Comparative Analysis between Wind and Solar Forecasting Methods Using Artificial Neural Networks and Fuzzy Logic

Reju Roy and N. Vinothini

Abstract--- The main objective of the study is to suppress the Renewable energies, with effects in supporting sustainable development. Today, Increase the demand for Renewable energy resources (RES) in distribution systems. In this paper presents a control strategy of three-phase grid interfacing inverter to utilize the renewable energy Source with a grid efficiently. Controlling of the inverter in such a way that to utilize the following compensate load current, compensate load voltage, compensate reactive load power and load neutral Current. The Renewable Energy Source may be Solar, or Wind depends on distribution system voltage level. All these works of the inverter are done either individually or combined to overcome the unbalanced effects of all types of linear, non-linear, balance or unbalance loads at the distribution level. The increasing use of renewable energy contributes to lower pollution generated by other methods of producing electricity, preserves other types of fuels with an effect on environmental protection and also lowers the price of electricity to consumers. Through its components and models, the prototype will have a positive impact on decision support process in the renewable energy field for both producing units and regulators. The forecasting methods using neural networks. An artificial neural network (ANN)and fuzzy logic is a computational model based on the structure and functions of biological neural networks. Information that flows through the network affects the structure of the (ANN) and fuzzy logic artificial neural network because a neural network changes - or learns, in a sense - based on that input and output.

Keywords--- Renewable Energy Integration, Neural Network, Wind Power Plants, Photovoltaic Generation.

I. INTRODUCTION

The Renewable energy technology has undergone substantial development in the last three decades. Variable energy generations, mainly from renewable energy resources such as wind and solar energy plants have made operational difficulties for the electric power framework in light of the vulnerability associated with their yield for the time being. At the point when the infiltration level of the variable age is high, the irregularity of these assets may unfavorably influence the task of the electric matrix. Hence, wherever the variable age assets are utilized, it turns out to be exceptionally alluring to keep up higher than ordinary working stores and productive vitality stockpiling frameworks to deal with the power adjust in the frame. The working stores that utilization petroleum derivative creating units ought to be kept as low as conceivable to get the most elevated advantage from the sending of the variable generations. Therefore, forecasting these renewable resources takes on a vital role in the operation of power systems and electricity markets. The rest of this is composed as the incorporates an audit of factual models for variable ages and a concise prologue to artificial neural networks (ANN).

The data used to build the artificial neural networks (ANN). The various solar power forecasting modeling stages. The artificial neural networks (ANN) is loosely a

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simple biological analogy of the brain. They are implemented in widespread applications with different approaches such as supervised, unsupervised, and reinforcement learning approaches. In the supervised learning approach, the artificial neural networks (ANN) learns from the data by training them to approximate and estimate the function or the relationship between the input and the output variables. The algorithm helps teach the artificial neural networks (ANN) to recognize similar patterns. In the propagation concept, information flows in one direction between the neurons (nodes), and the errors back propagate in the opposite direction, changing the strength of the neural connections (joins) between the hubs while endeavoring to limit the blunders by utilizing a suitable streamlining strategy, for example, the slope plunge technique. After adequate preparing cycles with known information, the weights between the hubs are balanced until the point that they give a right reaction. At that point, the artificial neural networks (ANN) will provide the correct response to the input data that it has never seen before. The artificial neural networks (ANN) can learn to generalize in this fashion. More sophisticated algorithms are introduced for training artificial neural networks (ANN) with different optimization methods to improve the performance. The artificial neural networks (ANN) are fit for giving to the variable ages of wind and sun oriented power when the verifiable information is accessible. The artificial neural networks (ANN) is considered as a black box since it isn't giving an adequate subjective comprehension of the connection between the info and the yield factors. An audit of artificial neural networks (ANN)-based determining models that are executed to figure the sunlight based irradiance and vitality can be found in artificial neural networks (ANN) model uses the most widely used vanilla feed-forward neural systems, sometimes called the single hidden layer network. The artificial neural networks (ANN) model is used as a nonlinear statistical tool to forecast solar power. Its performance is compared with other models.

II. LITERATURE REVIEW

These days by the change of semiconductor and power electronic innovation, the traditional utilization of non-direct loads is more noteworthy than previously. So the nature of energy breaks down with the broad utilization of non-direct loads in both transmission and conveyance frameworks. In by and large power, quality says that as the quality of current and voltage. It can be defined that the measure, analysis, and improvement of the bus voltage with a sinusoidal waveform at rated voltage and constant frequency [1]-[2].The Power distribution systems ought to deliver their customers with an associate degree uninterrupted flow of energy with the smooth sinusoidal voltage at the contracted magnitude level and frequency, but the delivery systems, have several nonlinear loads, which significantly affect the quality of power supplies [1-4]. The concept of custom power was introduced by [15]. The term custom power means the utilization of electronic power controllers for distribution systems. The custom control devices will increase the quality and reliability of the power that has delivered to the customers. Customers are increasingly demanding more exigent quality in power supplied by the electrical company. A comprehensive review of compensating type custom control devices, issues of power quality, a survey of power quality problems, standards and indices proposed by different agencies and different approaches to boost power quality from time to time [16]. Power quality can be divided into three categories that are, voltage stability, continuity of supplying power, and voltage. Based on this classification, several examples of power quality level definitions were presented [17].

The power quality problem is an event showed a nonstandard voltage, current, and frequency that fails the distribution systems. Sensitive industrial loads, Utility distribution networks, and critical commercial loads all suffer from different types of outages and service delays which can cost significant financial loss per incident based on process downtime, idle workforces, lost production, and other factors. In this transient electromagnetic studies are presented for the following two custom power controllers: the static distribution compensator (DSTATCOM), and the dynamic voltage restorer (DVR) [18] Demonstrated that power quality measures could be applied both at the user end and also at the utility level. The work identifies some essential steps that can be implemented at the service level without many systems upset. The models of custom power equipment, namely DVR are presented and applied to mitigate voltage dip which is very prominent as per utilities are concerned using a new PWM-based control scheme. It has mentioned that in the case of DSTATCOM capacity for power compensation and voltage regulation depends mainly on the rating of the dc storage device. A DVR system based on downstream fault limiting function and a flux type feedback controller has been proposed and integrated [19-20]. It would act as a significant implicit inductance in series with the distribution feeder in a fault condition. It can defend from sudden sags, swells, and it minimizes the stress on the DC Link

In a recent device that will enhance power quality using Unified power quality conditioner. The versatile device that might operate as the active series filter and shunt active filter. It can obey objectives like, maintaining a balanced sinusoidal (harmonic free) nominal voltage at the load bus, removing harmonic current from the supply, load balancing and power factor correction. From the above analysis all types custom control devices used in industrial and commercial power systems. The problems included in the harmonic control and reactive power compensation of such converters are discussed, and an application guide is provided. Limits of distress to the AC power distribution system that affect other equipment and communications are recommended. In this work, the proposed Adaptive Frequency Passiveness Control was used to solve all problems.

III. PROPOSED ARCHITECTURE

The artificial neural networks (ANN) model outperforms the multiple linear regression analysis (MLR) models and the persistence model. The performance of the artificial neural networks (ANN) relies upon how well it is prepared and on the nature of the information that is utilized. The normalized input data doesn't improve the performance but improves the model performance. Plotting the data, investigating the correlation and sensitivity analysis between the variables, as well as data cleansing of outliers are essential data preparation steps before building the forecasting model. The more exact climate figures we utilize, the more precise sun oriented power estimates will be created. Using the arrangement factors and the collaborations between the factors improve the execution of the multiple linear regression analysis (MLR) model significantly, but this is not the case for the artificial neural networks model.

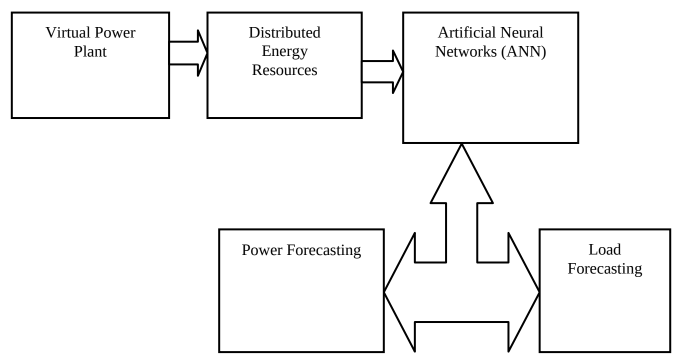

Figure 1: Proposed Architecture

Virtual Power Plant

A virtual power plant (VPP) is a system that integrates several types of power sources, (such as the microchip, wind-turbines, small hydro, photovoltaic's, backup genets, and batteries) to give a reliable overall power supply.

Distributed Generation

The Distributed generation is also known as distributed energy refers to power generation at the point of consumption. Generating power on-site, rather than centrally,eliminates the cost, complexity, interdependencies, and inefficiencies associated with transmission and distribution.

Artificial Neural Networks

Artificial Neural Networks are relatively crude electronic models based on the neural structure of the brain. The brain gains as a matter of fact. It is common evidence that a few issues that are past the extent of current PCs are without a doubt reasonable by little vitality proficient bundles. This cerebrum demonstrating additionally guarantees a less specialized approach to create machine arrangements. This new way to deal with processing likewise gives a more effortless corruption amid framework over-burden than its more conventional partners.

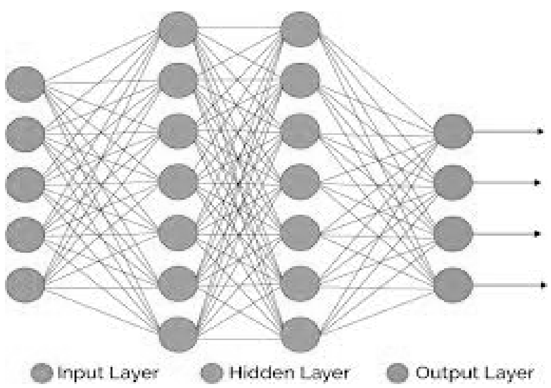

Figure 2: Artificial Neural Networks

These naturally motivated techniques for registering are believed to be the following real headway in the figuring business. Indeed, even straightforward creature brains are equipped for capacities that are at present outlandish basic examples substantially less summing up those examples of the past into activities without bounds. Presently, progresses in organic research guarantee an underlying comprehension of the regular reasoning instrument. This exploration demonstrates that brains store data as examples. Some of these examples are extremely entangled and permit us the capacity to perceive singular countenances from various edges. This process of storing information as patterns, utilizing those patterns, and then solving problems encompasses a new field of computing. This field, as said previously, does not use conventional programming but instead incorporates the generation of tremendously parallel frameworks and the readiness of those frameworks to tackle particular issues. This field likewise uses words altogether different from conventional processing, words like-behaving, react, self-organize, learn, generalize, and forget.

Fuzzy Logic

The fuzzy rationale is connected with incredible achievement in a different control application. All the purchaser items have Fuzzy control. A portion of the illustrations incorporates controlling your room temperature with the assistance of aeration and cooling system, the counter stopping mechanism utilized as a part of vehicles, control on activity lights, clothes washers, vast monetary frameworks.

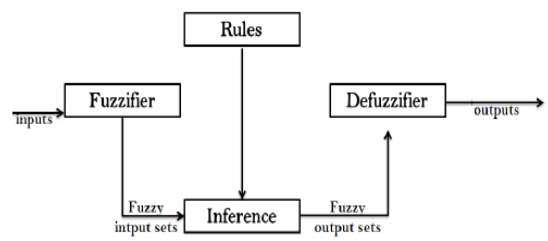

Figure 3: Fuzzy Logic

Fuzzy Logic in Control Systems

A control framework is a game plan of physical segments intended to adjust another physical structure, so this framework displays certain coveted attributes. Following are a few explanations for utilizing Fuzzy Logic in Control Systems.

- While applying conventional control, one has to think about the model and the target work detailed in exact terms. This makes it extremely hard to apply much of the time.
- By applying fluffy rationale for control, we can use the human skill and experience for outlining a controller.
- The fluffy control rules, fundamentally the If-Then principles, can be best used in outlining a controller.

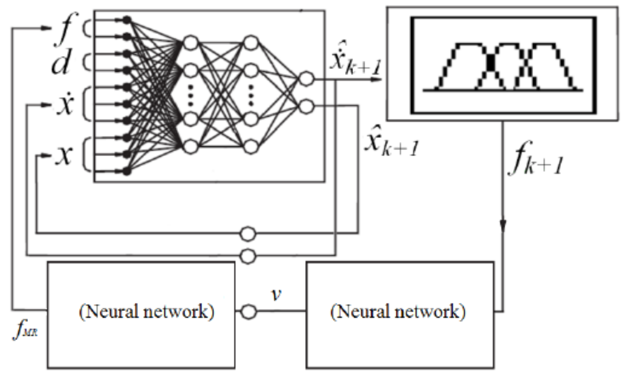

Figure 4: Artificial Neural Networks and Fuzzy

Artificial neural network prior rule-based knowledge cannot be used and prior rule-based can be incorporated ANN learning from scratch, and fuzzy cannot be determined using knowledge.

Models Description

1. Measurable Variable Generation Forecasting Models

Determining models are ceaselessly being enhanced to produce more precise conjectures of sun based and wind control. In this segment, the factual models that utilization both non-learning and learning approaches are portrayed.

2. Statistical Non-Learning Approach Models

These models describe the connection between predicted solar irradiance from numerical weather predictions (NWP) and solar power production directly by statistical analysis of time series from historical data without considering the physics of the system. This connection can be used for forecasts of the Future plant outcomes. Plenty of regression models are already implemented as time-series forecasting models, some of which include autoregressive integrated moving averages (ARIMA), and multiple linear regression (MLR) analysis models.

IV. SIMULATION RESULTS

The proposed system that is going to be represented in this phase is done using the Mat Lab Simulink model. To get the desired output, the simulation circuit has been designed in Mat Lab software by using the respective components that are present in the Mat Lab Simulink. This simulation results will be described in detail below.

An Implementation and Testing

MATLAB a high-performance for specialized figuring coordinates calculation, representation, and programming in a simple to-utilize condition where issues and arrangements are communicated in the natural scientific documentation. It is a prototyping situation, which means it centers around the simplicity of improvement with dialect adaptability, intelligent investigating, and different comforts ailing in execution arranged dialects like C and FORTRAN. While Matlab may not be as quick as C, there are approaches to bring it nearer. We need to invest less energy add up to from creating, troubleshooting, running, and until obtaining results.

Simulink

A block diagram environment for multidomain reproduction and Model-Based Design. It bolsters the system-level design, simulation, automatic code generation, and continuous test and verification of embedded systems. Simulink provides a graphical editor, customizable block libraries, and solvers for modeling and simulating dynamic systems. It is integrated with MATLAB, enabling you to incorporate MATLAB algorithms into models and export simulation results to MATLAB for further analysis. To show a framework and after that reenact the dynamic conduct of that framework. The essential strategies you use to make the straightforward model in this instructional exercise are similar systems that you use for more perplexing models. To make this basic model, you require four Simulink squares. Pieces are the model components that characterize the arithmetic of a framework and give input signals.

Modelling

To the display calculations and physical frameworks utilizing square graphs. You can demonstrate straight and nonlinear frameworks, calculating in genuine wonders, for example, grating, equip slippage, and hard stops. A farreaching library of predefined pieces causes you to manufacture models. You add from the library to your model utilizing the Simulink Editor. In the editorial manager, associate squares by the method for flag lines to build up numerical connections between framework segments. You can likewise refine the model appearance and add veils to alter how clients interface with the model. You can outline your models to be progressive by arranging gatherings of squares into subsystems. This approach empowers you to assemble discrete parts that mirror your genuine framework and recreate the collaboration of those segments.

Simulation

On the can interactively simulate your system and view the results on scopes and graphical displays. For simulation of continuous, discrete, and mixed-signal systems, you can choose from a range of fixed-step and variable-step solvers. Solvers are integration algorithms that computer system dynamics over time. The integration of Simulink and MATLAB enables you to run unattended batch simulations of your Simulink models using MATLAB commands. This instructional exercise demonstrates to reenact the model of a dynamic framework utilizing Simulink® programming and after that utilization the outcomes to enhance the model. After you set up the model for recreation, you can utilize an interface to include estimated framework information and set room temperature.

Performance

An elite Simulink show incorporates and reproduces rapidly. Simulink gives methods that you can use to accelerate the model reenactment. As an initial step to enhancing reproduction execution, utilize Performance Advisor. Execution Advisor checks for conditions that may back off your reproductions. The device can consequently roll out improvements to your model to address these conditions, or you can survey and apply recommended changes physically. Execution Advisor can check your model for conditions and settings that can slow down simulation speed. It can recommend modeling optimizations, implement them automatically, and run simulations in accelerator mode for you. Use Accelerator and Rapid Accelerator modes to achieve faster simulation without changing the model itself. Achieve faster simulation with your models by manually employing some of these optimization techniques.

Component-based Modeling

The component-based modeling and modular design. You can segment your model into design components and the model, simulate and verify each component independently. You can save individual components as subsystems in a library or as separate models. Use Simulink Projects to organize large modeling projects by finding required files, managing and sharing data and settings, and using source control. A segment is a bit of your outline, a unit level thing, or a subassembly that you can chip away at without requiring the more significant amount parts of the model. Componentization includes sorting out your model into sections. Componentization gives numerous advantages to associations that grow extensive Simulink models that comprise of multiple useful pieces. These componentization strategies bolster a broad variety of displaying necessities for models that differ in size and multifaceted nature. Most substantial models utilize a mix of componentization strategies. Simulink gives apparatuses to change over from subsystems to show reference. Due to the contrasts amongst subsystems and model referencing, changing from subsystems to display referencing can include a few.

Modeling Guidelines

These modeling guidelines help you develop models and generate code using Model-Based Design with Math works items. Applying these rules can enhance the consistency, lucidity, and clarity of your models. The rules likewise help you to distinguish show settings, pieces, and square parameters that influence reenactment conduct or code age. The high-honesty regulations and relating Model Advisor checks are abridged in the table. For the rules that don't have Model Advisor checks, it isn't conceivable to mechanize checking of the direction. Instructions without a corresponding

Block Creation

The built-in modeling functionality provided by Simulink, you can create custom blocks and add them to the Simulink Library Browser. MATLAB Function squares empower you to utilize the MATLAB dialect to characterize custom usefulness. These squares are a decent beginning stage.

Simulation Output Results

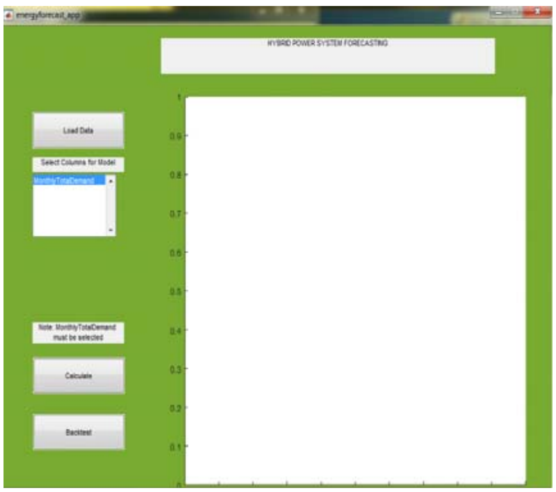

Figure 5: Hybrid Power System Forecasting

Energy Forecast

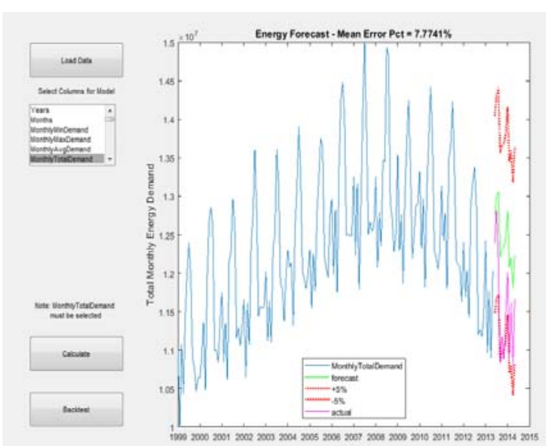

Figure 6: Energy Forecast

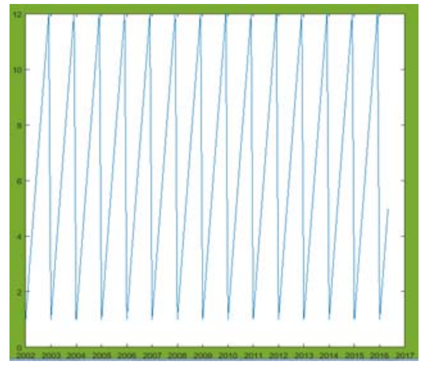

Figure 7: Months Variation for Power Demand

The month's variation for power demand is indicating during different years can be denoted in the graphical view.A voltage representation amplitude will be denoted in the y-axis and yearly difference in the x-axis.

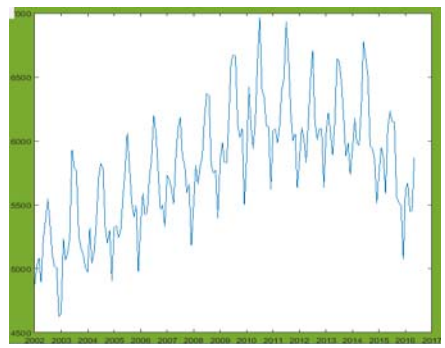

Figure 8: Monthly Minimum Demand

The month’s minimum variation for power demand is indicating during different years can be denoted in the graphical view. A voltage representation amplitude will be denoted in the y-axis and yearly variation in the x-axis. Power variation is on = 500 voltage.

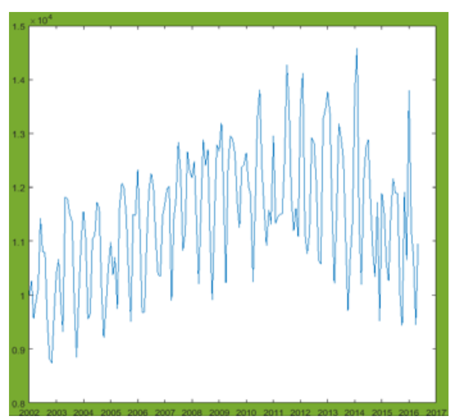

Figure 9: Monthly Max Demand

The month’s maximum variation for power demand is indicating during different years can be denoted in the graphical view. A voltage representation amplitude will be denoted in the y-axis and yearly variation in the x-axis. Power variation is on = 0.1x10^4

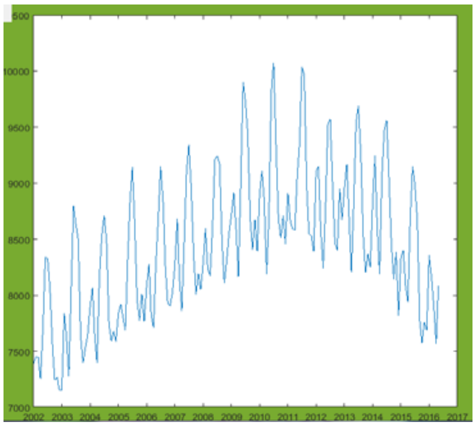

Figure 10: Average Monthly Demand

The average month's variation for power demand is indicating during different years can be denoted in the graphical view. A voltage representation amplitude will be denoted in the y-axis and yearly variation in the x-axis. Power variation is on = 500v

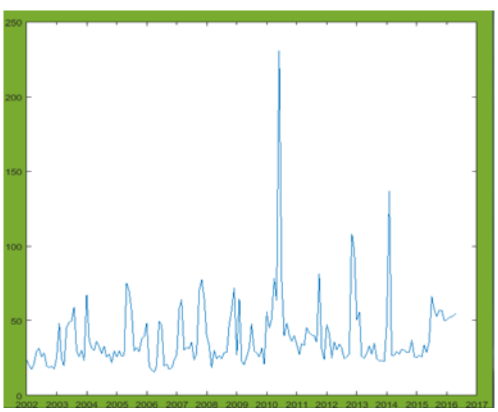

Figure 11: Average Prize on Demand

The average month's variation for prize demand is indicating during different years can be denoted in the graphical view. A voltage representation amplitude will be denoted in the y-axis and yearly variation in the x-axis. Average prize variation is on = 50v

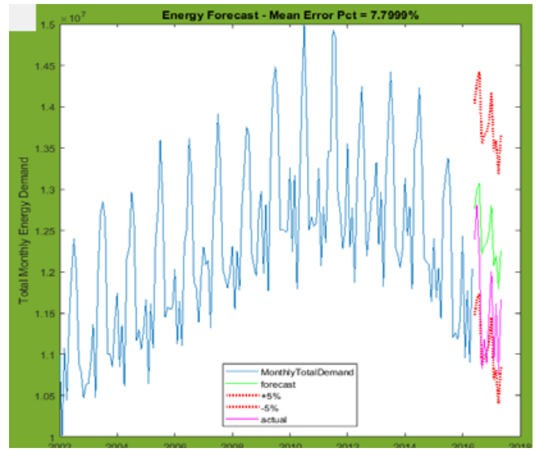

Figure 12: Total Demand

The total demand is indicating during different years can be denoted in the graphical view. A voltage representation amplitude will be denoted in the y-axis and yearly variation in the x-axis. Power variation is on = 0.5x10^7

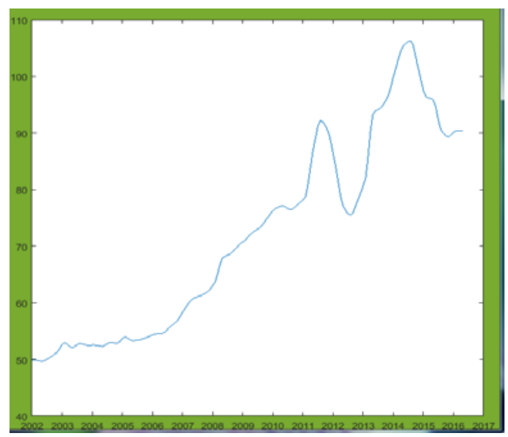

Figure 13: Total Prize

The total prize is indicating during different years can be denoted in the graphical view. A voltage representation amplitude will be denoted in the y-axis and yearly variation in the x-axis. Prize variation is on = 10

Table 1: Comparison between ANN and Fuzzy Methods

Module rated power	**ANN(Artificial Neural Network)**	**FUZZY system**
PV POWER	75W	100W
WIND POWER	700W	1000W
FUEL VOLTAGE	500V	700V
BOOST VOLTAGE	300	380
LOAD VARIATION	4.3%	5.1%
POWER DEMAND	2.3%	2.01%
EFFICIENCY	90.2%	93.10%

Parameters of PV

Stack Parameters

Stack Parameters	**Ranges**
The voltage at 0A at 1A	65 V, 63 V
Nominal operating point	133.3 A, 65 V
Maximum operating point	225 V, 37 V
Number of cells	65
Nominal airflow rate	300 (1/m)
Nominal supply pressure	1.5 bar, 1 bar
Nominal composition [H_2, O_2, H_2O]	99.95, 21, 1 (%)

Power Conditioning Unit Parameters

Rated voltage	211 V
Resistance	0.02 ohm
Inductance	Ten microfarad
Capacitance	200 microhenry
Ac line RMS voltage	120 V
AC line frequency	60 HZ
Output port series resistance	0.2 ohm
Switching loss current	0.03 A

V. CONCLUSION

The energy generations, particularly from wind and solar energy resources in the power grid, have led to these generations becoming a source of uncertainty with load behavior still being the main source of variability. The Generation and load balance are required in the economic scheduling of the generating units and electricity market trades. The Energy forecasting can be used to mitigate some of the challenges that arise from the uncertainty in the resource. The solar power forecasting is witnessing growing attention from the research community. The presents an artificial neural network model to produce solar power forecasts. Sensitivity analysis of several input variables for best selection, and comparison of the model performance with multiple linear regression and persistence models.

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