Hybrid of Persistence and Neural Network Algorithm Approach for Load and Renewable Energy Forecasting

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I.INTRODUCTION

Abstract: Microgrids, which combine distributed renewable energy sources (RESs), energy storage systems, & load management methodologies, have lately risen to prominence as a building element for smart grids. Because renewable energy sources are inconsistent, smart microgrids face various issues, including reliability, power quality, and supply-demand balance. As a result, anticipating energy production from renewable energy sources (such as wind turbines and solar panels) is becoming increasingly important for the power grid's efficient and continuous operation, as well as for maximizing RES use. Smart microgrids include energy demand forecasting, which aids in energy production planning & energy exchange with the commercial grid. In this article, an ANN with a distance technique is used to estimate load power while accounting for the penetration of renewable energy sources, and the average variation produced is analyzed. Eventually, a comprehensive Microgrid design in MATLAB/Simulink is shown, including the power sources, their power electronics, and a load and mains simulation. The presented method provides correct estimates, is more economical, and has a good generalization capability, as evidenced by the experimental analysis.

Keywords: Renewable energy sources, Microgrid, persistence, Artificial Neural Network

Conventional Energy resources are constantly depleting. Renewable energy sources must be added into the design to meet the ever-increasing energy demand. Environmental variables, on the other hand, can affect renewable energy sources, causing electricity generation to fluctuate. Even the availability of supplies is subject to daily or annual cycles (for example, solar energy is only accessible during daylight hours) [1]. As a result, the goal of the suggested solution is to employ reliable forecasting methods to assess different power & cost values, simulate a realistic microgrid, and combine it with a cost-optimized scheduler while assuring grid stability, smooth scheduling, and power management [2]. Day-ahead scheduling is created by creating 2885-minute slots in which market and economic estimates are combined to produce the next-day scheduling choice. Any deviations on the actual run-day are managed by the spinning operating reserve, which can be a diesel generator set, to ensure that the load needs are met for the longest time intervals possible without the need for load-shedding or islanding [3].

This research aimed to examine the reduction of microgrid operating cost, by building accurate predictive model and improved scheduling technique. The paper is organized as follows: The forecasting approaches are explained in Section II. The ANN is described in Section III. The persistence method is depicted in Section IV. The literature review is included in Section V. The suggested work's goals and approach are presented in Section VI. Section VII assesses the results of the calculation. The result is shown in Section VIII.

II. FORECASTING TECHNIQUES

A smart grid's effective functioning, economics, & risk management require accurate prediction model. The forecasting methods provided here are divided into the following groups: Estimate of Spot Price Forecasting Demand & Load Forecasting Renewable Energy

A. Spot Price Prediction

Traditionally, power sectors have been mostly under government control, although this has altered as a result of the emergence of competitive markets and steady transformation. Electricity is undergoing global transformations similar to any other commercial commodity, resulting in a greater amount of choices for customers in the market. Electricity is traded using spot prices. The ability to accurately estimate spot pricing is critical to improving microgrid operations. Seasonality, Mean Reversion, Volatility, and Spikes are all properties of spot pricing, which is a type of time- series information.

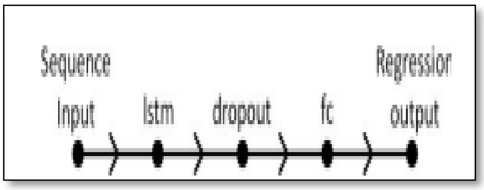

Fig. 1: Network Flow for Spot Price[4]

B. Demand Forecasting

Energy providers and other stakeholders in power generation, transmission, and distribution rely heavily on load demand estimates. The administration and market strategy of any power-utility group of companies are dependent on accurate load prediction model. Load forecasting could be broken down into three types [3]: Forecasts for one hour to one week are considered short-term predictions. Medium-term projections range from a week to a year. Forecasts made more than a year ago are referred to as long-term forecasts.

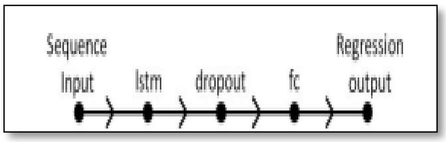

Fig. 2: Network Flow for Load[3]

C. Renewable Energy Forecasting

Solar photovoltaic farms and wind farms are the renewable energy sources employed in the suggested paradigm. Due to the huge level of uncertainty associated with wind-speeds and wind-power generation, forecasting solar electricity production is comparatively easier than forecasting wind power generation [4]. Solar power generation, on the other hand, has a daily seasonality and follows a pattern yearly, classifying under simpler time-series models. There are three steps to renewable energy forecasting:

a) Weather Forecasting: Weather data feeds the prediction models, which generates wind-speed & irradiance values.

b) Power Converter Simulation: Forecasts of wind speed & irradiance are supplied into simulation models incorporating power converter uses. The outputs are the predicted values of wind and solar electricity.

c) Up-scaling to regional levels: The simulation's power values must be ready to work in a real-world environment. For further study, the up-scaled power is put into the load flow integrated smart grid system.

III. Artificial Neural Network

ANN is basically based upon the neural structure of the brain. It tries to imitate the functioning of the brain. As we know that brain stores information and ANN provides a new field of computing which involves the creation of massive parallel networks to solve specific problems. As neurons provide the ability to remember and apply the previous experiences, ANN works on a similar pattern to achieve high computational rates due to massive parallelism fault tolerance capability[5].

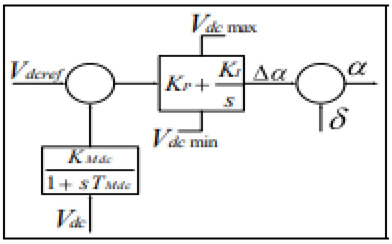

Fig 3: Structure of ANN Controller[5]

IV. Persistence Algorithm

Persistence is a straightforward way of forecasting that follows the basic rule of: today equals tomorrow, and was chosen after considering the numerous forecast methods discussed above. The persistence approach is based on the assumption that the forecasted conditions would not change. For a look-ahead time of up to 4-6 hours, it is believed to have superior accuracy than more complex forecast systems. It also helps to discover how the error distribution varies when the forecast situation changes[6]. The persistence approach was compared to the fuzzy neural technique for wind forecasting of an offshore wind farm in Denmark, and it was found that the persistence approach is as effective for modest look-ahead times as the Fuzzy-NN method. For short-term wind estimates, the persistence approach is commonly used. The explanation for this is that wind power fluctuates a lot, and there is no set daily pattern for wind output. As a result, using recent data to forecast would produce more accurate outcomes than relying on weather forecasts. The main process of persistence forecasting is to estimate future power using an average of historical power.

The forecasting formula is as follows [7]:

$$P(t+k \mid t) = \frac{1}{T}\sum_{i=0}^{n-1} P(t - i\square t)$$

V.LITERATURE SURVEY

Li et al.,(2019) A new technique of forecasting power load using the feedback neural network with the feature of input delay is suggested in this study in addition to the challenges in conventional forecasting mathematical designs that lack the capacity to self-learn, self-adapt and have poor reliability of the forecast system. The features of the design of the Elman neural network are examined, the Elman neural network experimental framework is designed, and then tested in the power grid with actual data. The findings demonstrate that this model-based power grid load forecasting has good precision and has good sensitivity and learning potential for power grid load[8].

Wensheng et al.,(2020) proposed a local Integrated Energy Load Prognostic Approach depend on the CNN-LSTM design with consumer energy label distinction. Differential user-based analysis might use actions and allow the person use the tag, and then climate conditions like time period 3 users could use the label as input data depending on the energy form, CNN - LSTM model for load forecasting and verification, in which CNN derives successful input images and LSTM is great at storing time series data. The CNN mark distinction - LSTM design has strong performance at the local level of detailed power load forecasting, as per user-based outcomes[9].

Ruicheng et al.,(2019) an modified probabilistic load forecasting framework is suggested to adapt to the effect of renewable energy. Firstly, probabilistic residual forecast design is established to capture the uncertainty of load. Then, implemented with the help of forecast mixture and variable selection, the enhanced point load forecast system is generated. Renewable power is regarded in both designs to analyze the consideration among load and renewable energy and modify the outcome. The numerical results of the study demonstrate that the designed method helps improve the predictive power and has greater adaptability to increasing capacity of renewable energy[10].

Usman et al.,(2018) introduces an MG energy management system (M-EMS) for grid-connected photovoltaic (PV) and battery energy storage system (BESS) based hybrid MG. The suggested M-EMS comprises of two components forecasting and optimization. The forecasting component is responsible for forecasting solar irradiance, heat and load demand, while the optimization module conducts optimal day-ahead planning of power generation and transmission demand in a grid-connected MG for economical operation. The suggested M-EMS for grid-connected hybrid PV-BESS MG is validated utilizing MATLAB/Simulink. Simulation result shows the productivity and effectiveness of the suggested approach for understudy case[11].

Yuan et al.,(2017) Based on modified particle swarm optimization, renewable energy sources are forecast to use the BP neural network (MPSO-BP). The updated method is faster in both search ability and speed contrasted to the standard method. After forecasting, The optimal platform is developed with the goals of total required cost and minimum loss of power. By organizing all sorts of DGs, the performance is optimized. The simulations outcomes confirmed the efficacy of the suggested design in hybrid microgrid multi-objective optimization. The hybrid microgrid was able to realize the optimized level of service via the energy management dispatch[12].

Sanchez et al.,(2019) A real-time simulation of an NSML controller for a microgrid linked to a grid was implemented. To monitor the active and reactive forces that are injected into the grid, the suggested local controller for each device is used. An RHONN identification is used to base each suggested local controller. The neural identifiers represent the corresponding nonlinear dynamics and enable disturbances induced by parameter variance and/or irregular situations of the grid to be rejected by the operator. The findings of real-time simulation show the effectiveness of the suggested scheme in achieving trajectory monitoring of DER communication system even in the existence of grid disturbances[13].

VI. PROPOSED OBJECTIVES

- **Proposed Work**

Forecasting of load and renewable energy resources is a very serious problem in micro grid systems in real time scenarios. Due to increase of various sources in the atmosphere which will increase the problems in the accuracies of the forecasting in terms of solar and wind power which can produce inaccurate results for the appropriate output. Costing is also one of the serious concerns in the same situation because effective resources are needed to control such activities. So an effective measure must be taken for the controlling of the environments to minimize the root mean square error rates which will further decrease the load and increase the effectiveness in the high energy renewable resources.

- **Objectives**

1) To implement suggested hybrid algorithm Persistence and Neural network to reduce root mean square error rate
2) To evaluate the performance of the proposed approach for the reduce emissions in terms of high efficiency of the system.
3) To compare the performance of the proposed approach with base approach.

- **Mean Square Error (MSE):** The Mean Square Error (MSE) is a calculate of prediction accuracy.

$$\text{MSE} = \frac{1}{N}\sum_{i=1}^{N}(P_i' - P_i)^2$$

- **Methodology**

1. Load the historical dataset for load forecasting

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2. Perform pre-processing part on this data
3. After pre-processing initialize the persistence algorithm and neural network
4. Next step hybrid of persistence and neural network for load forecasting to minimize the Mean Square Error (MSE)
5. Last step calculation of performance parameter of proposed work

VII.RESULTS

For calculating forecast values using persistence method and Neural network method. the forecast results for typical PV generation data for simulation using Matlab/Simulink. The PV data was obtained from a demo Matlab/Simulink model named "power_microgrid" .

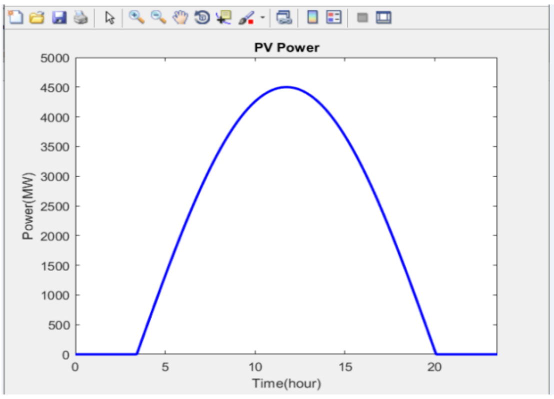

Figure 4:PV Power

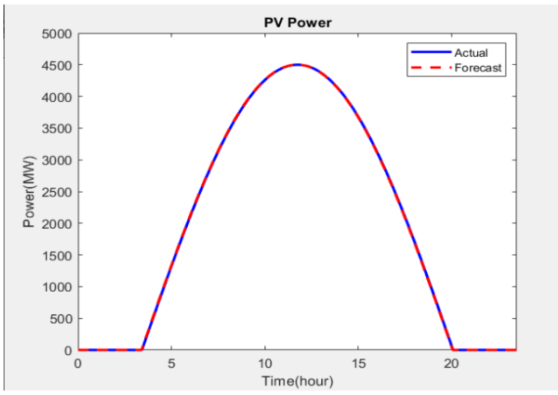

Figure 5:PV Power

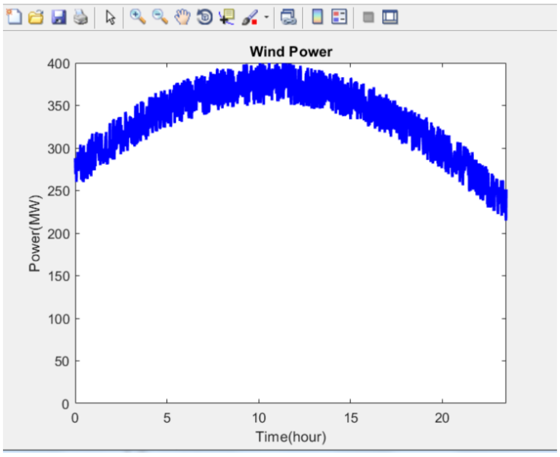

Figure 6:Wind Power

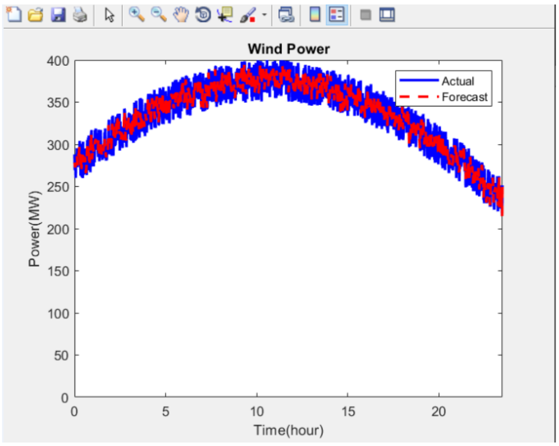

Figure 7:Wind Power

VIII.CONCLUSION

Microgrids are a cutting-edge section of the electric power industry that offers a range of benefits over conventional networks. Their modeling is an important aspect of the research into the activities that happen in microgrid. Physical modeling on lab equipment that replicates real equipment in a microgrid on a smaller scale, as well as mathematical modeling, are required because not all processes could be traced on a physical model. It was feasible to simulate the functioning of the SPP system, track the power flows, and run the model as per the power balance method. Employing a hybrid technique, The average prediction error was calculated after applying ANN & persistence to load power prediction while accounting for the share of renewable energy. The suggested method produces correct estimates, is more fast, and has a good generalization ability, as evidenced by the experimental analysis.

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