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Control Strategy for A Smart Grid-Hybrid Controller for Renewable Energy using Artificial Neuro and Fuzzy Intelligent System

M. Usman Haider Khan *, M. Siddique, M. Kamran Liaquat Bhatti, Waqar Tahir and M. Kashif

[1]Electrical Engineering Department, NFC IET Multan, Multan, 66000, Pakistan
*Corresponding author: M. Usman Haider Khan (usmanhaider7289018@gmail.com).

Abstract- **Energy generation using renewable energy resources is increasing with the passage of the time due to the fear of depleting energy resources and global warming. In Pakistan, the whole consumption of electricity in residential and business areas is nearly equal to 40%. More than 5% of energy needs are fulfilled by liquid natural fuel and town gasoline consumption within the residential and industrial sectors. Integration of the renewable resources may cause tripping issues and control of this tripping with the help of conventional controlling methods is time-consuming and wastage of energy. In this research paper, SEC based ANFIS controller for control strategy has been implemented. For this purpose, we used DVR for finding the fault and compensate the voltage drop to the maximum value to avoid tripping. Dynamic programming is used to design a controller which compares the voltage of both renewable resources with the nominal voltage and the triggers the control switches of Bridge through PWM according to the nominal voltage. The model shows that the accuracy and efficiency of the proposed solution are much better than the conventional controller.**

***Index Terms*— Global warming, Renewable energy, Conventional controller**

I. INTRODUCTION

Smart Grid EMSs face difficulties in the management of renewable energy sources such as Wind and solar energy. This problem is due to the uncertain nature of the available energy, which is caused by the difference between real-time and forecasted power production [1]. Being the top vital shape of electricity, electricity is dealing with a non-stop project of increased demand global. In step with the U. S. Energy records management a rustic's strength use, in particular power use, is linked to its economic increase [2]. For developing economies in the global, the increasing populace is turning into an essential motive for the upward thrust in electricity demand.

The global electricity business enterprise has also stated that there's a strong correlation between a country's electricity usage and its wealth. It has also expected a boom of 28% in power usage throughout 2015–2040, particularly in residential and business application grids [3]. Energy is generated by way of many specific electricity resources like coal, natural fuel, petroleum fuel, fossil gas, nuclear, hydro, renewable fuels, geothermal and others. Typically, it takes three generated through many unique power assets like coal, herbal fuel, petroleum fuel, fossil gas, nuclear, hydro, renewable fuels, geothermal and others. Three devices of source power to provide one unit of web page electricity of energy [4]. Three units of supply energy to produce one unit of web page energy of power [5]. Because of the expensive overheads, electricity fees extra in comparison to natural gas. Hence, we want to optimize our assets and generation overheads, electricity fees additional in assessment to natural gasoline. Series resonant converters have a limitation that it is challenging to regulate the voltage at light loads [5].

Hydrogen tank is also used to feed hydrogen to fuel cell but is so much costly and not an accurate prediction of the life-time of cells. The local controllers for DER can enhance the efficiency of smart grid operation by using the conventional methods (Extra Shunt Filters required to handle the harmonics of load [6]. As stated earlier in the primary intention of actual-time electricity tracking needs to be terrific tracking. The number one purpose of actual-time power tracking must be excellent predictions of strength utilization. It also needs to assist in putting into effect system with correct load stability. Power usage, it additionally ought to help to implement gadget with proper load balance. The proposed Wind and solar hybrid energy management system is shown in Fig. 1.

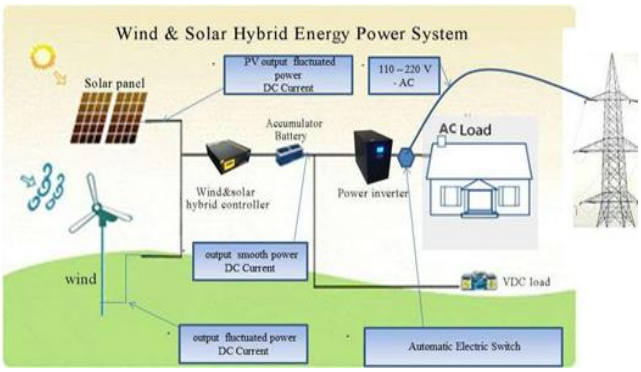

FIGURE 1. Wind and Solar Hybrid Power Energy System [7]

II. METHODOLOGY

A. PROBLEM STATEMENT

One of the solutions to tackle this issue is to use ESSs. By and large, ESSs maintain the power balance among generation and utilization by storing power during economic or off-peak hours and discharging it during significant expense or peak hours. Various supporting systems, for example, DIGs, ESSs and DSM are utilized to beat the flexibly demand mismatch of a smart framework. These methods are an essential control, anyway it has a few drawbacks, for example, high communication prerequisite, voltage drop due to Trade-off, distribution of load, harmonic, leakage inductances, Extra channels necessities, network is rigid to expand. In this way, the control system that is based on multi-master is used to defeat these disadvantages. Yet, the expense of master control is too much high.so to beat these advantages we proposed a Droop and Artificial Neuro Fuzzy Intelligent Control Method for Voltage Regulation by designing a controller and control procedure to power management of the smart network.

B. MAIN CONTRIBUTION

The main contribution of this research is to design an SEC and ANFIS controller for smart grid and compare their result. Design a DVR to compensate for the regulation in voltage, finding the faults as well as synchronization of the system. Design a PWM controller to control the switching signals of the Converter bridge circuit and regulate the frequency of the system.

C. IMPLEMENTATION OF HYBRID CONTROLLER

The method which we are using to design the controller for smart grid is hybrid control with neuro and fuzzy logic. In this system, the hybrid controller has been connected between Wind and solar systems. To control the output of the whole system, a controller has been designed to regulate the system power as well as system frequency.

To optimized and assessment for control Energy Management, the following argument has been carried out

- Optimizing the power-sharing between DERs and its outflow
- Optimizing the expense
- Load sharing and detection of fault using DVR compensation of voltage along with the compensator to share the voltage and to avoid the tripping between the Grids shown in Fig. 2.

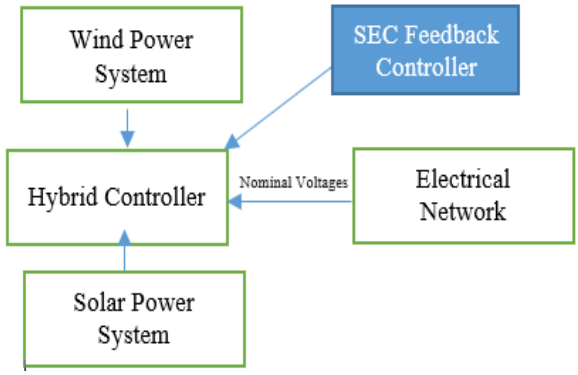

FIGURE 2. Proposed Methodology

III. RESULTS AND DISCUSSION

Evaluating the proposed methodology on ANFIS for the hybrid system, the SEC and ANFIS controller are used and compare together. The result shows that the SEC based ANFIS controller has 20% balance voltage drop from 0.120. The model has been designed in MATLAB Simulink, and when the fault occurs, the DVR injects the compensator voltage into the voltage of stator winding, as shown in figure 8 and figure 9. Stator voltage and compensator voltage are clearing the fault. The stator current reaches to 2.3. This will increase the mitigated voltage. With increasing the magnitude of voltage, the SEC and ANFIS activated, which shows that SEC based ANFIS control is more efficient than the SEC controller by itself. So, we have hybridized the system into AC controller and charged based SEC controller. An adaptive ANFIS is designed with renewable energies to show the control of Fuzzy adaptive system with DVR, as shown in Fig. 3.

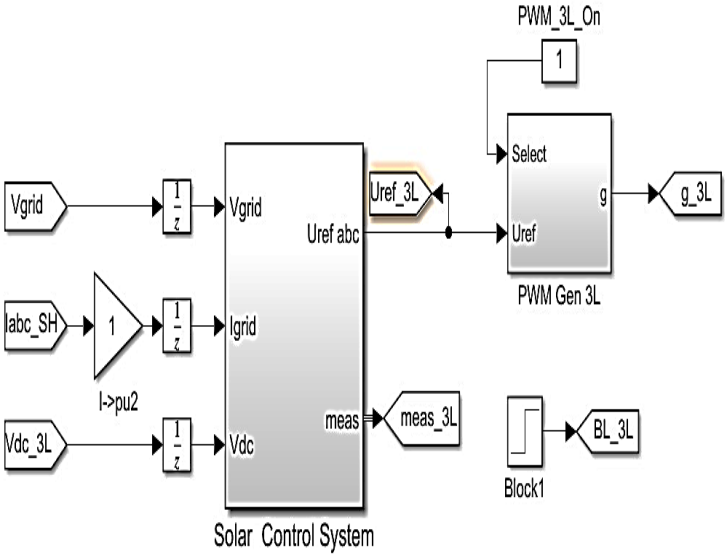

FIGURE 3. SEC Control System

The initial examination is the improved IEEE 14 buses test system used to examine the discrete functions of the feedback controller, as shown in Fig. 4.

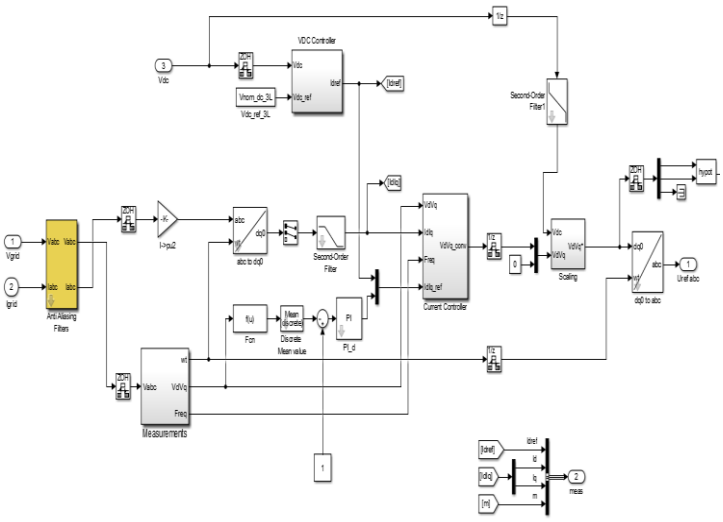

FIGURE 4. Complete Hybrid Controller Tested on IEEE -14 bus

To check the control accuracy of the controller a proposed subsystem block has been designed in MATLAB Simulink, as shown in Fig. 5.

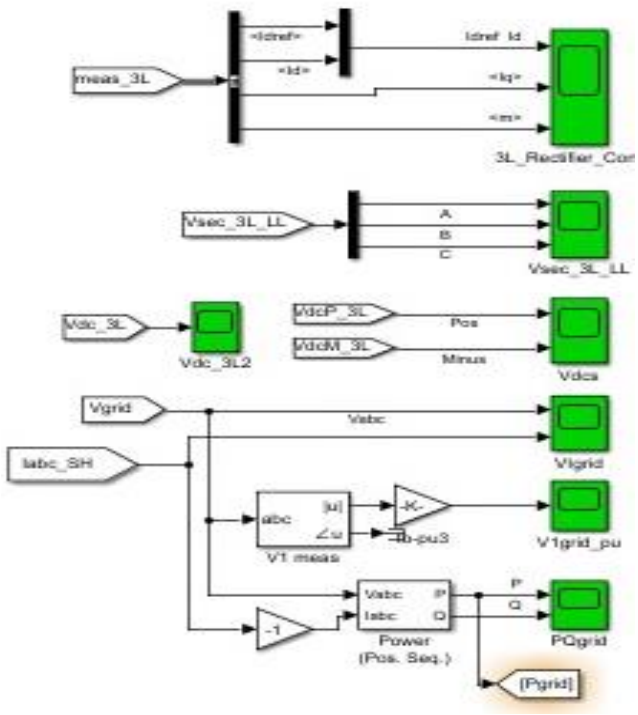

FIGURE 5. Proposed Subsystem Block

The load graph of the system is shown in Fig. 6. Once the regulation happens at the PCC at t is equal to 6 seconds. The results of the model show that these controllers have a significant effect on the flow of power and voltage levels.

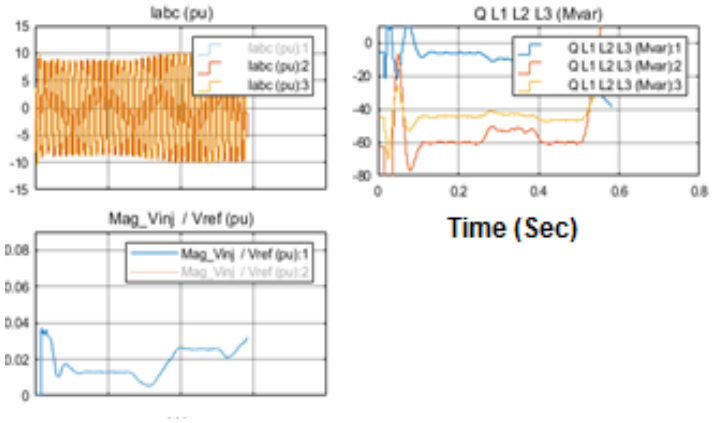

FIGURE 6. Proposed Subsystems to Check the Control Accuracy

Voltage to current graph is depicted in Fig. 7. It has been analyzed that voltage to the current graph. Power flow measurement with ANFIS and without ANFIS is shown in Fig. 8.

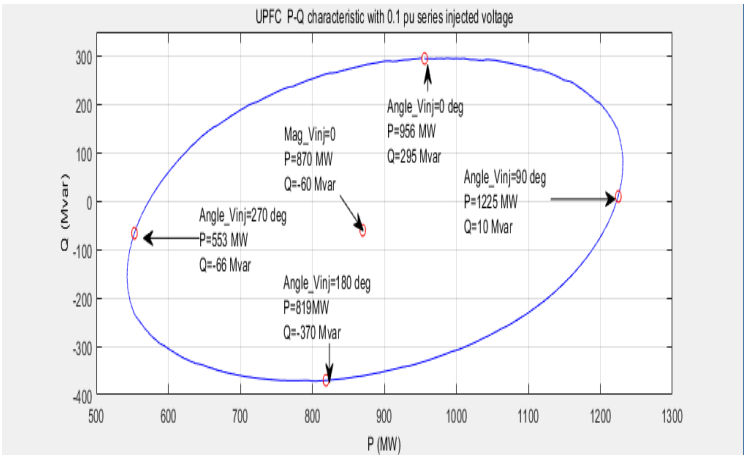

FIGURE 7. Graph Between Voltage and Current

The first two graph show the proposed system output behaviour with ANFIS and remaining two output graphs show the behaviour of power flow without ANFIS.

The dynamic behaviour of the system with and without the connection of the ANFIS is shown in Figure 9. In the situation when the ANFIS is not connected, the scale of voltage at the PCC decrease to 0.1(P. u). In the second case, when the ANFIS is associated, the voltage decrease at the PCC is 0.8 (P. u).
Harmonics detection of the system with ANFIS and without ANFIS has been evaluated and depicts in Fig. 10. The blue line graph shows the output of (ANFIS). At the same time, the yellow line graph shows the output of the harmonics analysis without ANFIS. Evaluating the proposed methodology on ANFIS for the hybrid system, the SEC and ANFIS controller are used and compare together.

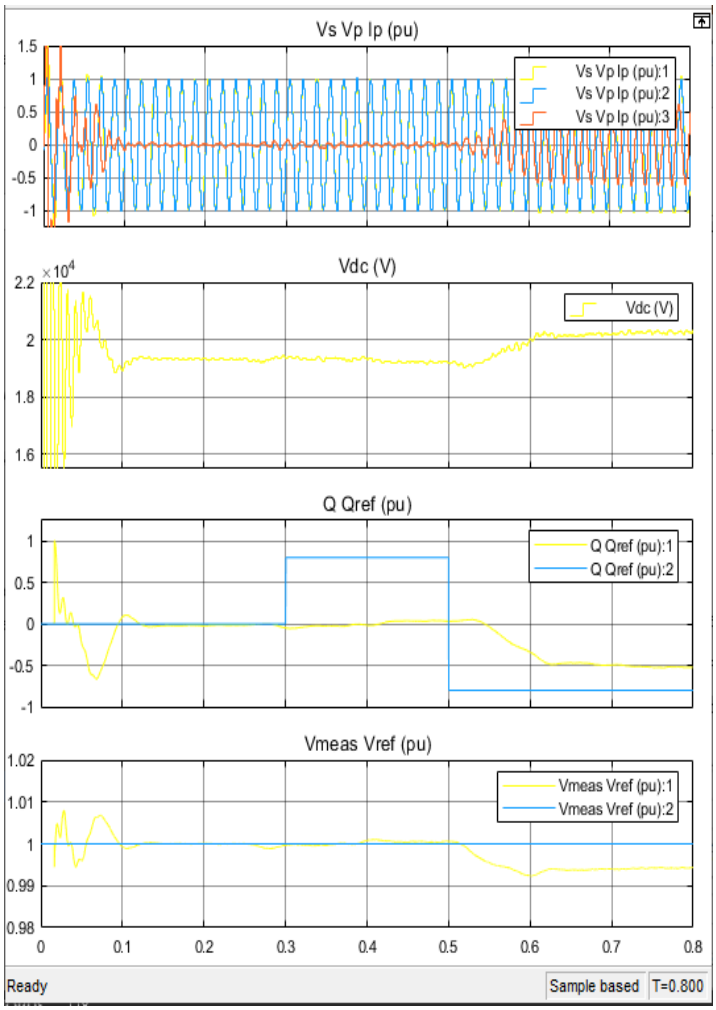

FIGURE 8. Power Flow Measurement with ANFIS and without ANFIS

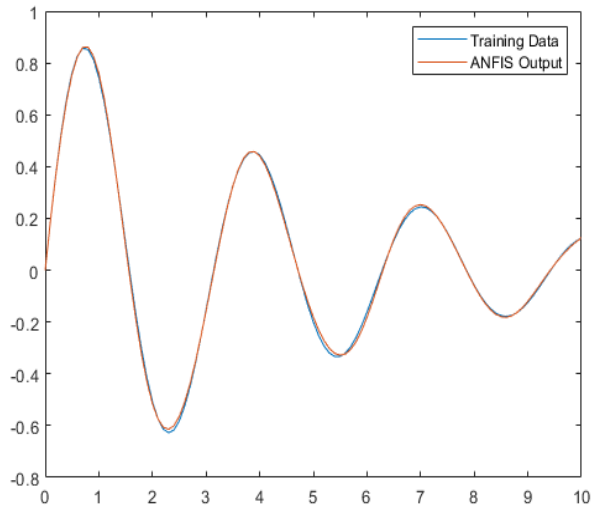

FIGURE 9. T raining Data vs ANFIS Controller Output

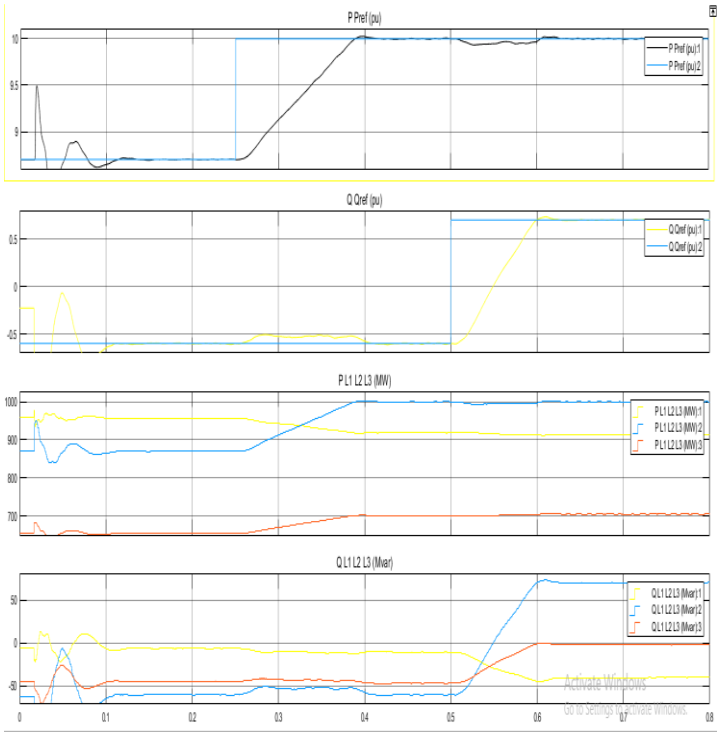

FIGURE 10. Harmonics Detection

The result shows that the SEC based ANFIS controller has 20% balance voltage drop from 0.120 and the model has been designed in MATLAB Simulink and when the fault occurs the DVR injects the compensator voltage to the stator voltage and during fault as shown in Fig. 8 and Fig. 9. The stator voltage and compensator voltage are clearing the fault, and the stator current reaches to 2.3 this will increase the mitigated voltage and then the SEC and ANFIS activated which shows that SEC based ANFIS control is more efficient than the SEC controller by itself, so we have hybridized the system into AC controller and fees based SEC controller.

IV. CONCLUSION

In this research paper, we have implemented ANFIS controller SEC side for controlling the system power. We have utilized DVR for identification the fault and to compensate the Drop voltage to maximum voltage to avoid tripping. Dynamic programming is used to design a controller which compares the voltage of both renewable resources with the nominal voltage. Transistors in the converter are activated through PWM technique. It has been analyzed that; the results of the proposed technique are much better than the previous technique. The proposed methodology on ANFIS for hybrid system the SEC and ANFIS controller is used and compare together. We have hybridized the system into AC controller and charged based SEC controller. Designed an Adaptive Neuro-Fuzzy Inference System (ANFIS) based controller for improving low voltage ride-through capability of a Hybrid Renewable Energy System. The model shows that the accuracy and efficiency of the proposed solution with and aspect is much better than the previous studies.

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