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# Analysis of Wind Potential using Dynamic Response and Intelligent Controller for Enhanced Output

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**ABSTRACT:** This paper discuss about the wind energy potential at a particular location and as per the forecasting and predictions an intelligent control system can be modelled for the desired output. In this work a site has been selected as per the wind energy potential. The climatic analysis has been done and as per the analysis various capacity plants already installed at the site nut as far as the maximum power point tracking research this work can be the best option as per the data available from the past and can be used in MPPT techniques by using fuzzy control theory. If a 120 m height of turbine plant will be considered firstly the data will be retrieved from the sources and a predefined rule set can be designed as per the data available from the last few years and can be designed for the enhanced output. The modelling of the wind energy conversion system connected with the grid has been done in the Matlab and output of the model has been analysed for the future scope.

**KEYWORDS:** MNRE Ministry of New and Renewable Energy, IGBT Insulated gate bipolar transistor, Fuzzy Control System, THD Total Harmonic Distortion, WECS Wind energy conversion system, MPPT Maximum power point tracking.

## I.INTRODUCTION

India is blessed with abundant renewable energy resources like solar, wind, hydropower, biomass, etc., and has taken a leap in RE capacity additions in last few years as part of country's commitment towards sustainability. With more than two decades of experience, the wind sector occupies an important place in our RE portfolio. Wind industry represents successful 'Make in India' narrative with all wind turbines being made in India and over 80% of the components manufactured indigenously. The year-wise installed wind power capacity up to FY 2022-23 is shown in Figure 1. As on 30.04.2023, wind power has contributed more than 42.8 GW (42868.08 MW) of India's installed capacity. Wind energy also represents water smart electricity resource with least water consuming source of energy where the water requirement is negligible after commissioning as against other forms of electricity generation. The government's ambitious goal of achieving 500 GW Non-fossil energy capacity by 2030 highlights the country's commitment towards sustainable development. In order to meet the ambitious goal, it is necessary to not only refine and strengthen the business and regulatory framework for wind power in India, but also to provide the reliable and updated information on the Indian wind resources. [1]

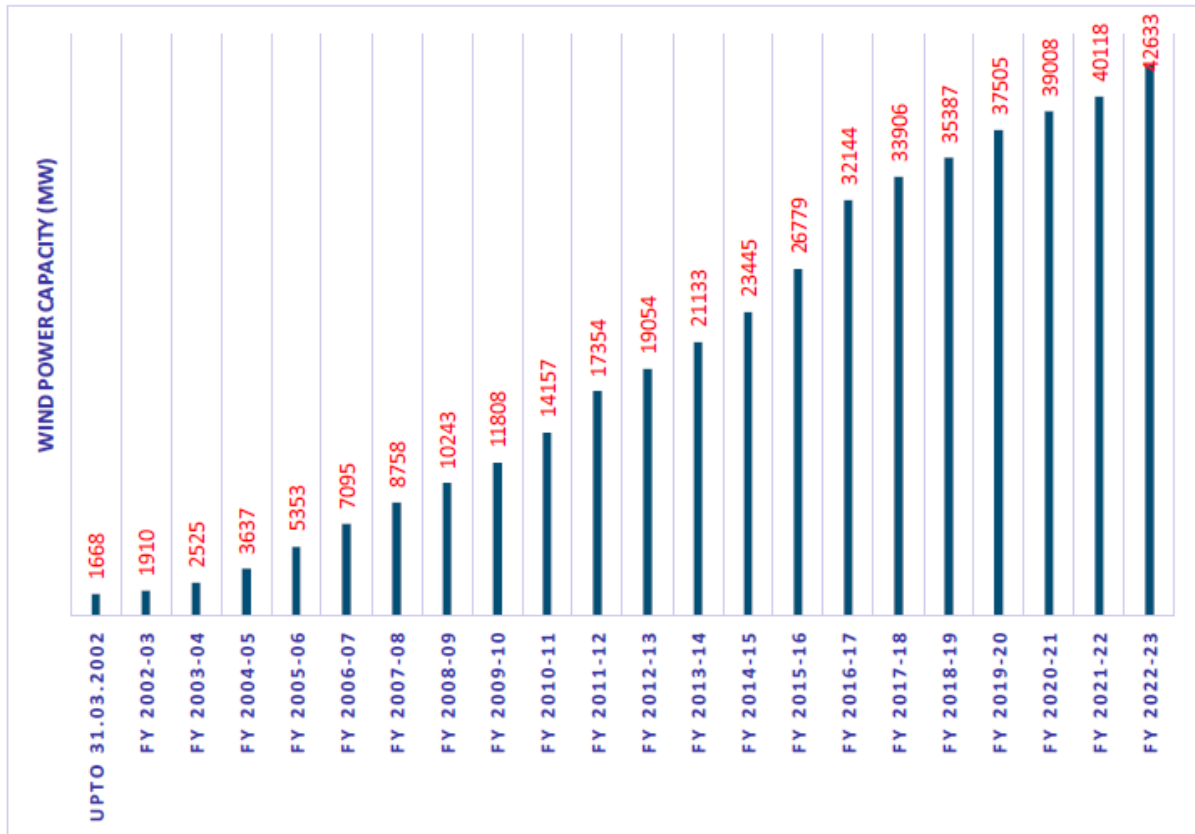


Fig. 1 Cumulative growth of wind power in India

As we can see that the target of 43 MW till now and as per the European Union the target of several GW from the wind energy has to achieve. This will make the engineers and scientists much more aware about the challenges and efficiency as well as the innovative ideas for the outputs from the generating stations. The work from the future forecast about the technical parameters and the control system design based on this data will help in making the artificial controller for the better output.

## II. CLIMATE ANALYSIS

For this practical analysis let us select a particular location in this case we have selected a north part of India like Jaisalmer and while selecting a particular coordinates and location the detailed analysis covered and also the wind potential density.

The random site selected from the Jaisalmer has a coordinates of Latitude 26.9 and Longitude of 70.92. With the help of the climate consultant software we can analyse the wind velocity ranges around the year or any customised date in between data wanted to retrieve for the research like seasonal variations and so many information required for the detailed analysis and this will be very helpful for the modelling and analysis of the control system.

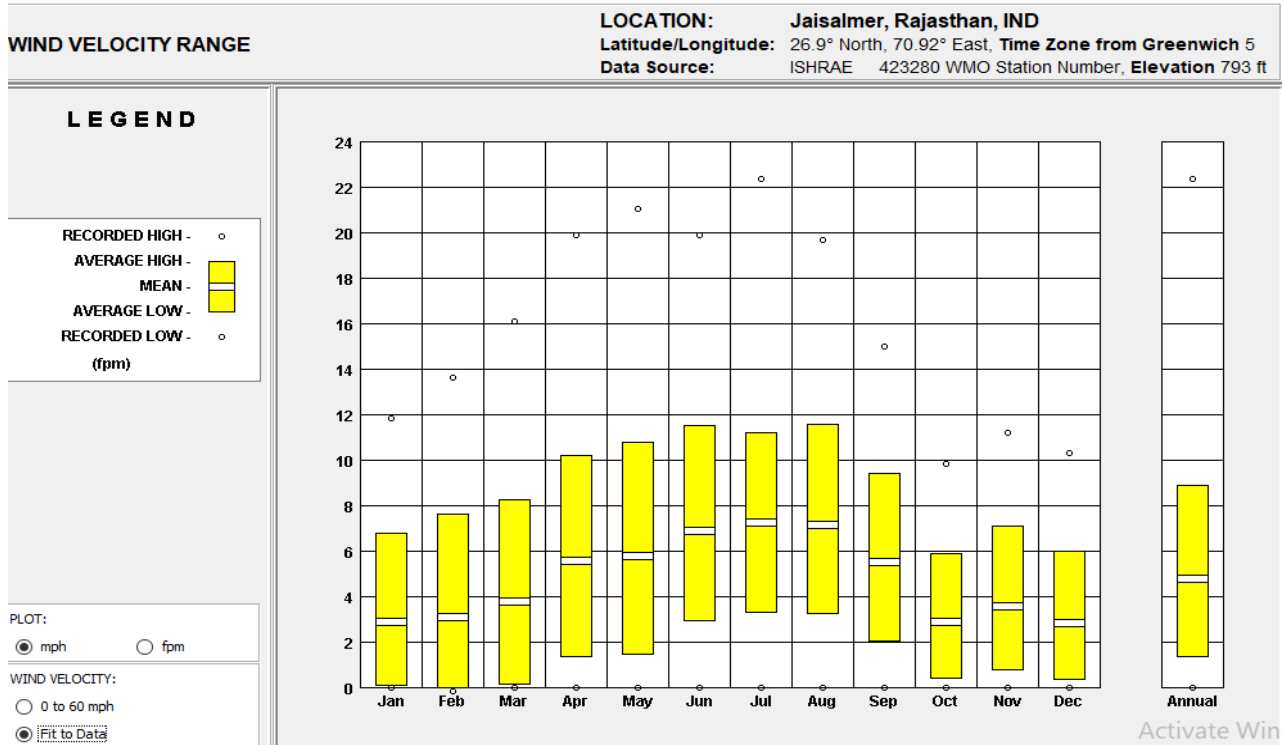


Fig. 2 Wind velocity range

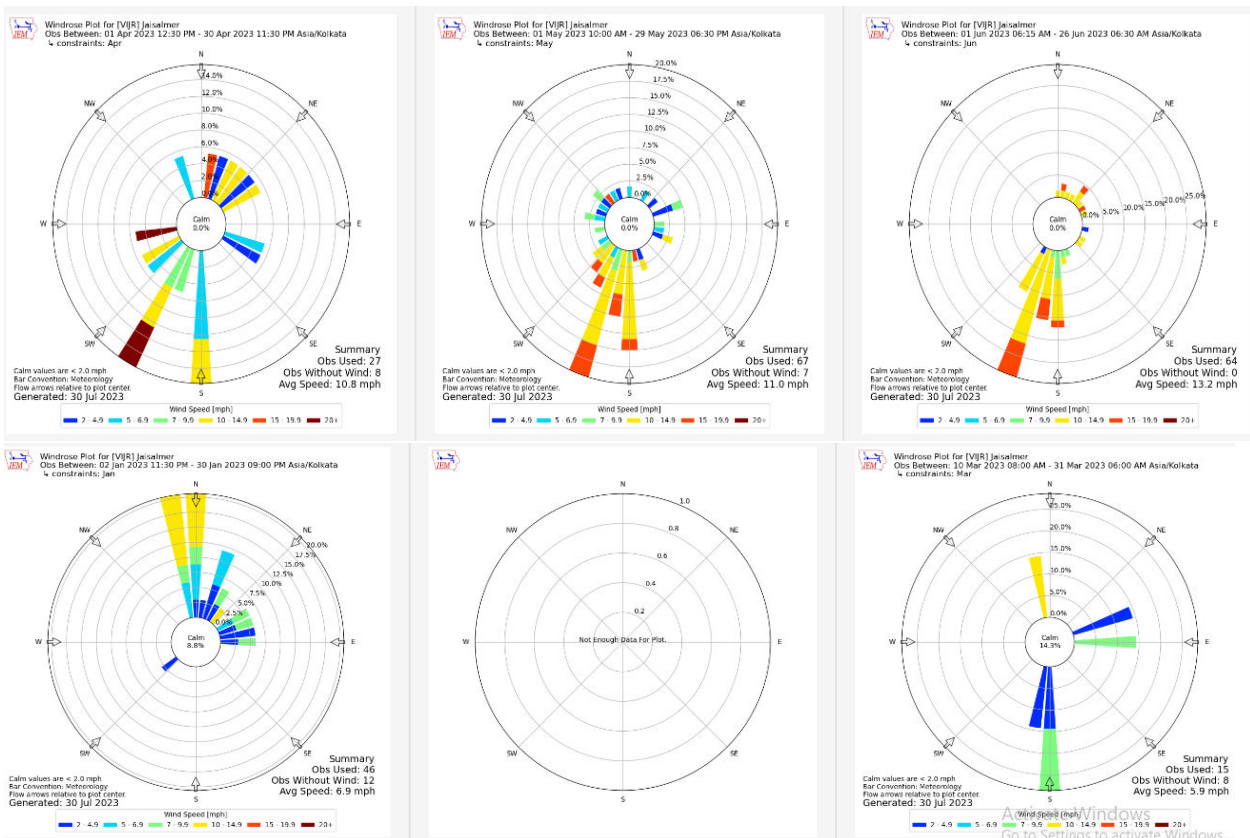


Fig. 3 Monthly Wind Rose Diagram of the selected location

From the above climate analysis we can see that the variations in wind all over the year and considering different seasons of that particular site. For the installation of wind turbine the pre installation analysis is very important for the further output derived from the generating station in the future. As we can see from the help of various software's the wind rose diagram of site can be derived. All these details can be used for the controller design. The wind energy is nonlinear in nature and vary accordingly so if a control technique has to define by using all these data available and can be used for the intelligent controller like fuzzy control system.

### III. FUZZY CONTROL SYSTEM

Fuzzy logic starts with the concept of fuzzy set. A fuzzy set is a set without a crisp, clearly defined boundary. It can contain elements with only a partial degree of membership. Fuzzy logic controller may consist of three basic blocks, namely, Fuzzification, Inference system and Defuzzification. Rule base fuzzy logic controller is used when system dynamics are not well known or when they contain significant non linearities. Fuzzy logic controllers apply reasoning similar to how human beings makes decision and thus the controller rules contain expert knowledge of the system. The big advantage of fuzzy logic control system when applied to wind turbine is that the turbine system neither needs accurately described nor does it need to be linear. Fuzzy logic is a powerful tool since it allows the control of the system whose parameters are unknown or incomplete and as a result difficult to model mathematically. Fuzzy logic control consist of three main stages: input, processing and output. At the input stage membership functions are used to fuzzify the input values. The now fuzzified input is fed into the processing stage where an inference mechanism applied the appropriate rule from the knowledge base to come up with a set of fuzzy outputs. This output is then defuzzified using an appropriate technique. [5]

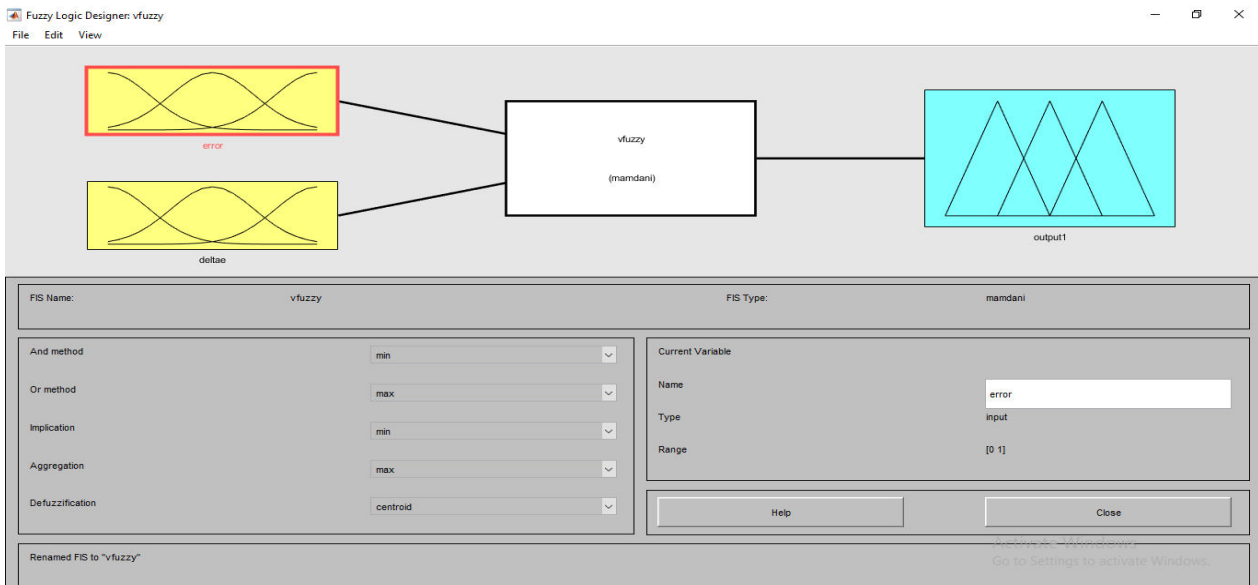


Fig. 4 Membership Functions of Fuzzy system

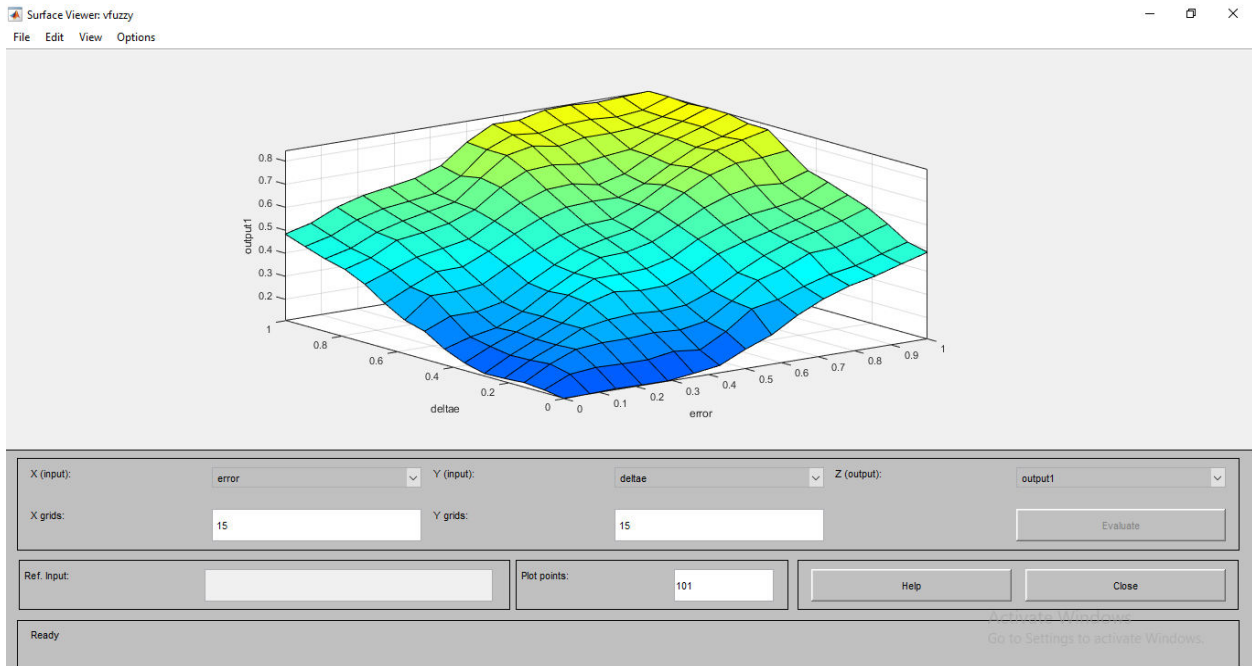


Fig. 5 Surface view of Fuzzy system

#### IV. RESULT AND DISCUSSION

In this work a basic wind energy conversion system has been designed in the Matlab software and a provision of maximum power point tracking system installed in the wind turbine. Conventionally the PID controller used for this system but now a days fuzzy control system are very popular so by using fuzzy control technique in this model the outputs derived from the model is found satisfactory. The main concern is to derive the rule table of the fuzzy system in which the outputs and inputs are predefined. So by considering the wind rose diagram of that particular location and also the data available the inputs and outputs can be arranged accordingly from the past data for the future predictions of the wind patterns and design the fuzzy control logic rule table as per the data available. In this way we try to design the rule table as per the data recorded of last one year of that site and got the results. Many analysis also required to be done for the power quality improvements and at the time of fault clearance is also needed.

#### V.CONCLUSION AND FUTURE WORKS

This work deals totally on the data available of the location selected for the installation of the wind energy conversion system. The fuzzy control rule table has been designed after the analysis of the data available on the site or from the climate consultant software a person can easily understand the pattern of wind in the site. The future work can be done as the installation can be done by the assumptions and control system by the technique described above. The works can be done on the power quality improvement by the use of Facts devices in the developed model and the analysis has to be done as per the geographical parameters and new sites has to be selected for the extreme better output and that will be only possible by the pre installation analysis and behaviour pattern of the wind.

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