An Intelligent Microgrid Load Management System

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Abstract— Microgrid could be a small network of electricity users with a neighborhood supply that is typically connected to a centralized national grid. The increasing interest in desegregation of intermittent renewable energy sources into microgrids presents major challenges from the viewpoints of reliable operation and management. This work addresses the problems and challenges in microgrid management and controlling. It first reviews the state-of-art control method and trends followed by a general summary of the controlling principles (e.g., droop management, model predictive management, multi-agent systems, fuzzy logic based approach etc.). This paper next, introduces the microgrid load management for synchronization and controlling of sustainable energy sources like solar , wind turbine, fuel cell etc.

Keywords: Microgrid Load Management System, MATLAB Simulation Model, solar pv subsystem model

I. Current Status of Challenges

In year 2015, a multi agent based DC microgrid and two level management systems for microgrid controlling has been proposed. Two level energy management system includes skilled coordinated management layer and local intelligent management layer. In year 2016, Consensus based distributed voltage control for microgrid control for loading and source side management has been proposed. In year 2017, hybrid AC-DC microgrid system, advance energy storage solar-diesel microgrid, network microgrid for enhanced the power system resilience, modular ICT based energy management system for LVDC microgrid, robust model predictive control for energy management of isolated microgrid, optimum energy management of microgrid via distributed primal dual dynamics for fast frequency recovery was presented. In year 2018, fuzzy logic based energy management system for microgrid has been presented.

All the aforementioned methods have been found to miss the issue of load management based on available sustainable energy sources. Most of these methods covered only conventional energy sources based microgrid controlling.

II. Problem Formulation

Now days the power system is more intricate and more organized. It produces electricity by combustion of fossil fuels like diesel, coal, nuclear fuel, natural gas, etc. This generates injurious particles and gases which spoils environment also reducing the life span. Maximum utilization of sustainable energy sources is required. It is required that the microgrid is well synchronized and balanced and utilize more sustainable energy sources as compared with conventional energy sources.

III. Impact on Society

Penetration of distributed generation across India has not yet reached significant levels. Most emerging technologies such as micro-turbines, photovoltaic, fuel cells and gas internal combustion engines with permanent magnet generator require an inverter to interface with the electrical distribution system. Available microgrids are mostly based on conventional energy sources but less energized by non-conventional energy sources. Ii is required to utilize more of the power from available nonconventional energy sources in place of conventional energy sources. Hence we need to design microgrid which provides major power to connected load intelligently from nonconventional energy sources in place of conventional energy sources thereby making the power systems more environment friendly.

IV. Design Approach and Novelty

A. Block diagram

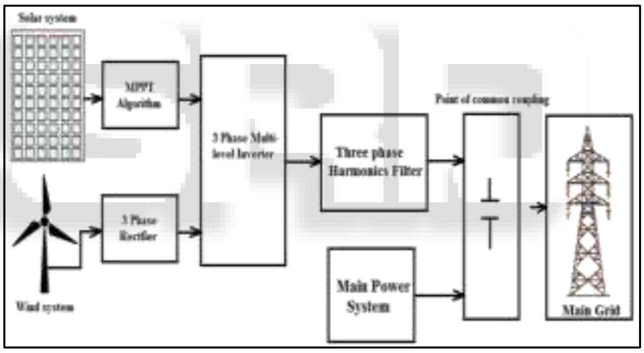

Fig. 1: Block diagram of solar and wind based microgrid

B. MATLAB Simulation Model

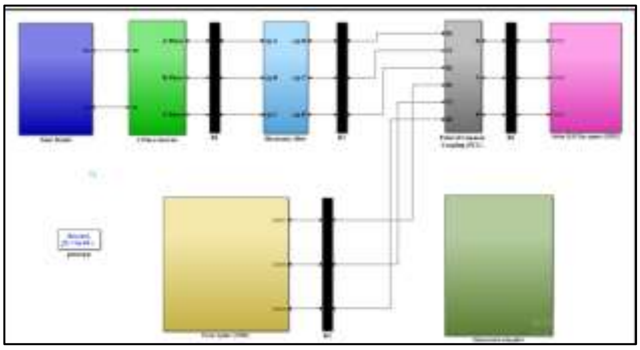

Fig. 2: Proposed matlab simulation model of solar grid connected system

Figure 2 shows the complete matlab simulink model of solar pv grid and wind turbine connected system. Blue block consist of solar pv subsystem model, green color block consists of three phase multilevel inverter with inverter controller subsystem, Light blue color block consists of LC filter for harmonics reduction from inverter output voltage and current. Gray color block consists of coupling transformer, pink color block is three phase infinite grid, yellow color block depicts three phase power system model and dark green color is bus bar measurement subsystem.

Sr No	Name of block	Specification
1	PV Array	Parallel string = 1; Series connected modules per string = 14; Module name = Moser Baer MBPV CAAP BB 245W; Maximum power = 245 W; Cell per module=60; Open circuit voltage (Voc) = 37.77V; Short circuit current (Isc=8.37A; Voltage at maximum power point Vmp (V) = 30.85; Current at maximum power point Imp (A) = 7.79 A
2	PWM IGBT Inverter	Snubber resistance = 5000 Ohm; Number of bridge arm = 3; Ron = 1MOhm
3	LC Filter	Inductor L = 20mH; Capacitor C = 10 mVar

Table 1: Solar PV subsystem MATLAB simulink model parameter specification

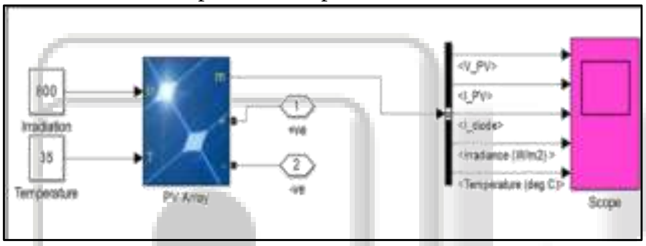

Fig. 3: Solar PV subsystem model

Figure 3 shows the solar PV subsystem model in which solar irradiation and temperature is adjusted. Moserbear MBPV CAAP BB 210 W solar pv panel was selected for this simulation model.

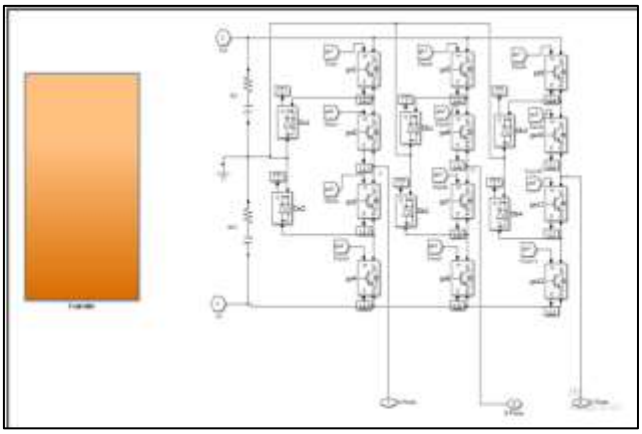

Fig. 4: Inverter model subsystem

Figure 4 shows the 12 pulse diode clap IGBT based multi-level inverter whose input is dc output power solar pv system and output is connected with three phase LC filter. Based on the comparison of different set of pulses, a 12 pulse inverter for three phase sinusoidal synchronized three phase supply generation is selected. (Figure 5).

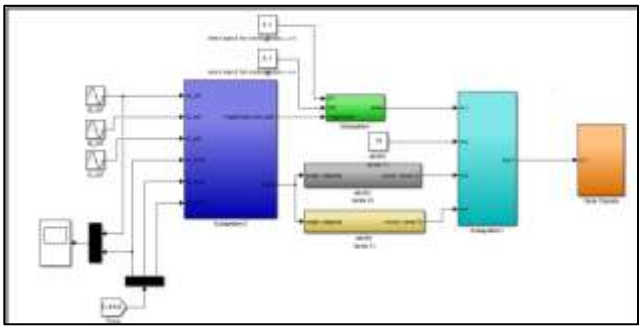

Fig. 5: Inverter controller subsystem model

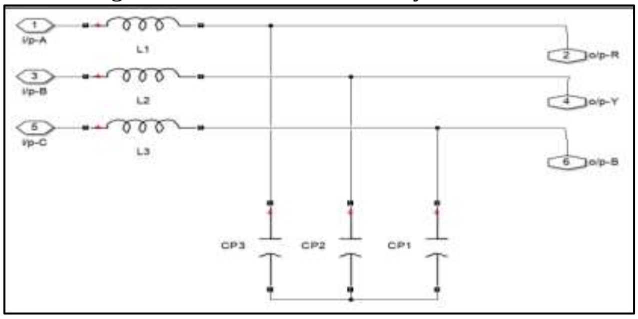

Fig. 6: LC filter for harmonics reduction of inverter output

Figure 6 shows the three phase LC filter in which three phase supply generated from inverter output was purified by removing the third and fifth order harmonics content from inverter output supply. Then after LC filter we get sinusoidal output power which is then fed to the coupling transformer for fed to the power system and infinite bus of power system. Figure 7 shows the coupling transformer which is used for sharing of PV system generated power with infinite bus of grid system.

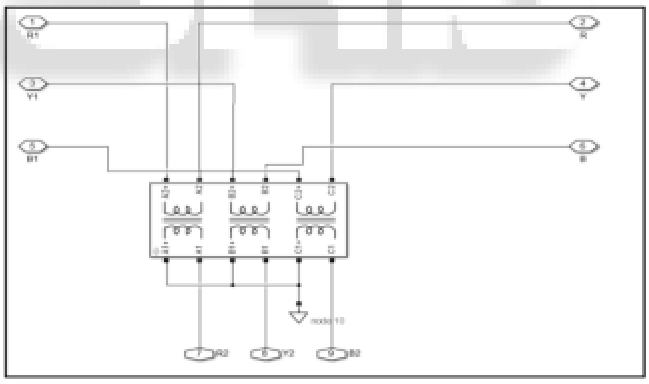

Fig. 7: Point of common coupling for coupling and synchronization of solar and grid system

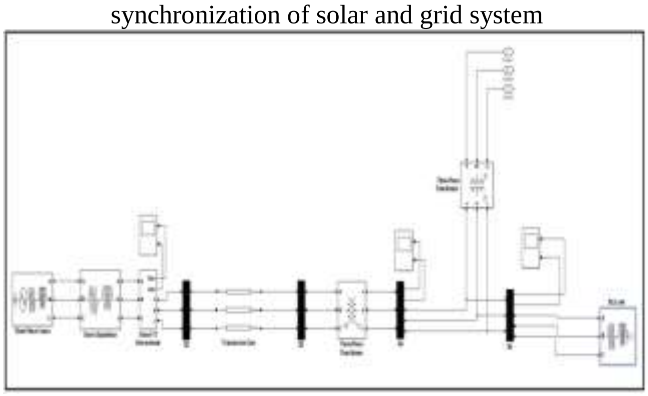

Fig. 8: Power system model connected with solar PV system

V. MATLAB SIMULATION RESULTS

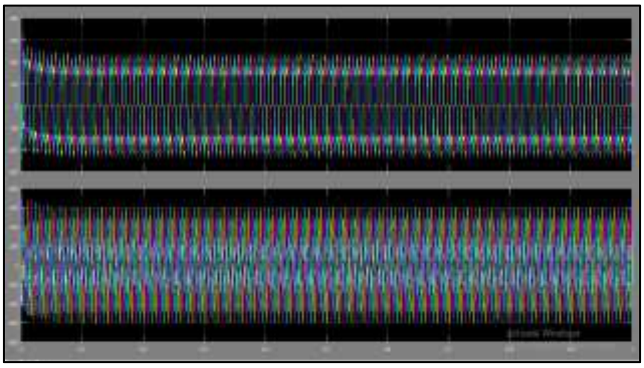

Fig. 9: Bus bar 1 three phase voltage and current waveform after inverter output

Figure 9 shows the three phase voltage and current waveform which is generated after three phase multi-level inverter system. From the waveform it is observed that the voltage and current have so many harmonics content presents but generated three phase supply is perfectly 120 degree apart from each other and having same magnitude.

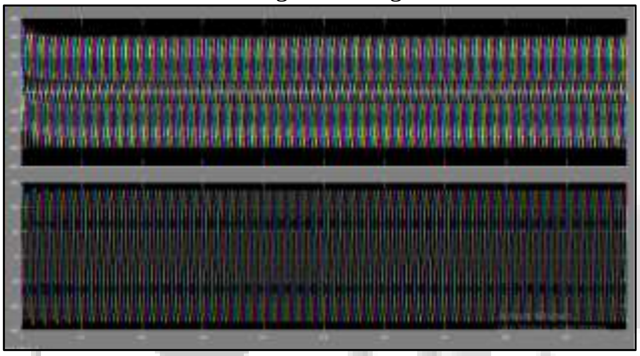

Fig. 10: Bus bar 2 three phase voltage and current waveform after LC filter output

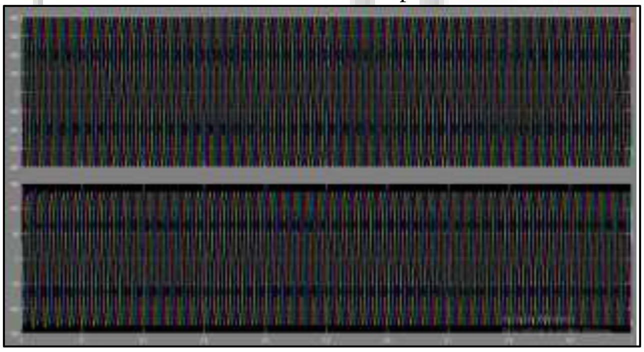

Fig. 11: Bus bar 3 three phase voltage and current waveform after grid connected with solar output (at point of common coupling)

Figure 10 shows the three phase voltage and current waveform after LC filter subsystem in which it is observed that harmonics content present in three phase voltage was completely removed while some small harmonics content was present in three phase current waveform.

Figure 11 shows the three phase voltage and current waveform measured at point of common coupling transformer at which PV generated three supply synchronized with ac grid and power system. It is observed that pure sinusoidal 11kv voltage was generated and synchronized with power system and grid system.

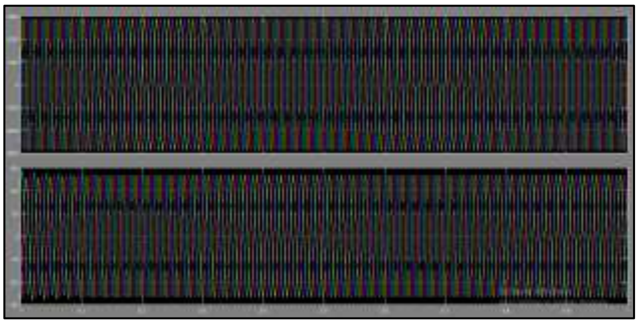

Fig. 12: Bus bar 4 three phase voltage and current waveform at infinite bus system (at power system grid)

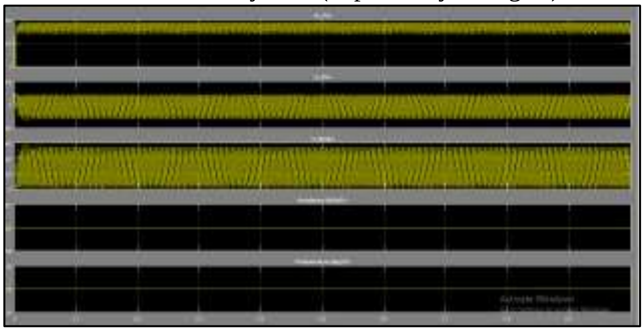

Fig. 13: Solar PV system output DC voltage and current waveform for constant irradiation and temperature condition

Figure 12 shows the three phase voltage and current waveform at infinite bus bar that is grid of power system. It is observed that proposed inverter system exactly synchronized the three phase system with infinite grid system.

VI. CONCLUSION

In this paper, various aspects for control strategies of DC Microgrid are reviewed from the recent research literature. There are some problems addressable by researchers for environment friendly operation of power system. Microgrid is developing as a superlative substitute to encounter the increasing request of reliable, green and clean power.

This paper proposed an idea of green power technology utilizing the non-conventional energy sources as Microgrid, it being the primary phase of upcoming smart grids. Mat lab simulation results show that, the proposed system can be successfully synchronized with the solar pv and wind turbine system and may utilize maximum power from sustainable energy sources as compared with conventional energy sources.

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