HYBRID WIND/PV/BATTERY INTELLIGENT ENERGY MANAGEMENT CONTROLLER FOR SMART DC- MICRO GRID

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Abstract

Changes in the global environment, risks of nuclear energy, loss of power grids, upward trends, and Energy costs increase the desire to rely more on renewable energy sources for power generation. Recently, most people prefer to live and work in smart places like integrated smart cities and smart colleges. Most of these smart grid systems are based on hybrid energy sources. Energy Management is a tough task. Therefore, intelligent energy management controller designs necessary. This paper proposes an intelligent energy management controller based on coupling. Fuzzy logic and FOPID (fractional order proportional integral differentiation) control method for smart DC micro grid. The hybrid energy source integrated into the DC micro grid is formed by the battery Banks, wind energy, solar power (PV) energy sources. Source side converter (SSC) is a controller through a new intelligent fractional order PID strategy to derive maximum power from renewable improves supply quality of energy sources (wind and PV) and DC micro grids. Choose Energy sources (wind and PV) are prioritized in cost-effective micro grids. Proposed controller Guarantees smooth output power and continuity of operation. Simulation results of the control method proposed below Matlab/ Simulink is presented and compared to the Super Twisting Fractional Order Controller.

Keywords: Renewable Energy, Smart University, DC Micro grid, Energy Management Control, Fuzzy logic control, Fractional order control.

Introduction

The global generates numerous kinds of pollution. Thermal energy plants (coal, oil) are answerable for atmospheric emissions connected to the combustion of fossil fuels. On the alternative hand, nuclear energy plants, whose improvement intensified following the oil crisis, have now no longer had a poor effect on air pleasant. On the alternative hand, they produce radioactive waste which reasons foremost troubles in phrases of garage, processing, and transport. Today, the concern of the use of most effective one electricity source with all its risks, and the outlet of the energy manufacturing marketplace are all elements that deliver renewable energies (hydraulic, wind, solar, biomass, etc.) an critical vicinity in energy manufacturing [1], [2].

The call for electricity via way of means of clients is typically now no longer flippantly allotted over the years and troubles of the phasing of electricity produced as opposed to electricity ate up arises. The stability of the grid relies upon at the stability among manufacturing and consumption [3]. The growth within side the penetration rate of renewable energies will consequently be conditioned via way of means of their participation in those one of a kind services, so that you can be preferred via way of means of the affiliation with those smooth electricity reasserts, of electrical electricity garage systems [4]. Storage is consequently the important thing to the penetration of those energies within side the energy grid. Not most effective does it offer a technical answer for the grid operator to make certain a real-time stability of manufacturing and consumption; however it additionally permits the first-class feasible use of renewable sources via way of means of warding off load dropping within side the occasion of overproduction. Combined with neighborhood renewable generation, decentralized garage could additionally have the benefit of enhancing the robustness of the energy community via way of means of permitting islanding of the place provided via way of means of this resource. Also, a well-located electricity garage device (ESS) will increase the pleasant of the energy provided via way of means of supplying higher manage of frequency and voltage and decreases the effect of its variability via way of means of including price to the cutting-edge provided, especially if the energy is introduced all through top periods [5], [6]. The integration of renewable energies collectively with the electricity garage device in a standalone micro grid is a rising studies place. Generally, it's far desired to integrate one of a kind renewable energies which include tidal, wind, and PV to yields a wonderful effect at the most ability of the electricity garage device. Usually, ESS is constituted via way of means of an aggregate of a battery and super capacitors, which enables increase battery life-time and gives a quick device reaction to compensate the transients [7]. However, hundreds are vital whilst all (electricity reasserts and battery garage systems (BSS)) are connected; thus, the AC grid is used rather than super capacitors [8].A micro grid is classed into DC, AC, or an aggregate of each type. Compared with AC micro grid, DC micro grid indicates numerous advantages which include fewer parameters to manage, facilitate integration, and simple structure. On the alternative hand, AC kind wishes extra

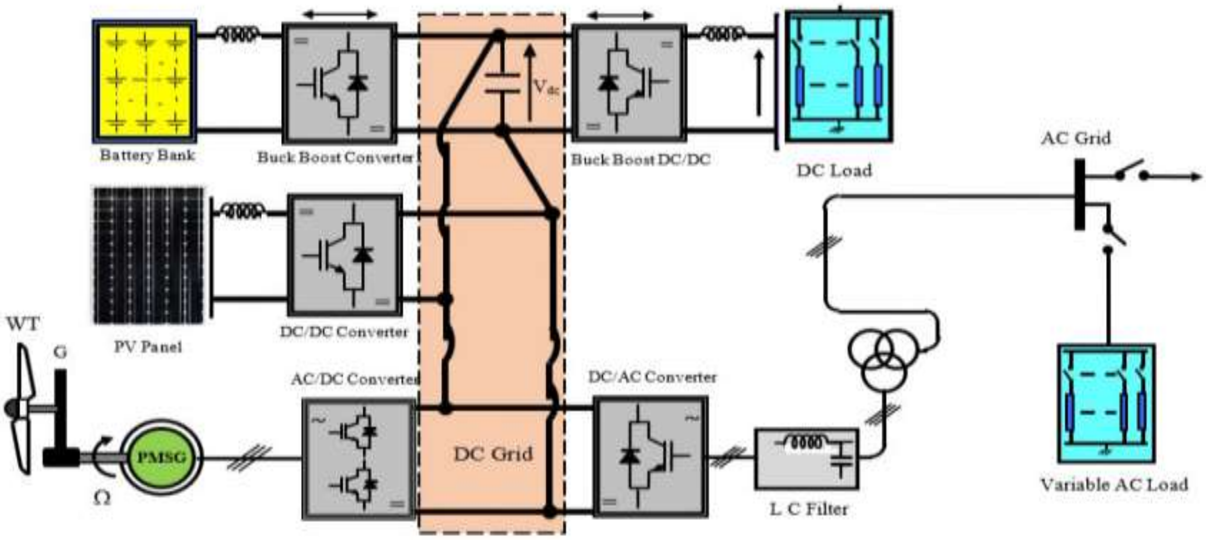


FIGURE 1. Studied hybrid system structure.

information just like the synchronization of the frequency and reactive energy, which makes the manage layout procedure a tough task. Moreover, a DC micro grid gives the opportunity to paintings in one of a kind modes like AC micro grid, standalone, or integrated with the AC micro grid [9], [10].Due to the present day improvement in energy electronics, the independent DC micro grid can paintings at its most performance. However, due to the renewable electricity reasserts stochastic nature, the easy operation and continuous energy transmission to the hundreds want a Supplementary electricity control unit. Numerous studies works at the electricity control in proportional integral (PI) control is proposed for calculations Source-side converter and load-side converter controllers. However, it is well known that victory is fixed. Very difficult to calculate under parameter uncertainty, or variation. Therefore, an IFOPID controller will be introduced to improve robustness and solve the problems you face PI loop. ! What is the novelty and contribution of the current work? It is summarized as follows. New fractional order PID controller (FOPID) Combined with a fuzzy logic strategy developed for DC micro grid integrates with multiple stochastic sources and an important DC load. Select fuzzy logic as fuzzy enhancement

Proposed Controller Design Process

The purpose of the proposed Intelligent Fractional PID the mission is to calculate the SCC controller law shown in. Generalized model represented by Ui and to (24) (26) Calculate the commonly shown LSC controller law Model represented by Up (27) (28) Number 15. Designing the proposed IFOPID requires two steps: First, the controller's law is calculated from the FOPID after that, the fixed gain is carried over to the fuzzy gain. Supervisor, thereby adapted controller proposed Aggressive and robust against parameter uncertainty. In proportional integral (PI) control is proposed for calculations Source-side converter and load-side converter controllers. However, it is well known that victory is fixed. Very difficult to calculate under parameter

Uncertainty or variation. Therefore, an IFOPID controller will be introduced to improve robustness and solve the problems you face PI loop.

Numerical Results

This paper proposes a complex hybrid energy system .Figure1 shows the integrated intelligent DC micro grid. You can distinguish between the three main parts: hybrid energy, wind energy, solar energy, BSS connected to DC link via each converter. Priority for smart colleges may include laboratory benches, fans, etc. Lights up. Maximum PowerPoint tracking algorithm is used for both wind and solar (PV) conversion systems operate them with maximum power. The energy management unit calculates the total energy consumed find generated to select the appropriate control mode.

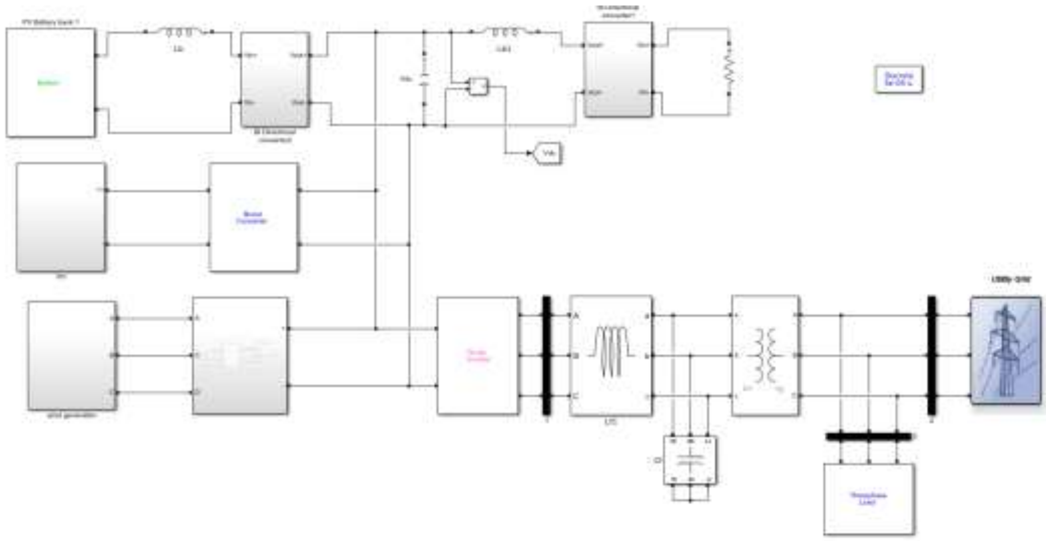
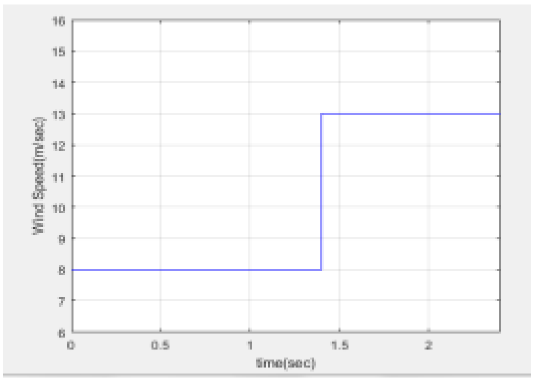


Fig. 1. Simulation diagram



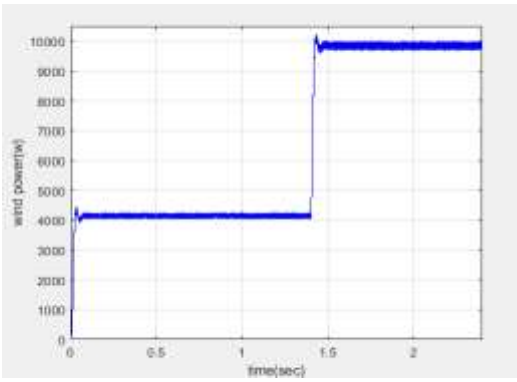


Fig.2. Wind Speed Fig.3 .Wind Power

The simulation result of the proposed system is the parameter formed and used in mat lab / Simulink are DC link reference value is fixed ~240V. Simulation test focuses on energy the results of the management unit shown in figure 11. First, figure 14. Wind power. 8000 watts of DC load connected to DC link via two load side converters for battery storage. The system on a chip (SOC) is initially 80%. Figure13 shows a wind profile between 813 m/s. Coward. 14 is wind power generated from 4000 to 10,000 watts depending on the wind speed. 3000 Watt SPV as shown in figure 15, energy is generated under radiation. Temperature of 600 watts /m2 and 25 ° C. Figure 16,

Power Pdg generated from both PV and wind. According to the current answer, the generated power Pdg it varies between 7000 and 13000 watts. Fig Figures 17 and 18 show battery performance and its SOC.From the results presented, the battery powers the micro grid Approximately 2300 watts at time intervals [01.4] seconds when SOC> 20%, at time interval

[1.42.3] The generated Pdg exceeds the load power. So the battery It is charged from the micro grid at about 4500 watts. Figure 8. The second part represents the expected load shows the intermediate circuit voltage for both SSC and LSC. PI and suggested IFOPID where to see it both adjust the intermediate circuit to its set value. But, the proposed IFOPID shows excellent performance in the following ways: Steady state error and convergence criteria.

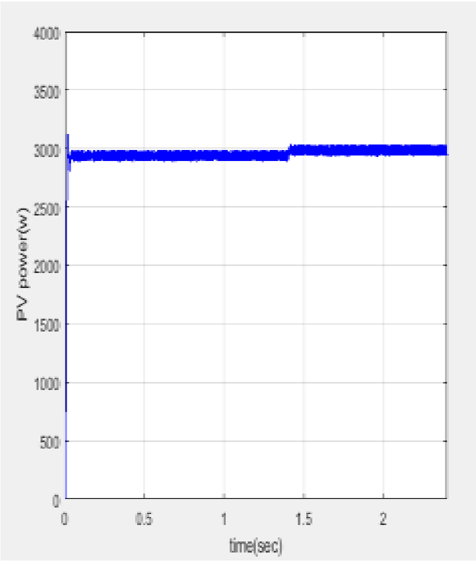


Fig.4. Solar power

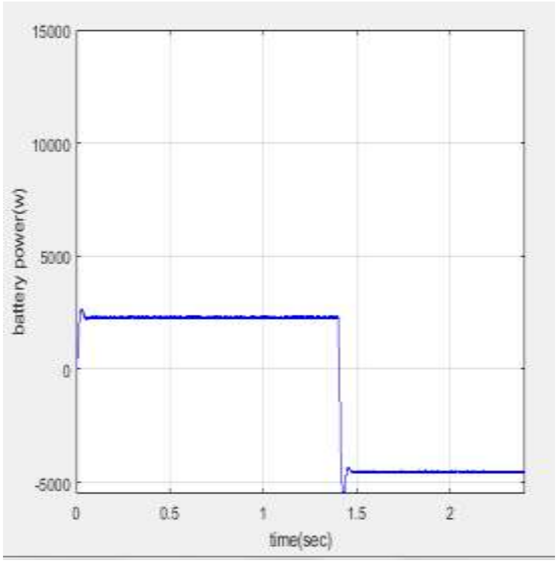


Fig.5. BSS Power

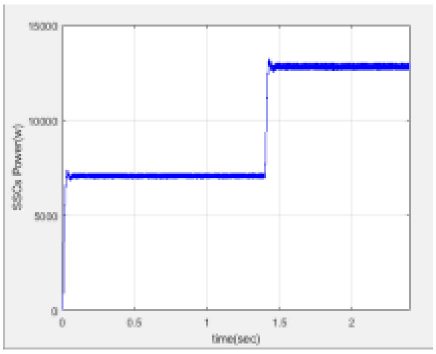


Fig.6 .SSCs Power

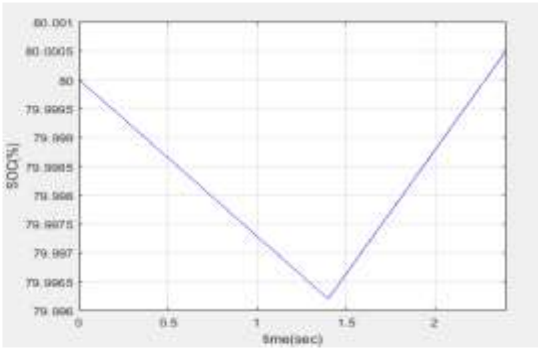


Fig.7. The Battery SOC

Fig. 9 shows that the proposed energy management control transmits a constant power to the loads, about 8300 watts. Fig.10, clearly indicate that the proposed IFOPID regulate the output voltage at its reference (220V). A comparative analysis with previous works has been performed in the present section to highlight the advantages of the proposed IFOPID. Comparative analysis.

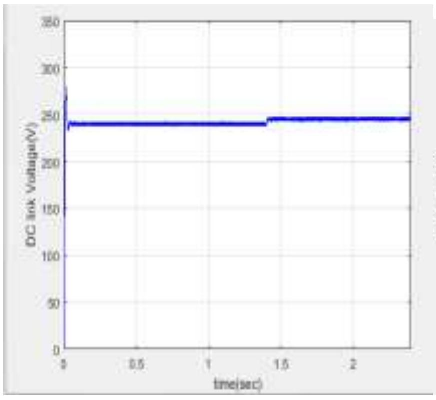


Fig.8. DC link voltage

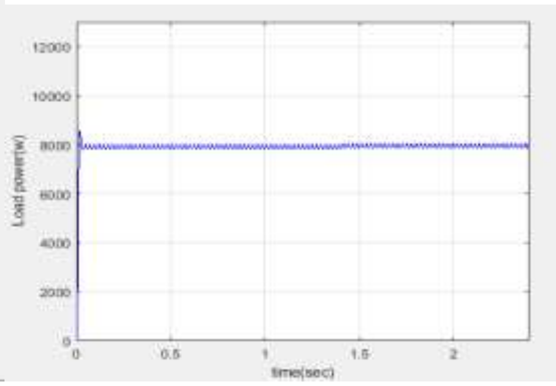
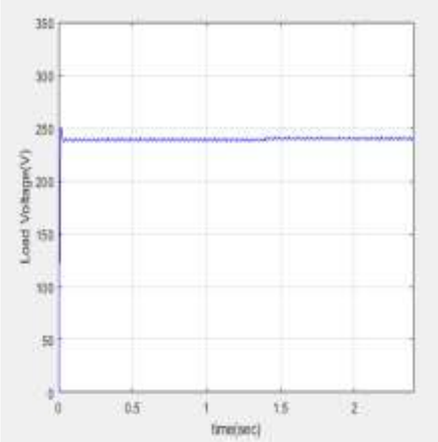


Fig.9. Load power



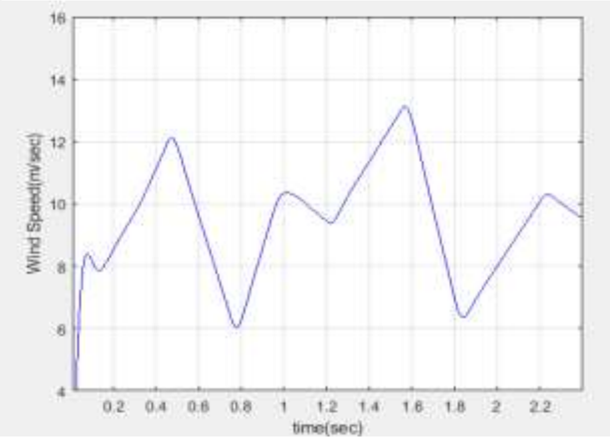
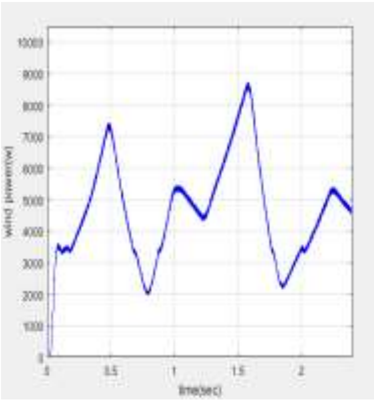


Fig.10. Load voltage Fig.11. Random Wind Speed

To test the robustness of the proposed power management Strategy, wind speed and random changes in the sun Radiation is used as shown in Figures 11 and 12, respectively. Figure 17, shows wind power generation with random wind. Profile. The wind system seems to work on an MPPT basis about the reported results. Figure 13, clearly shows how to do this.



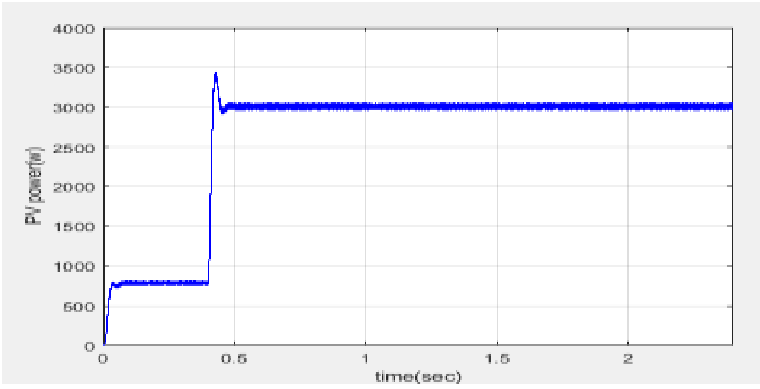
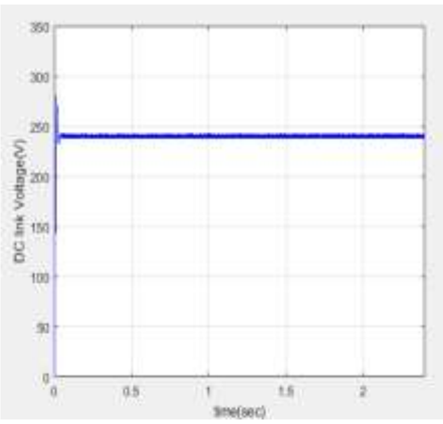


Fig.12. Wind Power under random Wind Speed. Fig13. Solar power under random solar radiance



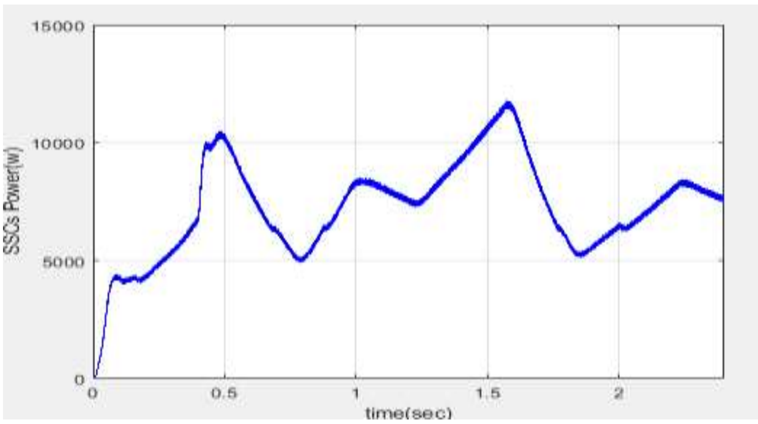
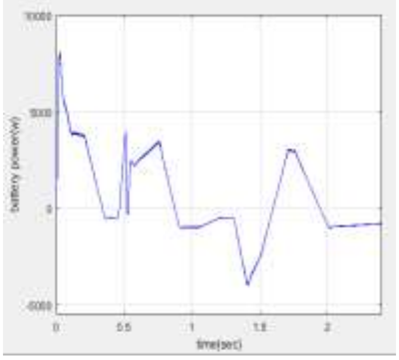


Fig.14. DC - link voltage under random variations Fig.15 SSCs Power under random variations



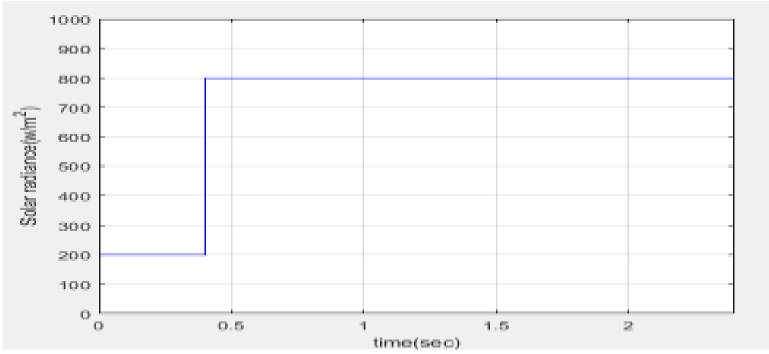


Fig.16 .BSS Power under random variations.

Fig.17 .Solar radiance

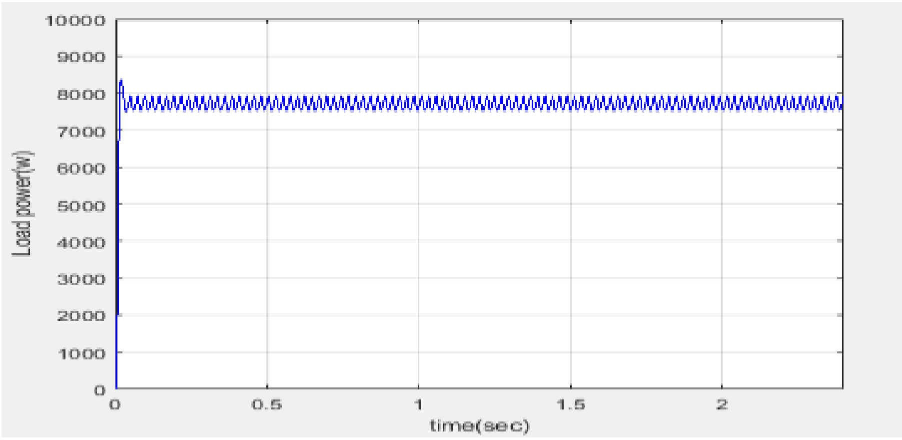


Fig.18. Load power under random variations.

The MPPT control forces the PV panel to extract the maximum power regardless of solar radiation variations. Fig.15, shows the power generated from both PV and wind sources. From the given results, it can be seen that the power generated is maintained between 5000-13000W which is the same as in the first test (see Fig. 16). In Figure 16, BSS performance under changing random fluctuations 5000 ~ -5000W. BSS is Charge / discharge mode. Figure 18, is proposed Energy management control sends a constant amount of power Load, about 8300W, this is the same. First case (see Figure 09). Finally the figure. 3, indicates DClink Voltage response. This is clear from the reported response. The proposed technique effectively regulates the DC voltage. Therefore, the

Proposed energy management strategy. Validate your goals well, even with random fluctuations Guarantees smooth output power and continuity of operation.

Conclusion

This article introduces a new fractional degree smart PID Controllers are proposed for power management Hybrid energy source connected to the smart grid via Intermediate circuit voltage. Hybrid energy sources also integrated DC micro grid consists of battery bank, wind power Energy and photovoltaic (PV) energy sources. origin Side converter (SCC) is controlled by a new intelligent controller Fractional order PID strategy to maximize power and improve the power quality supplied to the DC-micro grid and Renewable energy sources (wind and PV) and To design a micro grid in the most cost-effective way possible (wind and PV) energy sources are prioritized. Proposed scam the trolled ensures smooth output and continuity of operation. Simulation results of the control method proposed below Mat lab /Simulink is presented and compared nonlinear control. Extensive comparative analysis with Super Twist Fractional Order Control, FOPID and PID as shown in the Table 3, the proposed strategy will generate more power and will appear higher performance and proposed control strategies. From current comparative analysis, proposed controller generates +3.15% wind power, +50% solar powers, +2.5% load power over such as Super Twist

Fractional Order compared to PID control. Focus on future work experimental verification of the proposed controller with a real controller test bench.

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