Power Management in Hybrid Source DC Microgrid

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Abstract: - Smart-grid proficiency stresses the complex networks of the electricity, it will bring together in future smart infrastructure for power system through dynamics among sources. This research proposes the vital operation of renewable energy sources (RES) like solar photovoltaic (PV), wind energy, fuel cell (battery) with an existing grid of AC and diesel generator as standby, in the interpretation of the cognitive and reliable process of power systems. These sources modeling and simulation is performed for optimal power flow based on power flow chart for demand-side management. The designed system fulfills realistic operation for the power system, based on fundamentals. The constraints are lively for synchronizing of voltage, frequency and waveform at the PCC for grid integration with RES. Also, these are beneficial for the switching of protective devices through remote monitoring and control. Finally, with these features, the developed system testing are conceded for linear, nonlinear and dynamic loading. These results are proximate to the specified tolerance at different universal morals.

Keywords:- Renewable Energy Sources (RES), Photovoltaic, Battery, Smart Grid, Microgrid

I. INTRODUCTION

"A microgrid is a local network of energy. It offers integration of DER with a local load that can be operated with islanding or grid mode to provide flexibility to grid disturbances and high reliability. This distribution system addressed the essential for the application in place with electrical supply and delivery constraint in a remote area and critical load protection economically growth (Myles et al. 2011)" The EU research project has provided the following definition [1, 2]. "A microgrid consists of a distribution network with DER (PV, fuel cells, micro turbine, etc.), energy storage (battery, capacitor, etc.), and loads. This system can be operating autonomously if disconnected or interconnected from the grid. The micro sources operation in the network can provide an advantage to the system performance if correlated and managed efficiently." From the above definitions, a microgrid is a localized grouping of distributed energy resources, loads, and energy storage devices that can be operated in islanding and grid connected mode [3].

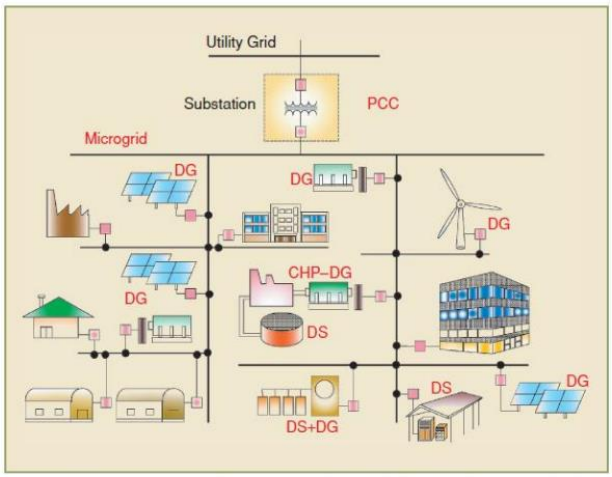

Figure 1: Microgrid Architecture

The microgrid is growing rapidly because of its ability to integrate DG. The development of DG has brought as many problems as it has solved for the distribution system. The main problem of the DG is related to the stability and reliability of the distribution system. So, the interconnection of the distributed generators with the distribution system does not create a microgrid. But it must be well controlled with proper control strategies. It gives rise to the concept of local generation and local control of power in a distribution system that is further named as microgrid [4].

The basic diagram of the microgrid is shown in Fig. 1. Microgrids can improve performance, reduce cost, and improve the efficiency of the power system due to reducing transmission & distribution (T&D) losses. The microgrid can benefit both customers and utility [5]. From the customer's view: Microgrid is a solution to both electricity and thermal needs, and increase local reliability, decrease emission, better power quality by boost up frequency and voltage and low-cost power supply.

II. SOLAR PV STAND-ALONE SYSTEM

In the current time power electronic and electronic hardware are winding up increasingly touchy when contrasted with their partners couple of years back. The hardware which is especially defenseless to this variety or debasement of power quality is the delicate loads. Unadulterated sinusoidal voltage is required for its legitimate task. Alongside the expanded affectability of

the gear, the developing affectability of organizations towards the creation loss on account of diminishment in the edge of benefit has likewise included to the weight the nature of power. From ages power has been considered as an essential right in the household life and it will dependably be there. Because of this very reason even a little intrusion in the supply prompts overwhelming grievances, regardless of whether no harms are identified with it.

Tripping of the electrical equipment on account of aggravations in the supply voltage is as often as possible depicted by customers as "horrendous power quality". Then again utilities regularly observe agitating impacts on account of the end customer hardware as the standard power quality issue. The inconvenience in assessing power quality concerns is elucidated by the method for interaction among the nature of power and the gear. What is "incredible" power quality for one gear could be "terrible" power for another. Two unclear gear may react differently to a similar power quality parameters due to contrasts in their gathering. Present day electronic gear isn't in charge of voltage agitating impacts; it moreover causes aggravations for various buyers. The principle guilty party behind this poor power quality is the utilization of power electronic devices that are for the most part the gear driven by converters and rectifiers like PC, speed drives and so forth that acts as non-direct load.

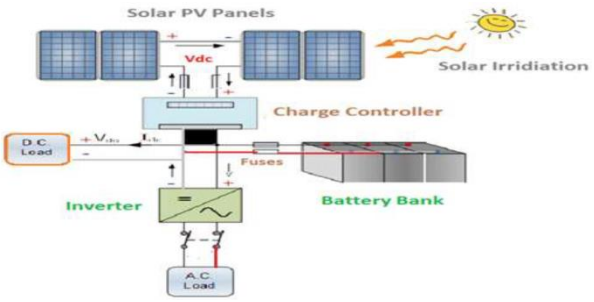

Fig. 2: Solar PV stand-alone power system

III. SMART GRID

Renewable energy sources use to generate green energy for reduce environment pollution problem. In this work build a PV system that is transmit a power to the grid. A grid connected photovoltaic system is becoming increasingly important for the solution in renewable energy. Various types of inverter have been proposed for PV grid connected application such as multilevel inverters, current source inverter, voltage source inverter and etc. In this block diagram shows PV to grid connected system. This work processed in two stage where, stage one is the DC-DC boost converter with MPPT (Maximum power point) tracking and second stage is the five-level inverter. For this stage proposed a new five-level inverter topology which is reduce the switched count and other parameters. After this stage levelled output passes through designed LCL filter which gives AC output and connected to grid.

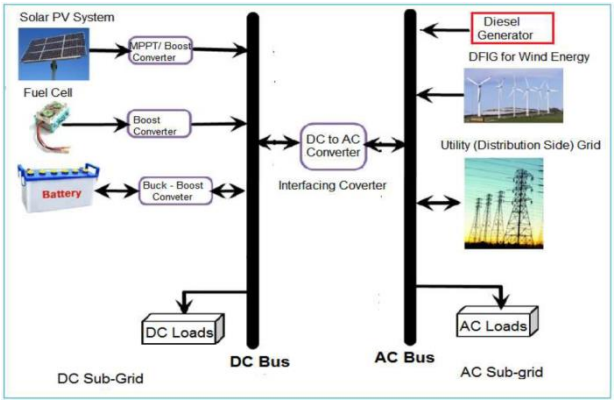

Fig.3: RES for grid integration

The day-ahead load shifting technique proposed in this paper is mathematically formulated as a minimization problem.

A heuristic-based evolutionary algorithm that easily acclimatizes was developed for solving this minimization problem and simulations were carried out on a smart grid which contains a variety of loads in three service areas, one with residential customers, another with commercial customers, and the third one with industrial customers. The simulation results show that the DSM strategy achieves substantial savings, though reducing the peak load demand of the smart grid.

The advanced measurement system based on synchro phasors was also implemented using DAQs real-time synchronous data. The developed system features a wide variety of competences such as online system parameters calculation and online voltage stability monitoring. These are implemented as an experimental case to improve WAM. Furthermore, the protection system was designed inside of the real-time software environment to monitor the real-time wide area data, and make a comprehensive and reliable coordination for the entire system and ideas related to the communication of a dc microgrid involving sustainable energy sources with the main ac grid have been also implemented and presented. The implemented system is obvious and possible in any research laboratory and for real-time real-world smart grid systems.

Various literature and publications on the topic of the thesis are discussed in the preceding section to recognize and describe the possibility of the research work. In this section scope, aim and objectives of the research involvement are defined.

The first part of the literature shows that the setting or spread of the grid interconnection with individual or multiple RES has certain challenges like:

- Providing the screening applications for power system parameters
- The power flow solution
- Multi-phase analysis
- Circuit model size
- Harmonics
- Determining the value of DG

- Modeling sub-transmission
- Assessing distribution reliability
- Loss analysis
- Protective device coordination

IV. METHODOLOGY AND RESULTS

The RES with modern authenticity is imparting for grid integration as a portion of a smart grid. In this chapter, expertise for RES like solar PV, wind energy, along with storage battery (fuel cell) with advanced features of grid integration is applied for monitoring and control of power system parameters. The system behavior is controlled by DSP as per the requirement of load and in which energy is supplied through RES with grid interconnection.

Technologies have been developed to harness this energy to fulfill this demand. These sources were individually used to supply the load. Each source has its own set up to harness energy convert into electricity and supply to the load. But the drawback of such a method is that they are not reliable and load get often interrupted which causes varieties of problems. To overcome the discussed difficulties the DSP controller has been adopted to take into consideration various energy sources. These can generate and supply an uninterrupted approach through a designed three-phase inverter. The algorithm has been developed for transit between the energy sources as per their availability such as harness the maximum amount of energy generated from RES.

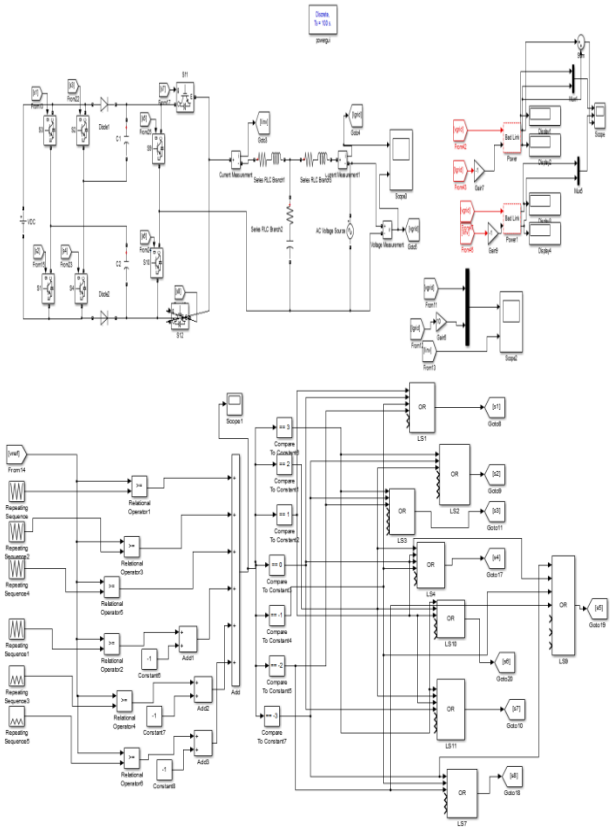

Fig.4: Simulation Model of Proposed Methodology

A grid connected photovoltaic system is becoming increasingly important for the solution in renewable energy. This work proposed as a PV to grid connected system.

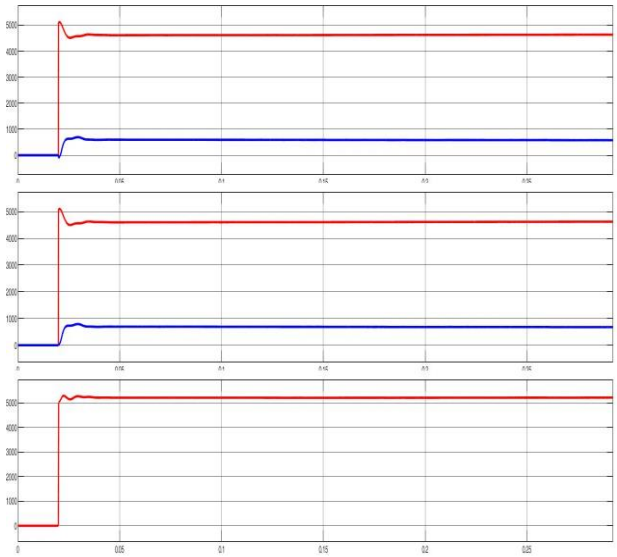

Fig. 5: PV power and current with respect to voltage

This work processed in two stage where, stage one is the DC-DC boost converter with MPPT (Maximum power point) tracking and second stage is the five-level inverter. For this stage proposed a new five-level inverter topology which is reduce the switched count and other parameters. After this stage levelled output passes through designed LCL filter which gives AC output and connected to grid.

Maximum PV output voltage is set to 290 according to the PV module and this voltage has approximately 50V peak to peak ripple. This high voltage ripple can damage a system and reduces the efficiency also increases the losses of the system. DC voltage of the PV output shown in fig. 6.

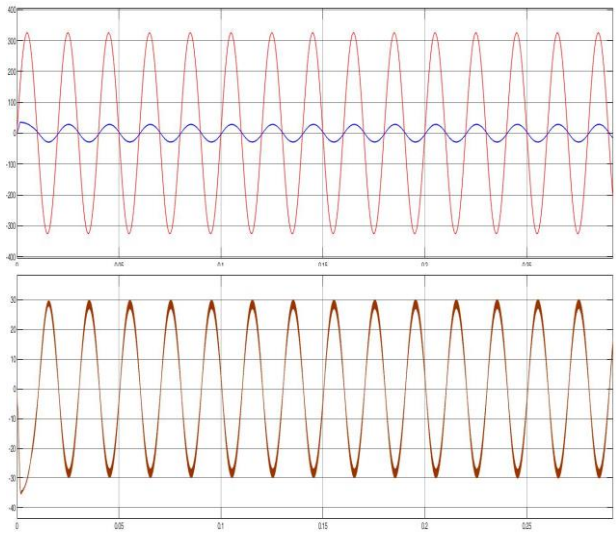

Fig. 6: Output Waveform of grid Voltage, grid Current and inverter Current

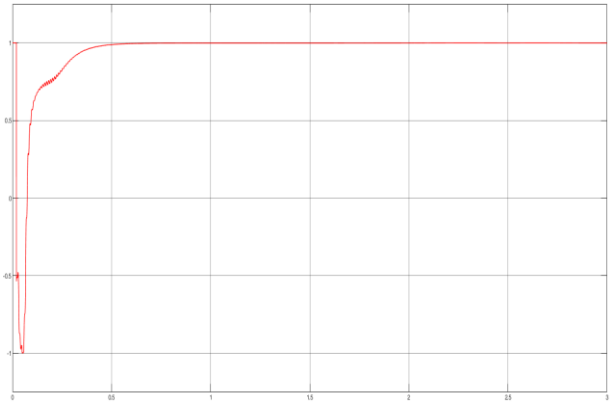

Fig. 7: Unity Power factor at the grid side

Power quality describes the importance of the issues found in any electrical system; these issues are depended on the perspective of the end-user network. But it is repeatedly detected that there is a deviation in sinusoidal voltage and current waveforms. This distortion is nothing but the harmonics and the reason for the concern at different stages in electrical power systems. This harmonic distortion affects different electric machines, telecommunication systems, etc. Non-linear loads keep on adding to harmonics and the most widely used non-linear loads are power convertors, speed control of motors, transportation systems, and domestic appliances. After a certain level, reactive impedance of the system form tank circuit with the inductive reactance of the system at the resonant frequency which gives rise to the large currents.

V. CONCLUSION

The smart grid distribution system developed through power electronics will support to utilize RES and operate in an automated way. The whole configures both communication network and power line network has successfully achieved in session to work in the mode of master-slave towards the fulfillment of dynamic loading on demand-side management.

Hence it is concluded that the proposed designed and developed pilot model shows consistency in the results and having the evidence of successful integration of RES into the grid thus called Smart Grid. It is expected that when a large scale RES integrates is future of the world large scale development of this pilot model will be, an integrated part for all smart grid operation purposes. The simulation results shows that the standard deviation of the utilization factors of the inverters with the proposed approach is significantly less than that achieved with conventional Proportional Nominal Apparent Power Sharing (PNAPS) method.

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