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GRID CONNECTED HYBRID BIDIRECTIONAL DC-DC CONVERTER USING ANN ALGORITHM AND CHARGING EV

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ABSTRACT

The behavior of a grid-connected hybrid DC/DC Microgrid has been investigated. Different Renewable Energy Sources –photovoltaics modules and a wind turbine generator-have been considered together with a Solid Oxide Fuel Cell and a Battery Energy Storage System. The main contribute of this work is the design and the validation of an innovative online-trained artificial neural network-based control system for and the electrical grid. The operation of the hybrid micro grid has been tested in the MATLAB /Simulink environment under different operating conditions. The obtained results demonstrate the effectiveness, the high robustness and the self-adaptation ability of the proposed control system. It produces a step signal with reduced number of switches used when compared to conventional system. Simulation analysis has been done using MATLAB/Simulink and has proved that there is reduction in harmonics.

Keywords: DC-DC Converter, ANN, Charging EV, Grid, Hybrid.

I. INTRODUCTION

High efficiency power is attained using hybrid bidirectional DC-DC converter in micro-grid system Hybrid bidirectional dc/dc converter is based on photovoltaic (PV) and wind system that are driven by permanent magnet synchronous generator are fed to the grid through common single boost converter [1]. A battery that connected to the bidirectional dc/dc converter charges from grid and discharges through grid to the load. Model of the proposed scheme in d-q axes reference frame is developed. Steady- state performance of the system and transient response of the controllers are also presented to demonstrate the successful operation of the new hybrid system. The DC- DC converter is required to perform mainly two functions: first to match the battery voltage to the motor rated voltage and second to control the power flow under steady- state and transient conditions, so that the drive performance is as per the requirement [2]. The closed loop operation of bi-directional dc-dc converter feeding a dc motor and its energy recovery due to regenerative braking has been demonstrated. The characteristics of battery-operated electric vehicle under different drive condition are also presented. Regenerative method of braking of an electric vehicle helps in efficient utilization of the battery power to increase the range of the vehicle. Methods described in literature for the regeneration use complex control algorithms to deal with the energy flow during the transition from the motoring mode the newly presented method gives lower braking time and higher regeneration and does not necessitate any additional converters or ultra-capacitors. A hybrid system consists of two or more renewable energy sources used together to provide increased efficiency. When a source is unavailable or insufficient to meet the load demands, the other energy source can compensate the demands. Most of the prior systems use a separate DC/DC boost converter for PV and wind. In order to minimize the conduction and switching losses of the devices, it is necessary to have the minimum number of power converters power conversion stages [3]. During the past few decades the advanced technological nation of the world has been engaged in an energy and resources race that has brought us to the position of energy crisis [4]. Many developing countries have also been engaged in this race during last two decades or so. It is now widely recognized that the fossil fuels and other conventional resources, presently used in generation of electrical energy, may not be either sufficient or suitable to keep pace with ever increasing world demand for electrical energy. The prospects for meeting this demand and avoiding crises in supply would be improved if new and alternative energy source could be developed. Fortunately, many such sources exist. Undoubtedly many of these would be exploited more and more in future. Solar energy is the most abundant and constant stream of energy. It is available directly solar in isolation. Especially in countries like India where the government is facing oil crunch, the tapping of PV energy which is

available in abundance throughout the year will be very important [5]. On the other hand, wind energy is also playing a significant role in power generation programmes of many countries including India. The working principle of solar panel is well known that when light radiation falls on a p-n junction, a voltage is generated. The primary power comes from the striking photons. The use of solar insolation to generate electricity is increasing constantly over the past few years. As the worlds electricity demand is increasing, the use of photovoltaic system is attracting more and more attention of power planners. As the costs of PV modules and power electronic interface are showing declining trends, PV system are likely to play major role in supplying the future electricity demands of the world. Among the renewable energy sources, wind energy also seems to be prominent and quite promising for electric power generation [6]. Wind energy conversion has been found economic as compared to the cost of fossil fuels which are rising at a much faster rate. Therefore, the study of induction generators has regained importance, as they are particularly suitable for wind and small hydro power plants. The advantageous features of induction generators are less maintenance, operational simplicity, self-protection against faults, brush less and rugged construction. The induction generators, in general, can be operated in two different modes; namely grid connected mode and isolated mode. In grid connected mode of operation, the terminal voltage and frequency are fixed by the grid. But, in isolated mode of operation, they depend upon load, speed and excitation capacitance. The self-excited induction generators are particularly suitable for supplying loads in remote areas where grid is not available [7]. Power quality is a term that means different things to different people. Institute of Electrical and Electronic Engineers Standard IEEE1100 defines power quality as "The concept of powering and grounding sensitive electronic equipment in a manner suitable for an equipment. As appropriate as this description might see, the limitation of power quality to Sensitive electronic equipment might be subject to disarrangement. Electrical equipment sustainability to power quantity or more appropriately to lack of power quality would fall within a seemingly boundless domain. All electrical devices are prom to failure or malfunction when exposed to one or more power quality problems. The electrical devices might be an electric motor, a transformer, a generator, a computer, a printer, communication network, a household appliance. All of this device and others reactant towards advance to power quality issues, depending on the severity of problems. A simpler and perhaps more conscious definition might state. Power quality is a set of electrical boundaries that allows a piece of equipment to function in its instant intended manner without significant loss of performance or life expectancy. This definition embraces two thinks that the demand from an electrical device: performance and life expectancy. Any power rated problem that compromises either attributed is a power quantity concern. Along with definition of terms, explanation or included in parenthesis where necessary. A Well-established definition of power quality does not exist because it depends on one's reference frame. For instant, whilst one customer considers a certain voltage waveform as having a sufficient quality in order to maintain a production working properly, other customer can realize that some voltage has a poor quality [8]. One accepts of common arrangement is to considered power quality as a customer driven issues, that is the customer point or view determined for indicating a quality power. Based on this assumption, a power quality problem can be defined as Any power problem manifested in voltage/ current or leading efficiency derivation that result in failure or disoperation of customer equipment. This definition means that measurement of power quality taken from the performance and productive end-user equipment. If the electrical equipment is inadequate for those needs, the quality is said to be lacking [9]. Solar photovoltaic (PV) and wind have emerged as popular energy sources due to their co friendly nature and cost effectiveness. Hence, it is a challenge to supply stable and continuous power using these sources. This can be addressed efficiently integrating with energy storage elements. The interesting complementary behavior of solar insulation and wind velocity Patten coupled with the above-mentioned advantages, has led to their integration resulting in the hybrid PV wind systems. For achieving the integration of multiple renewable sources, the traditional approach involves using dedicated single input converters one for each source, which are connected to a common dc bus [9]. However, converters are not effectively utilized, due to the intermit ten nature of the renewable sources. In addition, there are multiple power conversion stages which reduce the efficiency of the system. Significant amount of literature exists on the integration of solar and wind energy as a hybrid energy generation system with focus mainly on its sizing and optimization. In the sizing of generators in a hybrid system is integrated. In this system, the sources and storage are interfaced at the dc-link, through their dedicated converters. Other contributions are made on their modeling aspects and control techniques for a

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standalone hybrid energy system. Single-phase improved power quality AC to DC converters. Many of the proposals in the recent years have combined two known topologies into one for PFC [10]. The selection of the topologies and conduction modes determines the line current and the voltage on the storage capacitor. The objective of the model focus on inverter technologies for connecting photovoltaic PV modules to a single-phase grid Indirect-drive and direct- drive turbines are comparatively evaluated [11]. The concerns about long-term availability of permanent magnet materials and its impact on the future of permanent magnet synchronous generator are addressed. Having cost and efficiency in mind, viability of indirect-drive squirrel cage induction generator for stand-alone wind energy conversion systems is discussed. As an efficient induction machine design, permanent magnet induction generator is also examined. Finally, the potential of using switched reluctance machine, as a generator [12]. This research work presents a mixed-integer linear programming (LP) formulation for the long-term transmission expansion planning problem in a competitive pool-based electricity market. The renewable energy sources like sun and wind are the alternate sources of green power generation which can ease the power demand problems. This paper presents the control approach for power flow management of a grid-connected hybrid photovoltaic (PV)–wind-battery-based system with bidirectional dc–dc converter. The main object of the proposed system is to meet the load demand, deal with the power flow from various sources, inject the additional power into the grid, and charge the battery from the grid whenever essential [13]. The main aim of this research work is a control strategy for power flow management of a grid-connected hybrid PV-wind-battery based system with an efficient multi-input transformer coupled bidirectional-dc converter is presented. The proposed system aims to satisfy the load demand, manage the power flow from different sources, inject surplus power into the grid and charge the battery from grid as and when required. A transformer coupled boost half-bridge converter is used to harness power from wind, while bidirectional buck-boost converter is used to harness power from PV along with battery charging/discharging control [14].

II. IMPLICATIONS OF POOR POWER QUALITY

Some of the implications of power quality especially related to power factor and harmonics are:

- Increases in line and equipment current leading to additional ohmic losses.
- Increases in line and equipment current leading to blocked capacity and increased capital investment.
- Increased losses leading to higher operating temperatures and consequent detection in life of equipment.
- Premature failure of equipment due to increased electrical and thermal stress.
- Mall function of equipment.
- Poor quality of production.
- Unplanned outages leading to losses of production.

III. NEED FOR POWER BATTERY

Power quality becoming an important concern because of much reason, one major reason is:

- To increase the efficiency of power system many new devices such as shunt capacitors and adjustable speed motors derive are gaining popularity. These devices increase the harmonic level power system which increases the concern.
- Power electronic devices and load that make use of control based on microprocessor and microcontroller are more affected by power quality issues.
- The interconnected network that is used now a days badly affected by the power system disturbance because if any component is failed an entire system is affected.
- The awareness of problem in to quality of power and difficulties faced like under voltage, over voltage, flickers etc., is among the utility costumer are end users is tremendously increasing which arises the demand of high and better quality of power.

IV. OBJECTIVE OF THIS RESEARCH WORK

- The objective of this research work is to yield the electrical energy from regenerative energy to the power source.

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- The main aim of this research work is a control strategy for power flow management of a grid-connected hybrid PV-wind-battery based system with an efficient multi-input transformer coupled bidirectional-dc converter is presented.
- Offering the automatic control with less expensive scheme.
- To provide the pollution free operation without the fuel source.

V. PROPOSED SYSTEM

Integration renewable energy sources (RESs) with hybrid microgrids is much needed to provide high DC power directly without any reactive power compensation. To meet the local load demand and requirements, the modern charging station needs to be upgraded. A charging station powered by photovoltaic (PV) energy produces uncertainties between PV and BEV which can be analyzed by radial distribution systems. The losses from AC-DC conversion can be minimized by selecting the proper operating voltage level at the charging station. Similarly, the number of required charging stations can be significantly reduced by developing multiport charging with real-time forecasting of charging station infrastructure. The PV and energy storage unit (ESU)-connected DC micro grid system is used to charge BEVs available at the charging station, and the DC bus connection with the RES has to follow requirements for network coordination, earthing, and DC network protection. A hybrid system consists of two or more renewable energy sources used together to provide increased efficiency. When a source is unavailable or insufficient to meet the load demands, the other energy source can compensate the demands. Most of the prior systems use a separate DC/DC boost converter for PV and wind in order to minimize the conduction and switching losses of the devices, it is necessary to have the minimum number of power converters power conversion stages. The block diagram of the proposed system shown below in Fig. 1.

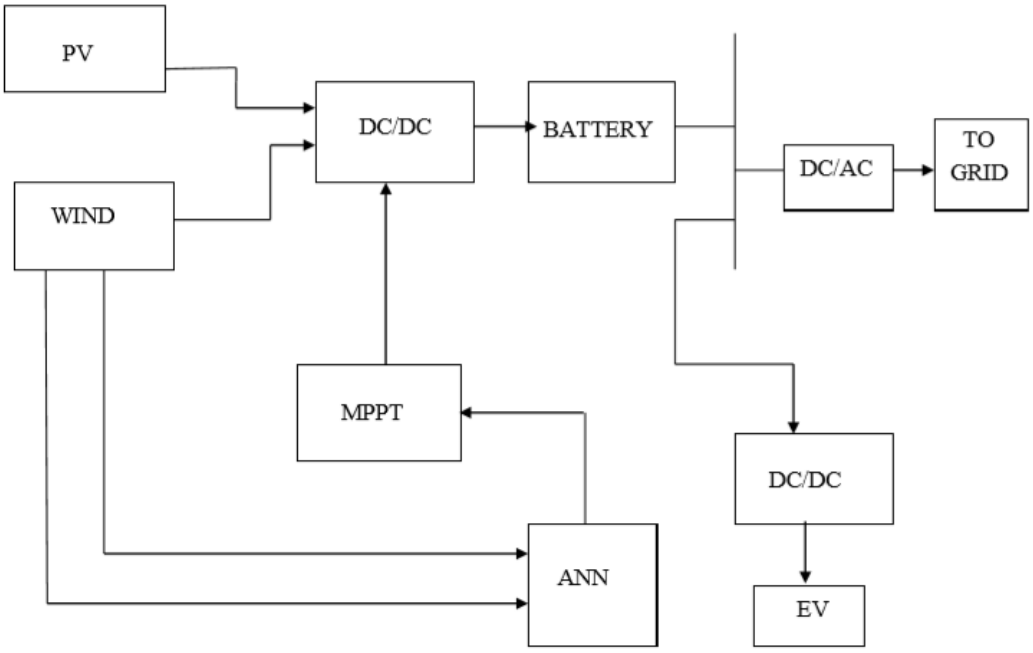

Fig. 1. Block Diagram of Grid Connected Hybrid DC to DC Convertor

The functional block diagram of the project consists of battery, bidirectional converter involves DC to DC converter, DC to AC converter, Pic microcontroller, Potential transformer, Current transformer, renewable energy systems and the Motor. In this project we are using the solar renewable energy system Solar panel.

VI. SIMULATION AND RESULTS

The name MATLAB stands for matrix laboratory. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK linear system package and EISPACK Eigen system package projects. MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. MATLAB has many advantages compared to conventional computer languages for

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solving technical problems. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. Specific applications are collected in packages referred to as toolbox. There are tool boxes for signal processing, symbolic computation, control theory, simulation, optimization, and several other fields of applied science and engineering. Simulation is well suited for education purpose [15]. It is an efficient way for designer to learn how a circuit and its control are working. It is normally much cheaper to do a thorough analysis than to build the actual circuit in which component stresses are measured. A simulation can discover the possible problems and determine optimal parameters, increasing the possibility of getting the prototype. New circuit concepts and parameter variation are easily tested. Destructive tests that cannot be done in the lab, either because of safety or because of costs involved, can easily be simulated. Response to faults and abnormal conditions can also be thoroughly analyzed. The software tool used for the simulation studies is MATLAB.

6.1 Simulink Model of Wind Driver Circuit

SVPWM space vector pulse width modulation technique is proposed to drive universal bridge. Bldc current is controlled with the help of abc_dq transformation & pi controller. Park transformation is involved to eliminate ripples in stator current with wind drive which shown in Fig. 2.

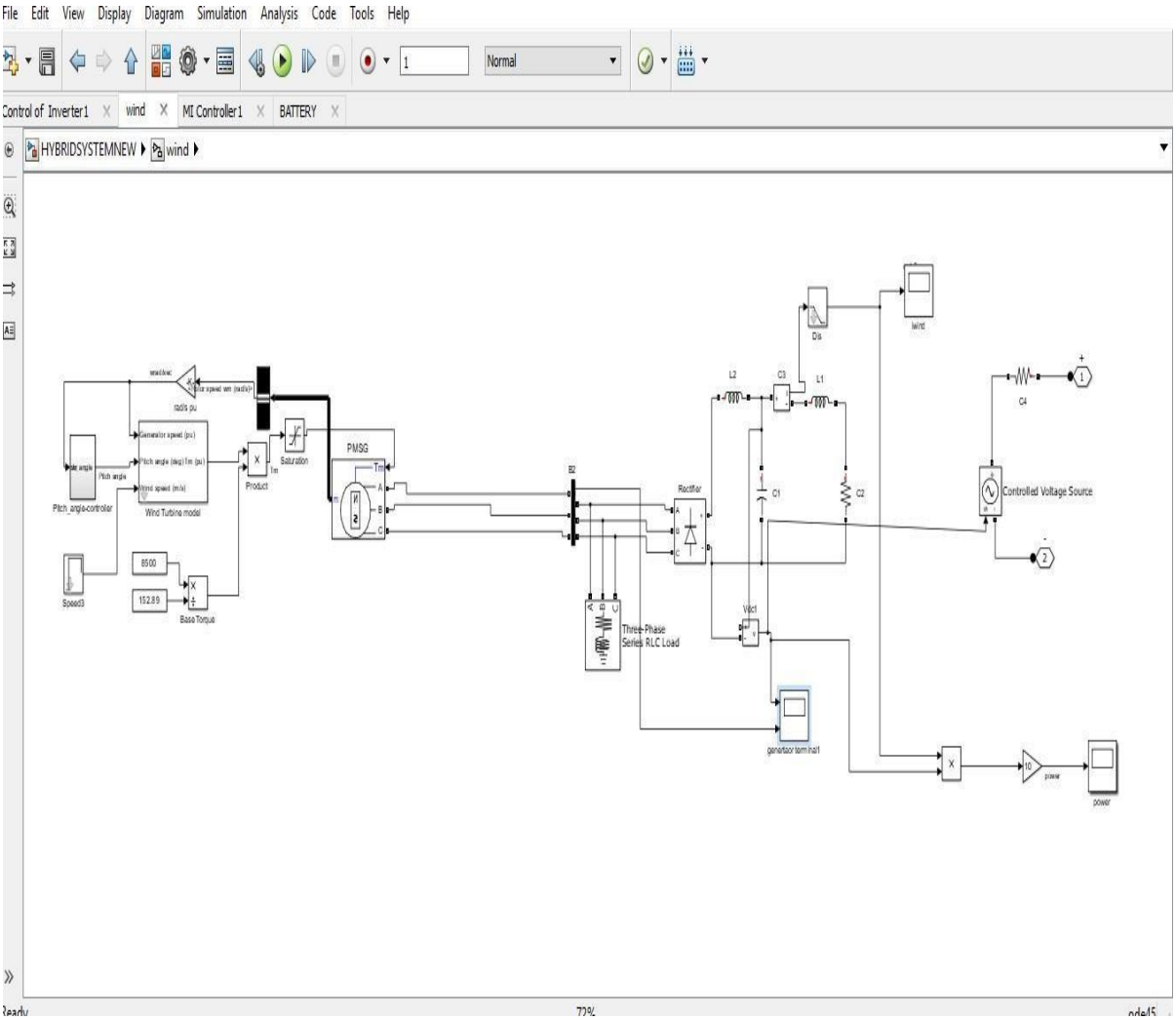

Fig. 2. Simulink Model of Wind Drive

6.2 Simulink Model of Bi-Directional Converter

Grid output voltage will be constant for 300v. and battery capacity 120v 100ah.With involving this bi-directional dc to dc converters, the extracts the maximum power from PV and Wind transfer it to linear/ non-linear loads and grid which shown in Fig. 3. A MATLAB simulation is performed to verify the converter performance and the simulation circuit.

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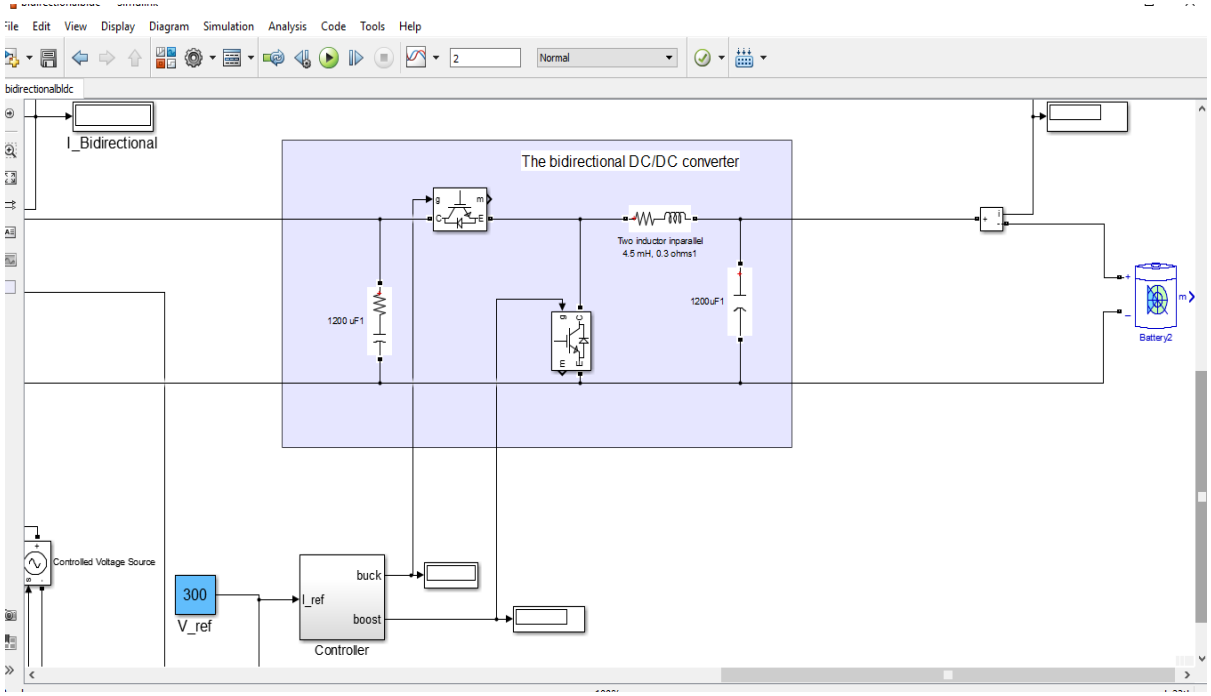

Fig. 3. Simulink Model of Bi-Directional Converter

6.3 Simulink Circuit Model of Current and Voltage of Grid Injection in ANN

In this simulation model, using of bi-directional dc to dc converter is injected for control over MPPT among for fast response and reduce the tolerance. To facilitate power extraction from both pv array and wind, which deliver the current controlled to maximum renewable sources which shown in Fig. 4. the existing circuit model, the proposed circuit model consists of two renewable power sources connected to the multi-input transformer but they do not have a dedicated converter connected to them. Five level inverters are used in the output side of the circuit model which helps in obtaining the required output [16].

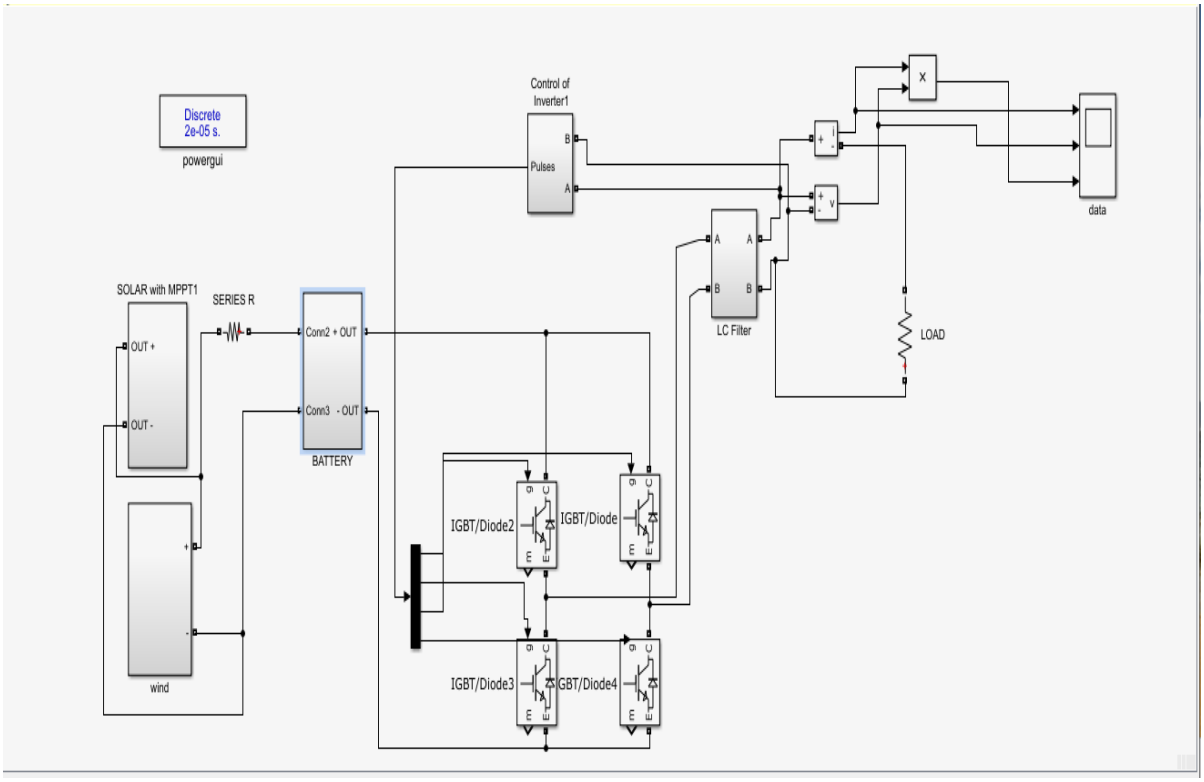

Fig. 4. Simulink Model for Current and Voltage Grid Connection in ANN

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6.4 ANN Logic

If the voltage measured is higher than the reference voltage, then the bidirectional should send some current to the battery (i.e. buck converter), if V_measured < V_reference ---> bidirectional should send current to the R_MG (i.e. boost converter) Closed loop control system is implemented for bi directional dc-dc converter stage. Proportional integral controller is used in this simulation. A closed loop control system of bi-directional DC-DC converter using ANN circuit is shown in Fig. 5.

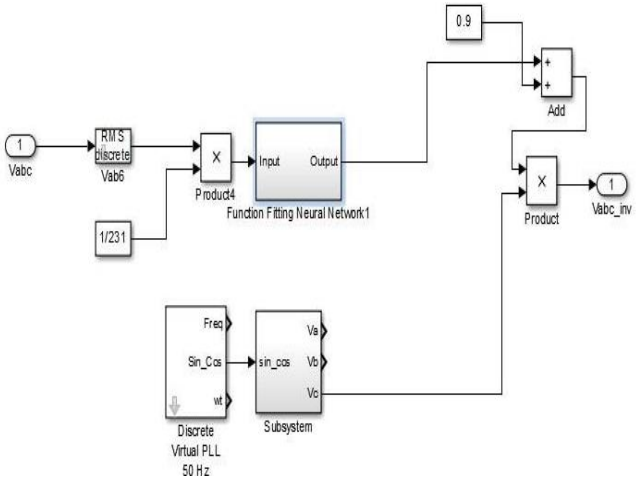

Fig. 5. Closed Loop Control System of Bi-Directional DC-DC Converter using ANN

6.5 Simulation Result of Grid Voltage and Current Injection

This scope output shows the bi-directional converter of voltage and current waveform which shown in Fig. 6. since the load response in simulation based maximum power.

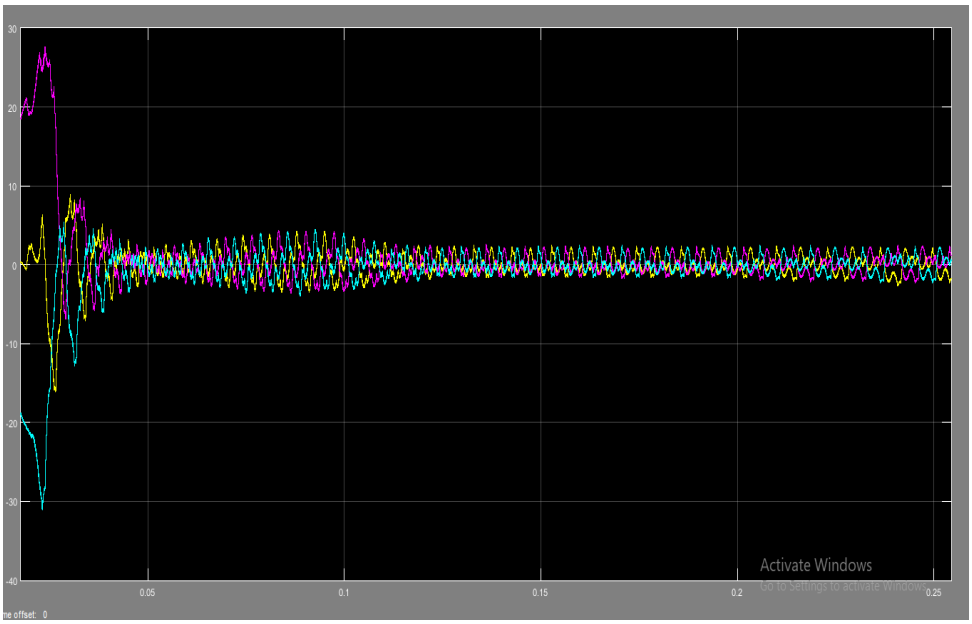

Fig. 6. Simulation Result of Current and Voltage Waveform

VII. CONCLUSION

A grid-connected hybrid PV-wind-battery based power evacuation scheme for household application is proposed. The proposed hybrid system provides an elegant integration of PV and wind source to extract maximum energy from the two sources. It is realized by a novel multi-input transformer coupled bidirectional dc-dc converter followed by a conventional full-bridge inverter. A versatile control strategy which achieves better utilization of PV, wind power, battery capacities without effecting life of battery and power flow management in a grid-connected hybrid PV-wind-battery based system feeding ac loads is presented. The simulation results obtained to minimizing the harmonics in simulations and are supportive in demonstrating

the capability of the system to operate either in grid feeding or stand-alone mode. The proposed configuration is capable of supplying un-interruptible power to ac loads.

VIII. REFERENCES

[1] Becerra R. C., Ehsani M., and Jahns T.M., (2012), ''Four-quadrant brushless ECM drive with integrated current regulation,'' IEEE Trans. Ind. Appl., vol. 28, no. 4, pp. 833--841. Proceedings of the IEEE Int. Conf. on Automation and logistics, pp. 2029—2034.

[2] Cao J., Cao B., Bai Z. and Chen W., (2007)," Energy regenerative Fuzzy Sliding mode Controller design for Ultra capacitor –Battery Hybrid Power Electric Vehicle," Proceedings of the IEEE Int. Conf. on Mechatronics and Automation, pp. 1570– 1575.

[3] Chen C.H. and Cheng M Y., (2007) ''Implementation of a highly reliable hybrid electric scooter drive,'' IEEE Trans. Ind. Electron., vol. 54, no. 5, pp. 2462—2473.

[4] Dixon J.W, and Ortlizar M.E, (2002). "Ultracapacitors + DC–DC Converters in Regenerative Braking System," IEEE Aerospace and Electronic Systems magazine, Vol. 17, No. 8, pp. 16–21.

[5] Cao J., Cao B., Bai Z., Xu P and Wu X., (2007)" Neural network control of Electric Vehicle based on Position –Sensor less Brushless DC Motor," Proceedings of the IEEE Int. Conf. on Automation And logistics, pp. 2029–2034.

[6] UgurFesli, Rafi BAYIR, Mahmud OZER, IEEE, (2006), "Design and Implementation of a Domestic Solar-Wind Hybrid Energy System" Proceeding of Transmission and Distribution Conference and Exhibition, IEEE PES- 2006, pp. 29- 36.

[7] Cao J., and Cao B., (2009)," Fuzzy-logic - Based Sliding Mode Controller Design for Position -Sensorless Electric vehicle," IEEE Trans. Power Electron. vol. 24, no. 10, pp. 2368—2378.

[8] Wen Shao, Behan Zhang, Chuanxiong Mao, Yoshi Chen, Biao Mao, Yi Chen, JieZeng, Xun Chen, IEEE, (2012), "Modeling and Simulation of the Asynchronous Wind Turbine" Innovative Smart Grid Technologies - Asia (ISGT Asia), pp. 1-5.

[9] Vinoth, S., Rajasekar, C., Sathish, P., Sureshkumar, V., Yasminebegum, A., Ahammad, S.H. and Girimurugan, R., 2023, May. Optimization of process parameters on wire cut electrical discharge machining and surface integrity studies of AA6070/MgO composites. In Journal of Physics: Conference Series (Vol. 2484, No. 1, p. 012012). IOP Publishing.

[10] Yu S.Y and Kwasinski A, Apr. (2013), "Analysis of soft-switching isolated time-sharing multiple-input converters for DC distribution systems," IEEE Trans. Power Electron., vol. 28, no. 4, pp. 1783–1794.

[11] Cao J., Cao B., Bai Z and Xu, (2008)" Regenerative – Braking Sliding mode Control of Electric Vehicle based on Neural network Identification," Proceedings of the IEEE Int. Conf. on Advanced Intelligent Mechatronics, pp. 1219–1224.

[12] Adithya, K. and Girimurugan, R., 2023. Benefits of IoT in automated systems. Integration of Mechanical and Manufacturing Engineering with IoT: A Digital Transformation, pp.235-270.

[13] Yuncong Jiang; Qahouq, J.A.A.; Orabi, M., (2012)"AC PV solar system distributed architecture with maximum power point tracking," IEEE 34th International Telecommunications Energy Conference (INTELEC), pp.1-5.

[14] Ye M, Bai Z.F., and Cao B., (2007), "Robust H2/Infinity Control for Regenerative Braking of Electric Vehicles," Proceedings of the IEEE Int. Conf. on Control and Automation, pp. 1366–1370.

[15] Cao J., Cao B., Bai Z and Xu P., (2007)" Neural network Self -adaptive PID control for Driving and Regenerative Braking of Electric Vehicle," Proceedings of the IEEE Int. Conf.on Automation and Logistics, pp. 2029–2034.

[16] Vairavel, M., Girimurugan, R., Shilaja, C., Loganathan, G.B. and Polat, Z., 2022, November. Analysis of hybrid electrical vehicles: Types, formulation and needs. In AIP Conference Proceedings (Vol. 2452, No. 1). AIP Publishing.