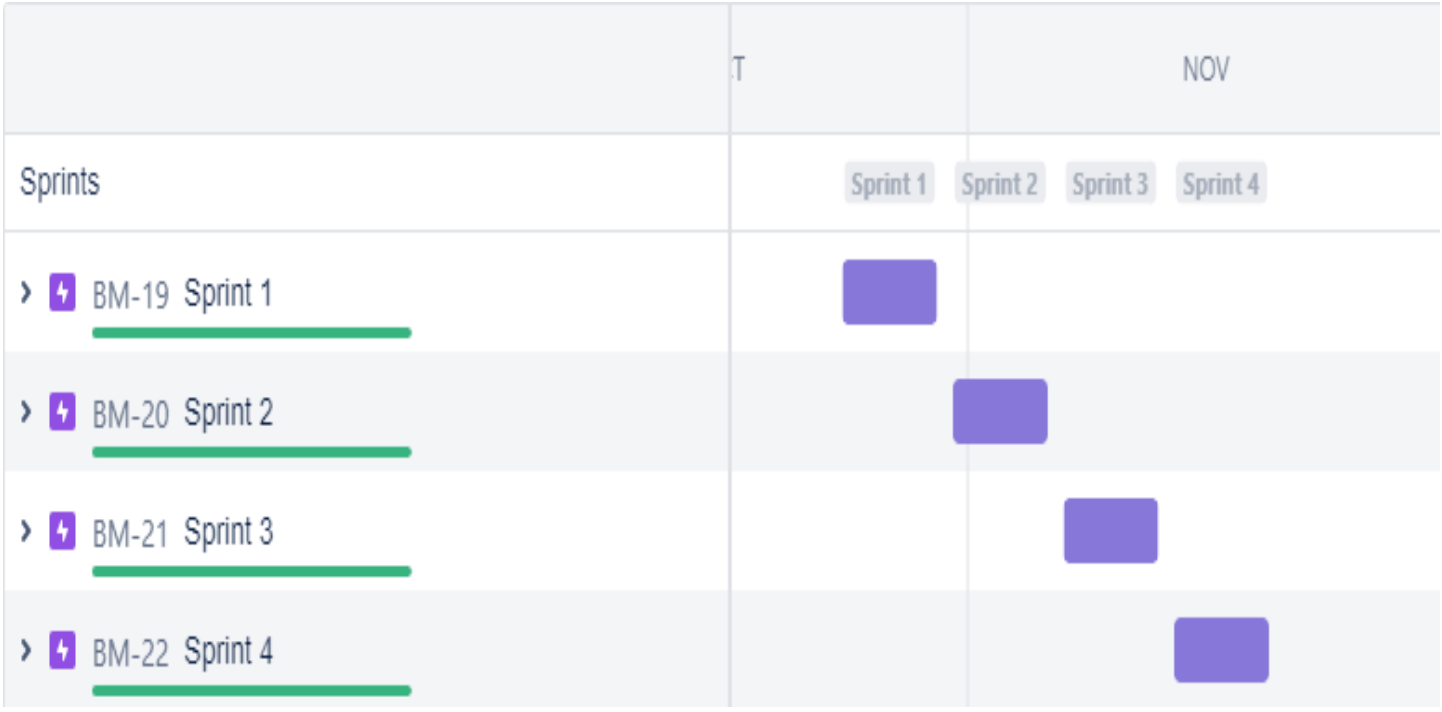
6.1 Sprint Planning & Estimation:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Point	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.	2	High	BALASHANKAR M
Sprint-1	Confirmation	USN-2	As a user, I will receive confirmation email onceI have registered for the application	1	High	SUREKA V
Sprint-1	Information about wind energy	USN-3	Find wind dataset or Create a New Dataset	2	Low	BALASHANKAR M, SUREKA V
Sprint-2	Alternative registration method	USN-4	As a user, I can register for the application through mobile number	2	Medium	BALASHANKAR M
Sprint-2	Login	USN-5	As a user, I can log into the application by entering email & password	1	High	SUREKA V
Sprint-3	Dashboard	USN-6	In the dashboard you can search the location with longitude , latitude or by name	1	Low	SAI RAKSHIT S B
Sprint-4	Check Weather	USN-7		1	Medium	POOVARASAN K
Sprint-4	Predicting Energy Wind Output	USN-8	The pop-up will show the predicted energy output in KW/h	2	High	ELANGOVAN A

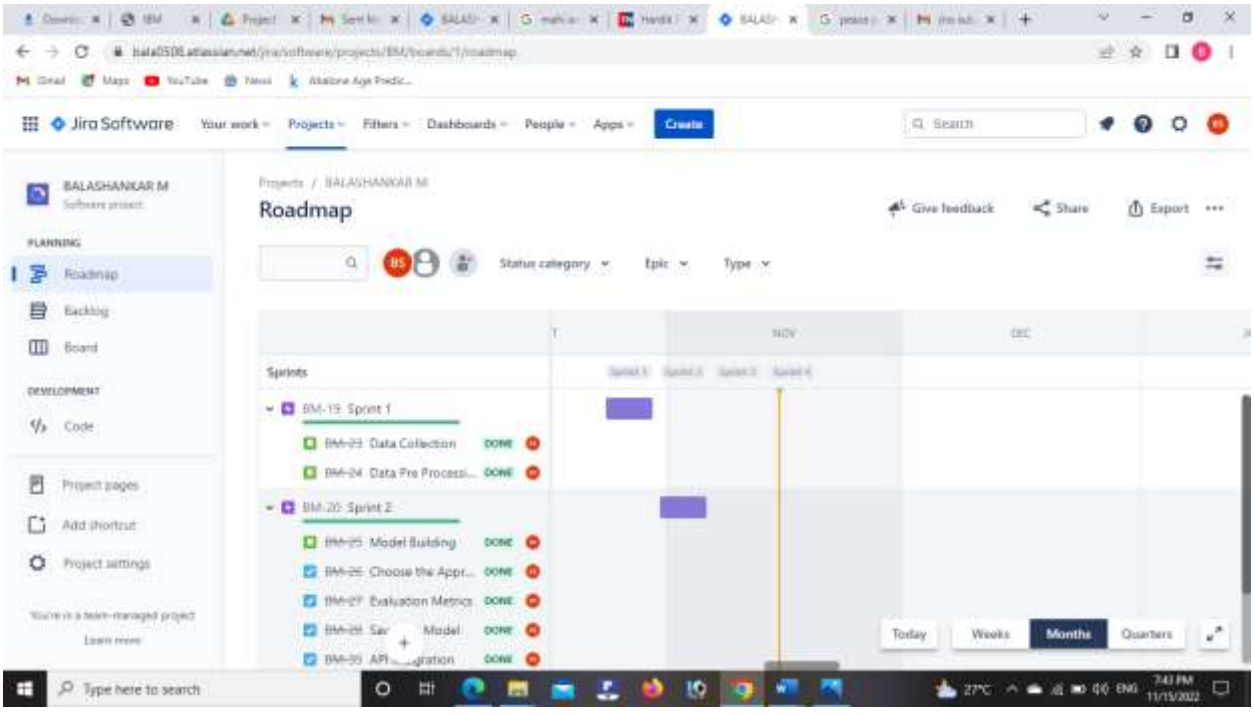
6.2 Sprint Delivery Schedule:

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	04 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

6.3 Reports from JIRA:




BURNDOWN CHART
7
6
5
4
3
2
1
0
Actual
24-29 oct 2022
Sprint-1
31 oct-05 oct 2022
Sprint-2
07-12 Nov 2022
Sprint-3
14-19 Nov 2022
Sprint-4
Planned
BURNDOWN CHART Planned
BURNDOWN CHART Actual
BURNDOWN CHART Velocity


Jira Software
Your work
Projects
Filters
Dashboards
People
Apps
Create
Search
BALASHANKAR M
Roadmap
Give feedback
Share
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Epic
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PLANNING
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Code
Project pages
Add shortcut
Project settings
Sprints
BM-19 Sprint 1
BM-23 Data Collection
BM-24 Data Pre Processi...
BM-20 Sprint 2
BM-25 Model Building
BM-26 Choose the Appr...
BM-27 Evaluation Metrics
Today
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Months
Quarters
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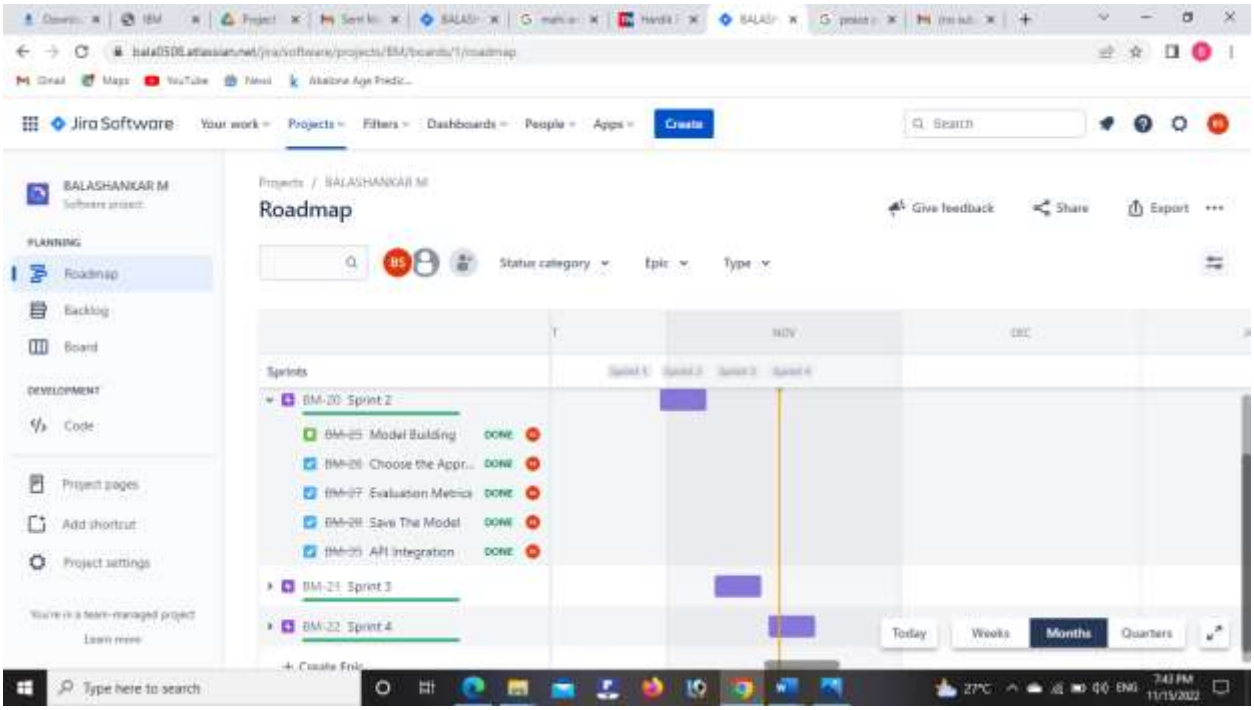
Jira Software
Your work
Projects
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Dashboards
People
Apps
Create
Search
BALASHANKAR M
Roadmap
Give feedback
Share
Export
Status category
Epic
Type
PLANNING
Roadmap
Backlog
Board
DEVELOPMENT
Code
Project pages
Add shortcut
Project settings
Sprints
BM-20 Sprint 2
BM-25 Model Building DONE
BM-26 Choose the Appr... DONE
BM-27 Evaluation Metrics DONE
BM-28 Save The Model DONE
BM-35 API Integration DONE
BM-21 Sprint 3
BM-22 Sprint 4
Today
Weeks
Months
Quarters
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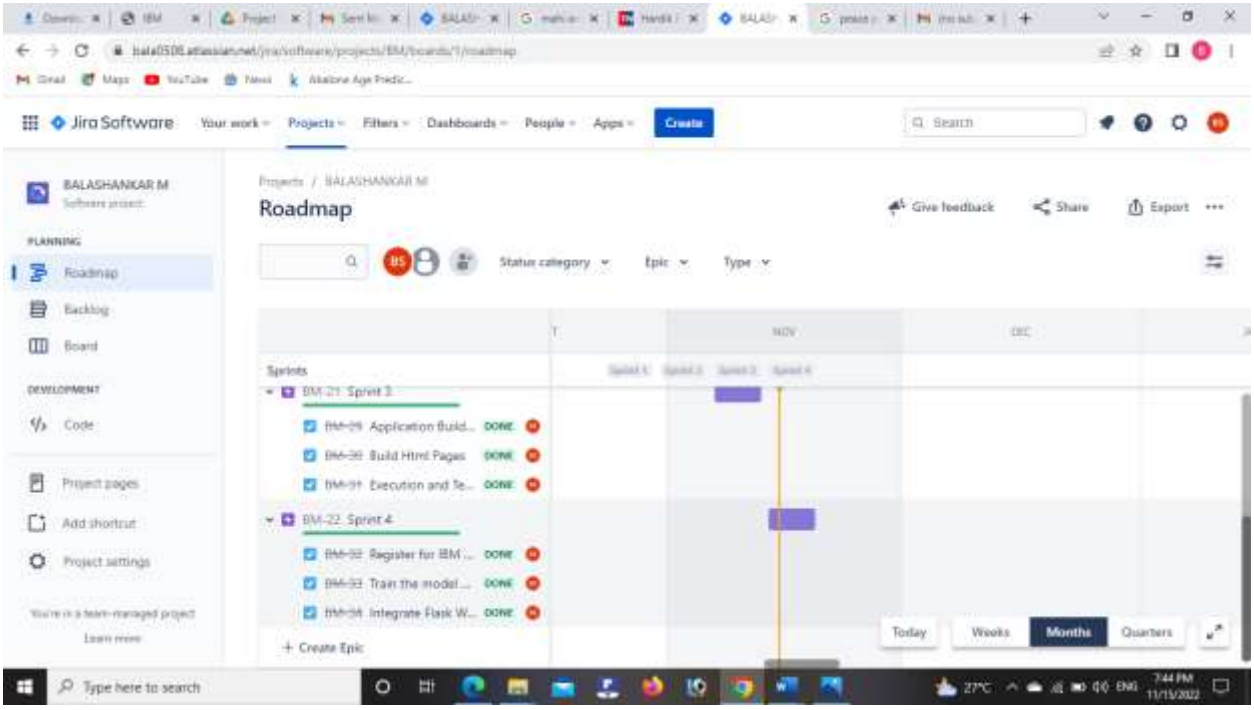
Jira Software
Your work
Projects
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Apps
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BALASHANKAR M
Roadmap
Give feedback
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Export
Status category
Epic
Type
PLANNING
Roadmap
Backlog
Board
DEVELOPMENT
Code
Project pages
Add shortcut
Project settings
Sprints
BM-21 Sprint 3
BM-29 Application Build... DONE
BM-30 Build Html Pages DONE
BM-31 Execution and Te... DONE
BM-22 Sprint 4
BM-32 Register for IBM ... DONE
BM-33 Train the model ... DONE
BM-34 Integrate Flask W... DONE
+ Create Epic
Today
Weeks
Months
Quarters
Type here to search

7. CODING & SOLUTIONING:

7.1 Features:

- We added the weather prediction to Web Application.
- We used the Random Forest Regression for model building. It provides more accurate values.
- There is a possible to add more cities to Web Application.
- The Web App consists of index and predict pages.
- Index contains the basic details of the project and the one button “CLICK HERE TO PREDICT WIND ENERGY”.
- If you click on that it will be redirected to the page of prediction, It contains the weather predict options and wind energy prediction option.
- Finally the predicted output shown in the Unit KW/h.
- We made our cloud for the web application to interact with it. So anyone from everywhere can access our web app and predict the wind energy.
- The use of the app ais easier to access.

8. TESTING:

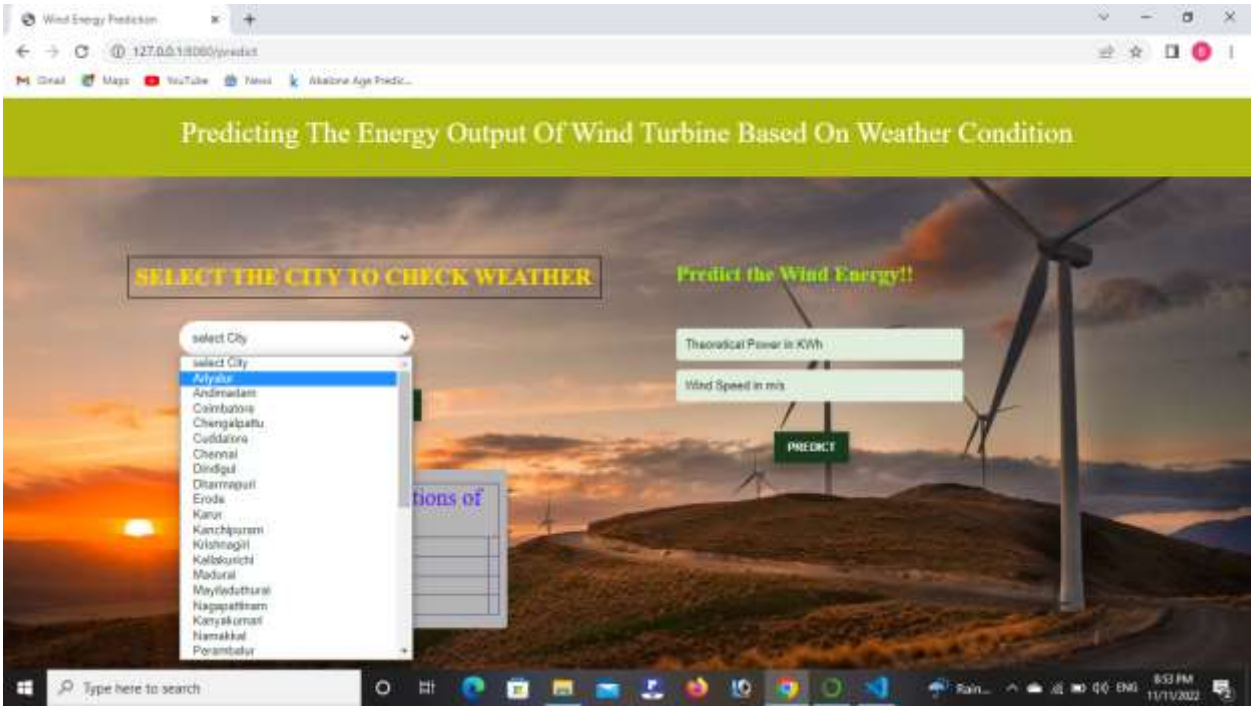
8.1 Test Cases:

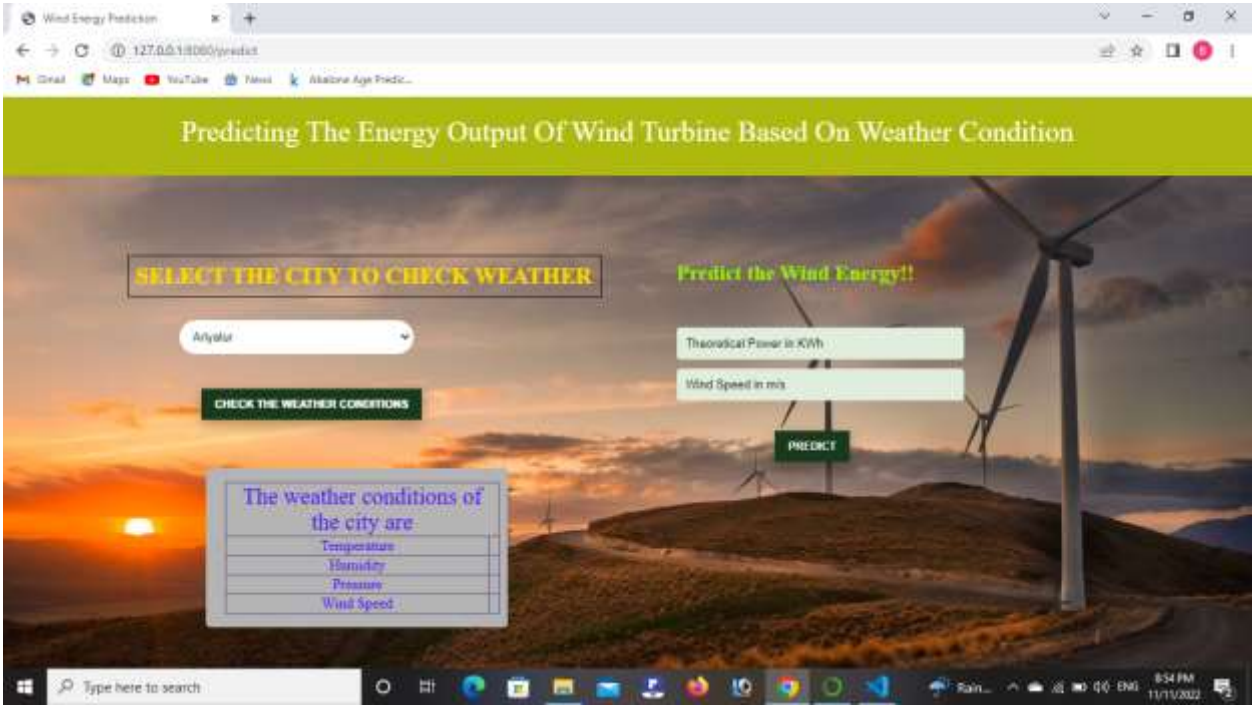
Test Scenarios

1. User use our web app and see the index page first
2. In index page user can use the button "CLICK HERE TO PREDICT 3.
3. WIND ENERGY" and it redirects into the predict page

   User can see weather details by select the city and click "GET THE WEATHER DATA OF THE CITY"
4. Give the inputs of " Theoretical Power and Wind Speed" and click "PREDICT"
5. The results will show in the Unit Of KW/h

8.2 User Acceptance Testing


Predicting The Energy Output Of Wind Turbine Based On Weather Condition
SELECT THE CITY TO CHECK WEATHER
select City
Ariyalur
Coimbatore
Cuddalore
Chennai
Dindigul
Dharmapuri
Erode
Karur
Kanchipuram
Krishnagiri
Madurai
Nagapattinam
Kanyakumari
Namakkal
Perambalur
Predict the Wind Energy!!
Theoritical Power in KWh
Wind Speed in m/s
PREDICT


Predicting The Energy Output Of Wind Turbine Based On Weather Condition
SELECT THE CITY TO CHECK WEATHER
Ariyalur
CHECK THE WEATHER CONDITIONS
The weather conditions of the city are
Temperature
Humidity
Pressure
Wind Speed
Predict the Wind Energy!!
Theoritical Power in KWh
Wind Speed in m/s
PREDICT

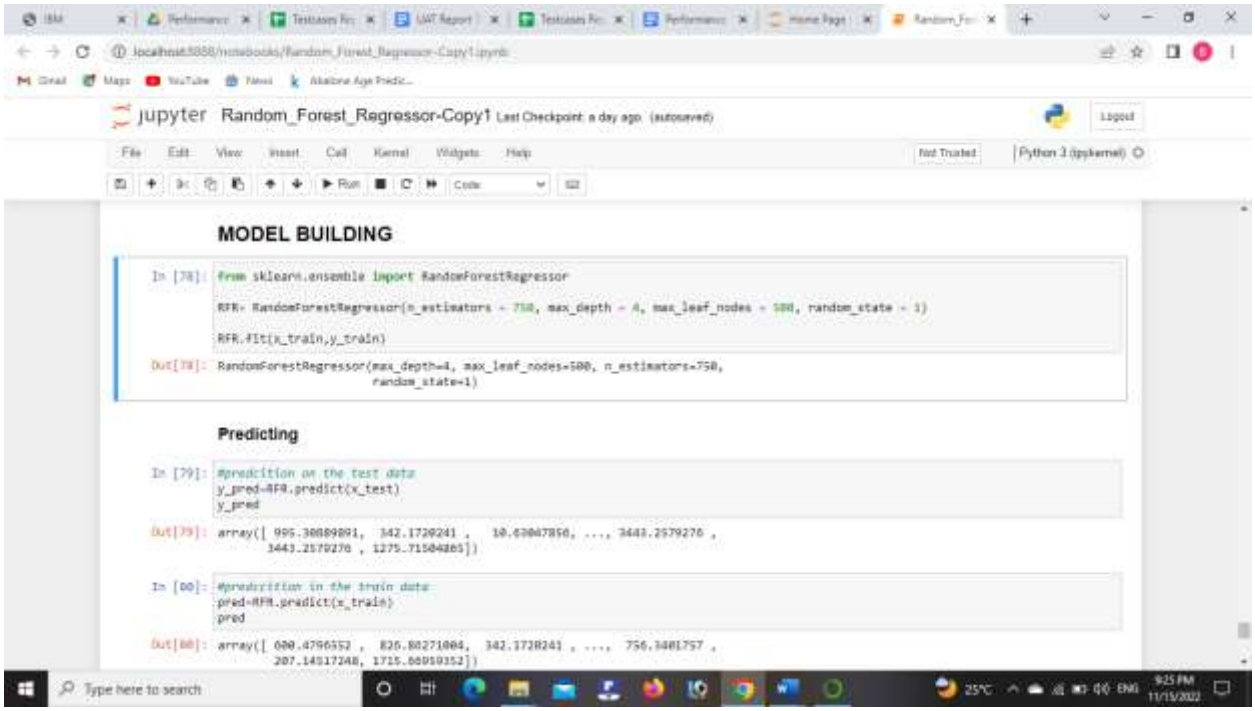

Predicting The Energy Output Of Wind Turbine Based On Weather Condition
SELECT THE CITY TO CHECK WEATHER
select City
CHECK THE WEATHER CONDITIONS
Predict the Wind Energy!!
Theoratical Power in KWh
Wind Speed in m/s
PREDICT
The weather conditions of the city are
Temperature
22.27000000000004 °C
Humidity
96 %
Pressure
1012 mmHG
Wind Speed
8.1 Km/s
Type here to search

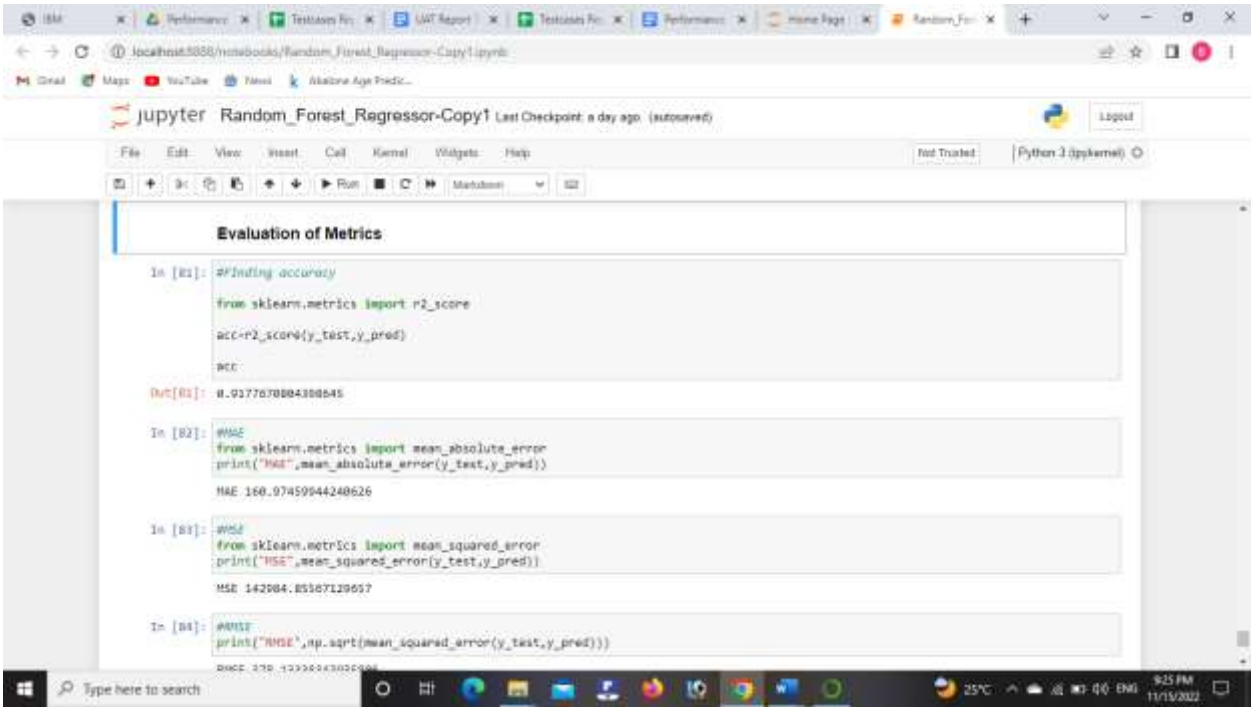

Predicting The Energy Output Of Wind Turbine Based On Weather Condition
SELECT THE CITY TO CHECK WEATHER
select City
CHECK THE WEATHER CONDITIONS
Predict the Wind Energy!!
500
PREDICT
The weather conditions of the city are
Temperature
22.27000000000004 °C
Humidity
96 %
Pressure
1012 mmHG
Wind Speed
8.1 Km/s
Type here to search

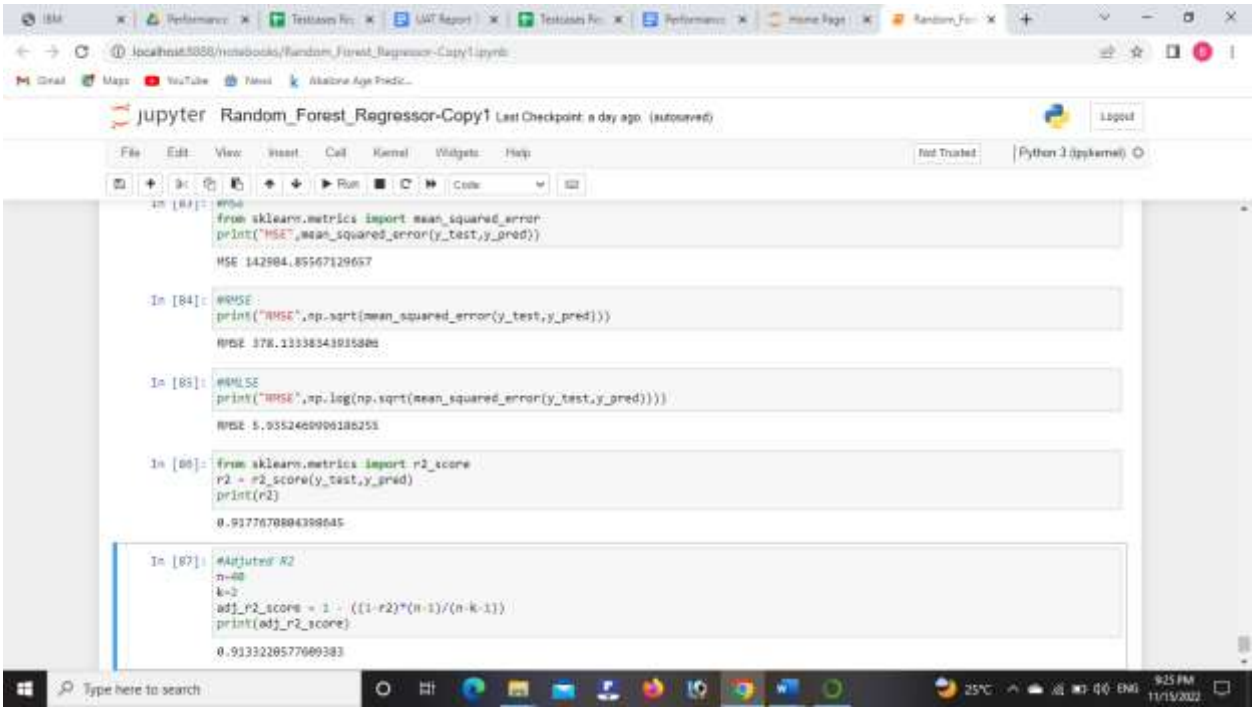
9. RESULTS:

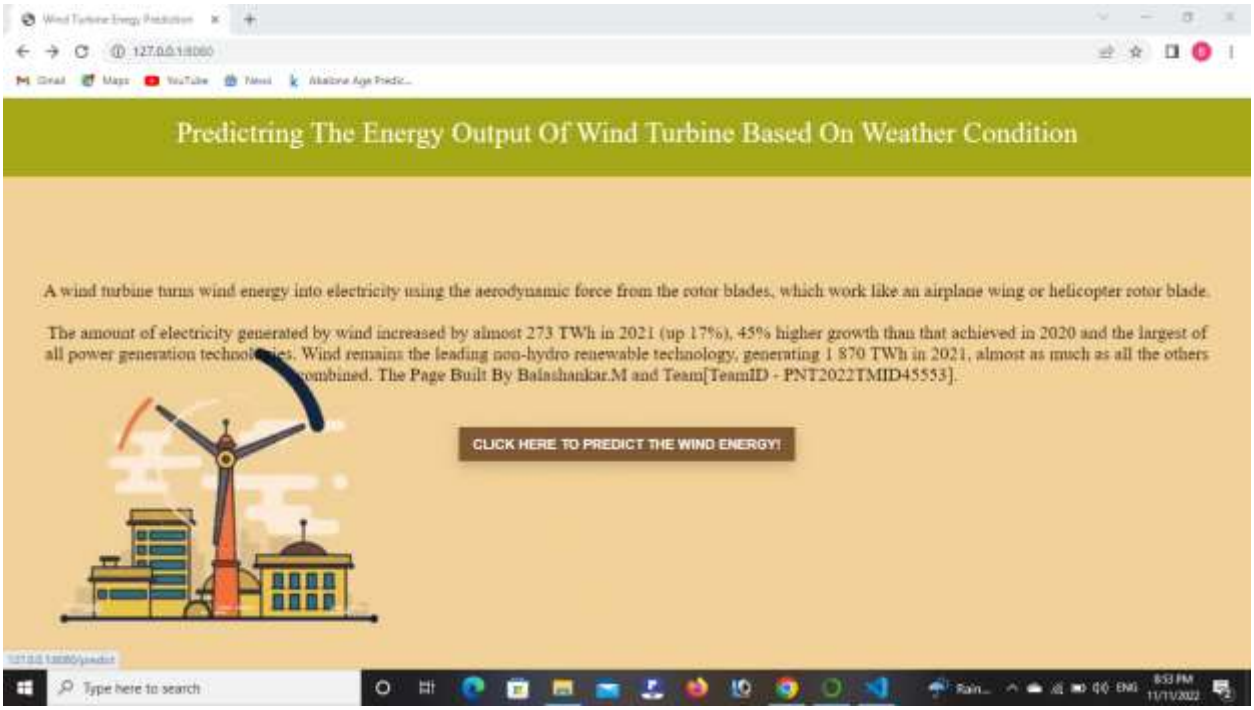
9.1 Performance Metrics:

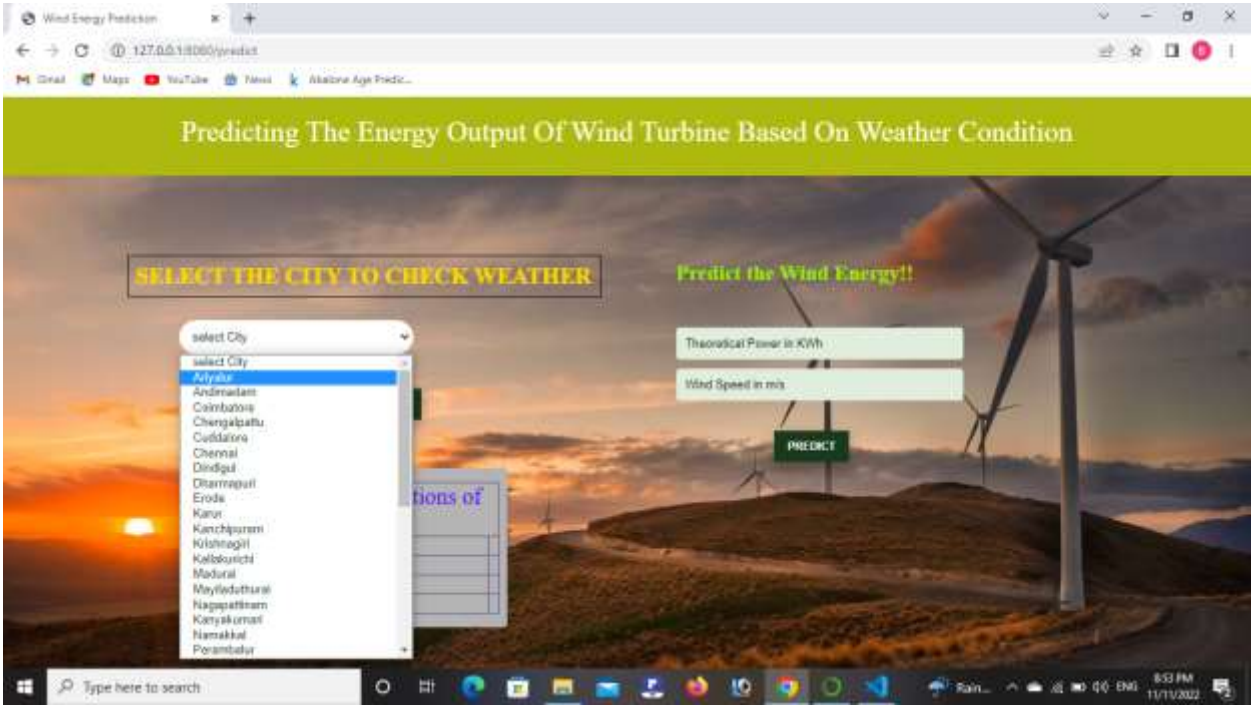
We evaluated the Performance using the Metrics. Accuracy score, RME, RMSE. RMLSE, R2, Adjusted R2.




jupyter Random_Forest_Regressor-Copy1 Last Checkpoint: a day ago (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
Evaluation of Metrics
In [81]:
#Finding accuracy
from sklearn.metrics import r2_score
acc=r2_score(y_test,y_pred)
acc
Out[81]:
0.9177670804308645
In [82]:
#MAE
from sklearn.metrics import mean_absolute_error
print("MAE",mean_absolute_error(y_test,y_pred))
MAE 160.97459944240626
In [83]:
#MSE
from sklearn.metrics import mean_squared_error
print("MSE",mean_squared_error(y_test,y_pred))
MSE 142984.85567129657
In [84]:
#RMSE
print("RMSE",np.sqrt(mean_squared_error(y_test,y_pred)))
Type here to search


jupyter Random_Forest_Regressor-Copy1 Last Checkpoint: a day ago (autosaved)
Logout
File Edit View Insert Cell Kernel Widgets Help
Not Trusted
Python 3 (ipykernel)
from sklearn.metrics import mean_squared_error
print("MSE",mean_squared_error(y_test,y_pred))
MSE 142984.85567129657
In [84]:
#RMSE
print("RMSE",np.sqrt(mean_squared_error(y_test,y_pred)))
RMSE 378.13338543935886
In [85]:
#RMLSE
print("RMSE",np.log(np.sqrt(mean_squared_error(y_test,y_pred))))
RMSE 5.935246090618255
In [86]:
from sklearn.metrics import r2_score
r2 = r2_score(y_test,y_pred)
print(r2)
0.9177670804308645
In [87]:
#Adjusted R2
n=40
k=2
adj_r2_score = 1 - ((1-r2)*(n-1)/(n-k-1))
print(adj_r2_score)
0.9133228577009383
Type here to search


Predictring The Energy Output Of Wind Turbine Based On Weather Condition
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.
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. The Page Built By Balashankar.M and Team[TeamID - PNT2022TMID45553].
CLICK HERE TO PREDICT THE WIND ENERGY!
Type here to search


Predicting The Energy Output Of Wind Turbine Based On Weather Condition
SELECT THE CITY TO CHECK WEATHER
select City
Ariyalur
Andimadam
Coimbatore
Chengalpattu
Cuddalore
Chennai
Dindigul
Dharmapuri
Erode
Karur
Kanchipuram
Krishnagiri
Kallakurichi
Madurai
Mayiladuthurai
Nagapattinam
Kanyakumari
Namakkal
Perambalur
Predict the Wind Energy!!
Theoretical Power in KWh
Wind Speed in m/s
PREDICT
Type here to search


Predicting The Energy Output Of Wind Turbine Based On Weather Condition
SELECT THE CITY TO CHECK WEATHER
Ariyalur
CHECK THE WEATHER CONDITIONS
Predict the Wind Energy!!
Theoratical Power in KWh
Wind Speed in m/s
PREDICT
The weather conditions of the city are
Temperature
Humidity
Pressure
Wind Speed


Predicting The Energy Output Of Wind Turbine Based On Weather Condition
SELECT THE CITY TO CHECK WEATHER
select City
CHECK THE WEATHER CONDITIONS
Predict the Wind Energy!!
Theoratical Power in KWh
Wind Speed in m/s
PREDICT
The weather conditions of the city are
Temperature 22.270000000000004 °C
Humidity 98 %
Pressure 1012 mmHG
Wind Speed 8.1 Km/h


Predicting The Energy Output Of Wind Turbine Based On Weather Condition
SELECT THE CITY TO CHECK WEATHER
select City
CHECK THE WEATHER CONDITIONS
The weather conditions of the city are
Temperature
22.270000000000004 °C
Humidity
98 %
Pressure
1012 mmHG
Wind Speed
8.1 Km/s
Predict the Wind Energy!!
500
PREDICT


Predicting The Energy Output Of Wind Turbine Based On Weather Condition
SELECT THE CITY TO CHECK WEATHER
select City
CHECK THE WEATHER CONDITIONS
The weather conditions of the city are
Temperature
Humidity
Pressure
Wind Speed
Predict the Wind Energy!!
Theoritical Power in KWh
Wind Speed in m/s
PREDICT
The energy predicted is 383.42 KWh

10. ADVANTAGES & DISADVANTAGES:

ADVANTAGES:

- Wind energy is free and with modern technology it can be captured efficiently.
- Once the wind turbine is built the energy it produces does not cause green house gases or other pollutants.
- Although wind turbines can be very tall each takes up only a small plot of land. This means that the land below can still be used. This is especially the case in agricultural areas as farming can still continue.
- Many people find wind farms an interesting feature of the landscape.
- Remote areas that are not connected to the power grid can use wind turbines to produce their own electricity.
- Wind turbines have a role to play in both the developed and third world.
- Wind turbines are available in a range of sizes which means a vast range of people and businesses can use them. From single households to small towns and villages can make good use of a range of wind turbines available today.

DISADVANTAGES:

- The strength of the wind is not constant and it varies from zero to gale force. This means that wind turbines do not produce the same amount of electricity all the time. There will be times when they produce no electricity at all.
- Many people feel that the countryside should be left untouched, without these large structures being built. The landscape should left in its natural form for everyone to enjoy.
- Wind turbines are noisy. Each one can generate the same level of noise as a family car travelling at 70 mph.
- Many people see large wind turbines as unsightly structures and not pleasant or interesting to look at. They disfigure the countryside and are generally ugly.

11. CONCLUSION:

The new invention, innovation, creation are to be favor for the nature not only favor the people. Because we need to maintain the nature as good as possible for the next generation. The wind turbines are the one of the best renewable energy sources. It's mainly fuel free. People need to update adopt theirself for the modern science and Technology. To avoid the use of Non-Renewable energy sources we use these kind of energy sources like solar, water energy, Wind turbine. To make a Better World We need to update ourself to latest technology and is not be affect the nature we use the nature we don't affect them.

12. FUTURE SCOPE:

By Offshore Wind Turbines:

This is a very effective method of generation of wind energy. Offshore wind turbines are constructed near the water-bodies. Energy which is generated by offshore wind is more as compared to on land. Almost 1,662 turbines are situated at 55 offshore locations across 10 European countries for generating electricity and that energy is enough for almost 500000 households [7]. Generation of wind energy by offshore wind turbines are not much used in India because of the Indian economy. Indian economy is not very strong to setup an offshore wind turbines industry but, due to scope of this type of generation of energy some companies came forward to set up the offshore wind turbines. In India, Gujarat is the first place which is planning to set up the offshore wind power project which is initiated by Suzlon Energy limited, it is world's fifth largest wind turbine supplier.

Highway Windmill:

Vehicles moving in a highway suffer a lot to drive the vehicle during night time due to lighting problem. It is not possible task to lay electric cables underground and provide lighting

throughout the length of the roads. In this paper, the drawback can be overcome by make use of VAWT (Vertical Axis Wind Turbine) [9]. The VAWT is coupled with disc type alternator placed on the highway road dividers. As the wind is forced by passing vehicles from both sides, the wind speed on the center place of highway roads will be more than at the pedestrian walking lane. This wind is forced to the VAWT from two directions heavily but this VAWT makes use of both the wind directions and rotates in one direction only. If the speed of the turbine increases results in increasing the speed of the alternator and the corresponding increased power is obtained at the output terminal. This power can be stored in battery bank which is placed under the windmill and utilized at night time for lighting purpose on the highway.

APPENDIX:

Application Building:

Flask App:

```
import numpy as np

from flask import Flask, request, jsonify, render_template

import joblib

import requests


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')
    apikey="a802b0f626c637d04185e582b5ad0d58"
    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)
```

Flask App_1:

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

app = Flask(__name__)
model = joblib.load('Power_Prediction.sav')
```

```
@app.route('/')
def home():
    return render_template('index.html')



@app.route('/predict')
def predict():
    return render_template('predict.html')



@app.route('/windapi',methods=['POST'])
def windapi():
    city=request.form.get('city')
    apikey="a802b0f626c637d04185e582b5ad0d58"
    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)
```

Index Page:

```
</html>
</head>
<title>Wind Turbine Enegy Prediction</title>
<style>
  body {
```

```
        background-image:
url(https://media3.giphy.com/media/L2ngJFciKq7WCVsCJ1/giphy.gif?cid=790b7611fe5a51515
db6a9f7609b0c3752fba5a069638cc4&rid=giphy.gif&ct=gges/m123.gif);
  top: 10%;
        width: 40px;
        height: 20px;
        background-repeat: no-repeat;
   background-color: #f2d299;
  background-position: left bottom;
        background-attachment: fixed;
        background-size: 700px;

  }

     .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: 'Times New Roman', Times, serif;
    font-size: 2.30vw;
    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%;


}
.inside{
    top: 90px;
    bottom: 0px;
    margin: 0px;
```

```
    left: 0px;
    right: 0px;
    position: fixed;
    padding-left: 40px;
    padding-top: 8%;
    padding-right: 40px;
    overflow: hidden;
    opacity: 100%;
    font-family: 'Times New Roman', Times, serif;
    color: black;
    font-size: 20px;
    text-align: center;
}
.myButton{
    border: none;
    text-align: center;
    font-weight: bolder;
    cursor: pointer;
    text-transform: uppercase;
    outline: none;
    overflow: hidden;
    color: #ffffff;
    font-weight: 700;
```

```
    font-size: 15px;
    background-color: #6d4321da;
    padding: 10px 15px;
    margin: auto;
    box-shadow: 0 5px 15px rgba(0, 0, 0, 0.20);
}
</style>
</head>
</body>
```

Predictring The Energy Output Of Wind Turbine Based On Weather Condition

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.

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.

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<button type="button" class="myButton">Click Here To Predict The Wind Energy!</button>

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

Predict Page:

```
</html>
    <head>
        <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);
    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: 2.3vw;
    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: 'Times New Roman', Times, serif;
    color: black;
```

```
    font-size: 20px;


}
.inside{
    top: 180px;
    bottom: 0px;
    margin: 0px;
    left: 51%;
    right: 0px;
    position: fixed;
    padding-left: 40px;
    font-family: 'Times New Roman', Times, serif;
    color: #96f400;
    font-size: 20px;
    font-weight: 100;
    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, 0.3);
    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-radius: 4px;
    box-shadow: white;
```

```
}
::placeholder{
    color: black;
    opacity: 1;
}
.left{
    top: 80px;
    bottom: 0px;
    margin: 0px;
    left: 0px;
    right: 45.5%;
    position: fixed;
    padding-left: 10%;
    padding-top: 5%;
    padding-right: 40px;
    font-weight: 700;
    -webkit-text-stroke-width: 0.2px;
    font-family: 'Times New Roman', Times, serif;
    color: rgb(255, 217, 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, 0, 0); width: 500px;"> SELECT THE CITY TO CHECK WEATHER</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 ="Kanchipuram"   >      Kanchipuram  </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 ="Sivaganga" > Sivaganga </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 ="Thoothukudi" > Thoothukudi </option>

<option value ="Tiruchirappalli" > Tiruchirappalli</option>

<option value ="Tirunelveli" > Tirunelveli </option>

<option value ="Tirupathur" > Tirupathur </option>

<option value ="Tiruppur" > Tiruppur </option>

<option value ="Tiruvannamalai" > Tiruvannamalai </option>

<option value ="Nilgiris" > 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>
```

Flask App Integration With Scoring End Point:

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

# IBM Cloud account Credentials.
API_KEY = "S0ahhsqevpUY0Eu1YKv5Kyl38OMCy3haa5WCXw0am_wL"
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('Power_Prediction.sav')

@app.route('/')

def home():

    return render_template('index.html')

@app.route('/predict')

def predict():

    return render_template('predict.html')

@app.route('/windapi',methods=['POST'])

def windapi():

    city=request.form.get('city')

    apikey="a802b0f626c637d04185e582b5ad0d58"

    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()]]
    print(x_test)
    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/1a772765-e95e-4920-a46b-25ede8ef1b44/predictions?version=2022-11-06', 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, port=8080)
```

GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-54199-1661768780

Demo Link:

https://youtu.be/ylHTNmoofPQ