Power Quality Control To Grid Connected Operation For Distributed Generation In Multiple Stages

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Abstract*- In recent years there has been a growing interest in moving away from large centralized power generation toward distributed energy resources. Solar energy generation presents several benefits for use as a distributed energy resource, especially as a peaking power source. This study presents a control strategy for managing power delivered to, or absorbed from, the grid, independent of local load or grid characteristics. To achieve this objective, the strategy requires the use of three levels of control structures. The first is related to phase-locked loop and grid-tie algorithms, which are employed to minimize disturbances during the grid connection. The second, which produces voltages with reduced harmonics levels at the distributed generation (DG) terminals, comprises the cascade voltage and current control. The third structure is the active and reactive power control mechanisms, adjusting of the DG voltage amplitude to keep the power flow through the grid at a specific set-point, independent of local load characteristics. In addition, the power control structures have to operate in a decoupled operation mode, whereby the active power control has to be faster than the reactive power control, or vice versa. In terms of their physical structure, a passive LCL filter is used to connect the voltage source inverter to the grid. To verify the findings and observations discussed in this study, a set of simulations results are presented.*

I. INTRODUCTION

The use of distributed generation (DG) sources is currently being evaluated as a solution to the problems of energy demand. DG systems based on renewable energy sources have played a key role in helping solve global energy production problems, due to their low environmental impact and technical advantages such as modular implementation. The use of non-linear loads such as variable-speed drives, light-emitting diode lamps, and compact fluorescent lamps, however, degrade the DG power quality. As a result, recent studies in DG have offered solutions which use power structures as a filter or as a DG system in order to improve power quality and re-inject the extra power into the grid, while in the phase-locked loop (PLL) algorithm method is used to adjust the P + R coefficients

A smaller number of studies address independently-controlled terminal voltage, where the DG is in grid-tie or stand-alone operation mode. In this evaluated an alternative structure, where the power flow is determined by regulating the amplitude of the DG system. In addition, these systems do not use closed-loop power control to determine the exact level of power to be transferred to the grid. They are also unable to produce voltages with reduced harmonics levels in the presence of non-linear loads, or make a dynamic adjustment of the resonant controllers in grid-tie operation. Based on the droop method control technique, which adjusts the DG terminal voltage amplitude and frequency according to the active and reactive powers delivered to, or absorbed from, the grid.

Conventional methods such as this, however, have several drawbacks that limit their application, such as slow transient response, the trade-off between power-sharing accuracy and deviations in the frequency and voltage, plus a high dependency on the DG output impedance. A voltage source inverter (VSI) is connected to the local load. Although the proposed a similar physical structure, the local load is inserted after the LC filter, where the latest L inductor is used only as a coupling between the grid and the DG system. As a result, the local load connection after the LC filter avoids distorted the current flow to and from the grid when a suitable control structure is used to produce voltages at the point of common coupling (PCC). Accordingly, this paper presents a different method for managing active and reactive powers through the grid. To achieve this goal, a power control analysis is proposed in order to obtain (a) the active and reactive power plants used to design the power controller; and (b) a general evaluation method to determine system behaviour when fast variation is imposed on the grid frequency and voltage, and the terminal voltage of the DG. To dynamically adjust the resonant controller coefficients, and reduce stability drawbacks during the DG connection to the grid, the PLL and grid-tie algorithms are employed. If islanding occurs, the voltage control continues to produce voltages at the DG terminals, while the power flow through the grid must be adjusted to zero.

II. DISTRIBUTED GENERATION

Distributed generation (DG) or decentralized generation is not a new industry concept .Centralized power generation became possible when it was recognized that alternating current (AC) electricity could be transported at relatively low costs with reduced power losses across great distances by taking advantage of the ability to raise the voltage at the generation station and lower the voltage near customer loads. In addition, the concepts of improved system performance (system stability) and more effective generation asset utilization provided a platform for wide-area grid integration. Recently, there has been a rapidly growing interest in wide deployment of distributed generation, which is electricity distributed to the grid from a variety of decentralized locations. Commercially available technologies for distributed generation are based on wind turbines, combustion engines, micro- and mini-gas turbines, fuel cells, photovoltaic (solar) installations, low-head hydro units, and geothermal systems. Deregulation of the electric utility industry, environmental concerns associated with traditional fossil fuel generation power plants, volatility of electric energy costs, federal and state regulatory support of “green” energy, and rapid technological developments all support the proliferation of distributed generation in electric utility systems

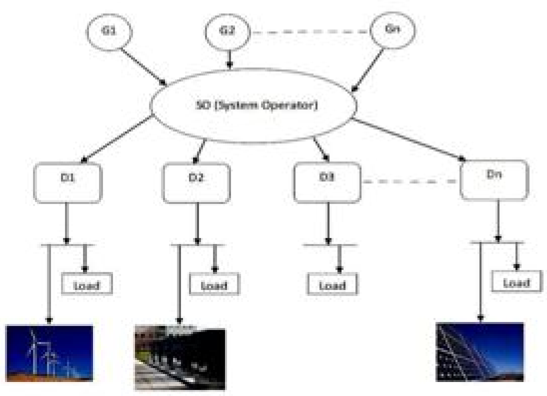

Fig1.Distributed generation

Solar photovoltaic

These systems are environmental friendly without any kind of emission, easy to use, with simple designs and it does not require any other fuel than solar light. PV systems generate DC voltage then transferred to AC with the aid of inverters

Control structures

Three levels of control structures are presented in the general diagram in Fig. 1. The first is related to the grid-tie and PLL algorithms used to track the DG and connect it to the grid. The second level is the cascade voltage and current control used to synthesise voltages with reduced harmonics levels when the local load is non-linear or unbalanced. To improve the capability of the voltage control, a set of resonant controllers with dynamic adjustment of the coefficients is used to reduce the DG system impedance at specific frequencies. The third level is the power control structure used to define the exact amount of power that will be transferred to, or absorbed from, the grid.

PLL Algorithm

To connect the DG to the grid, both system must be synchronised. This is achieved by means of PLL algorithm

GRID-TIE Algorithm

The application of this algorithm to ensure a safe connection between the DG and the grid. In order to achieve this connection, the DG and grid voltages must be synchronised (in-phase) and have the same amplitude. In general, the algorithm has a simple operation mode. Initially, the rms value of the grid and DG voltages are computed. Subsequently, the PLL algorithm is executed to obtain the synchronisation frequency, in which the average WPLL international power quality standards, and the static relay is off, a timer is incremented. When the timer achieves a specific value (tmax) the relay is turned on, which connects the DG to the grid. If the test conditions are beyond the limits or the relay is closed, the algorithm then returns and starts again, and a new evaluation of the system conditions is performed.

III. SIMULATION RESULTS

In this project we use MATlab for simulation Fig 2 shows the overall model in which Solar model(DG) is connected with DC to DC converter to improve the voltage. And it connected with grid tie inverter which controls PLL based voltage regulation control. And in order to remove the variation in voltage and current due to variable input(irradiance) we are using Shunt Active Compenstation. And in order to reduce the reactive power at load end we are using series active filter.The fig 3. Shows the IV and PV characteristics of PV module with respect various irradiance at the input. The fig 4. Shows the output voltage and current of solar module (DG) with respect to variable input to its input to produce a variation in the output voltage. The fig 5. shows the voltage and current in the grid after us adding shunt active filter. The SHAF is used to make a Fig 6. shows the Active and Reactive power before series active filter in which reactive power is high Fig 7. shows the Active and Reactive power after series active filter in which reactive power is low compared with Fig 6. And Fig 8. shows the output voltage and current of at load point and from the it is clear that the power factor at load point is nearly unity. The Fig 9 and 10 shows the FFT analysis output of load voltage and current. The THD of load voltage and current is approximately less than 2.5%.

IV. METHODOLOGY

In this project we are using four stages of control and in the first stage of control we are using PLL and grid tie algorithm to eliminate distraction in the line. And in next stage we are produce the voltage in the line using compensation devices. And in the next stage we are providing active and reactive power compensation. And finally with the help of LCL and VSC we connect it to the grid.

V. CONCLUSION

In this project the power quality of a grid connected distribution generation is improved. The solar PV is used as a Distributed Generation and it connected with grid with three stages of compensation. The voltage fluctuation is controlled by shunt compensation and grid tie inverter. And the active and reactive power is controlled by series compensation. The system is constructed in MAT lab Simulink tool and based on its result we propose that its output is better than the previous way of compensation. And from the results it is clear that output voltage and current are not varying and Reactive, active power are reduced. And also power factor is also unity the THD is 2.5%.Form the above statement and results i conclude the power quality of the system is improved by using proposed way of controlling.

Output waveforms

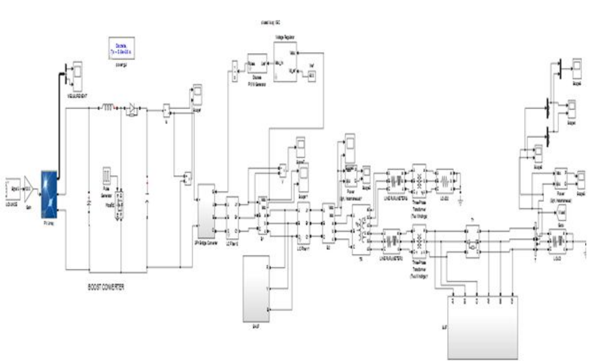

Fig 2. Over all simulation model

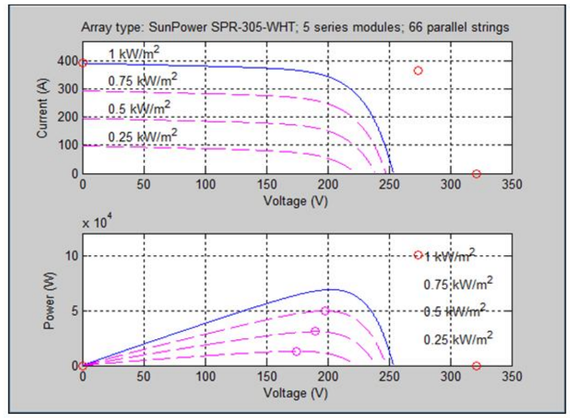

Fig3. IV & PV characteristics of solar PV

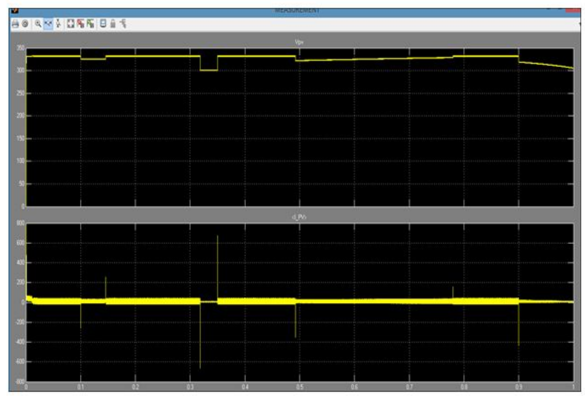

Fig 4. Solar output voltage and current

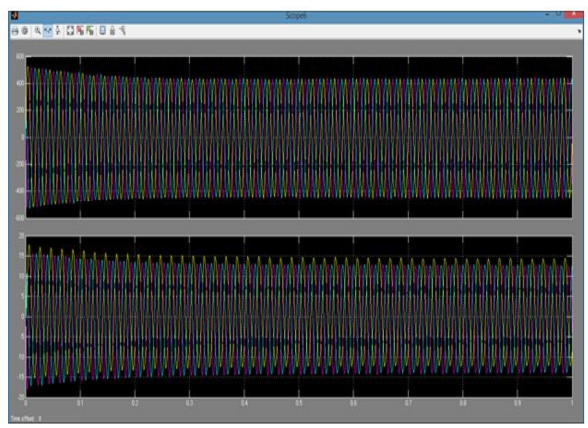

Fig 5.Voltage and current after SHAF

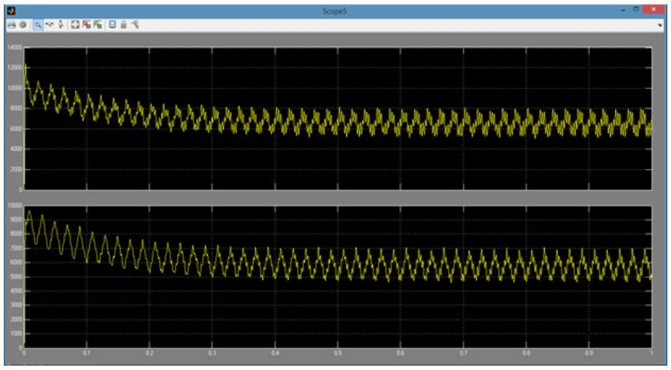

Fig 6. Active and reactive power before SEAF

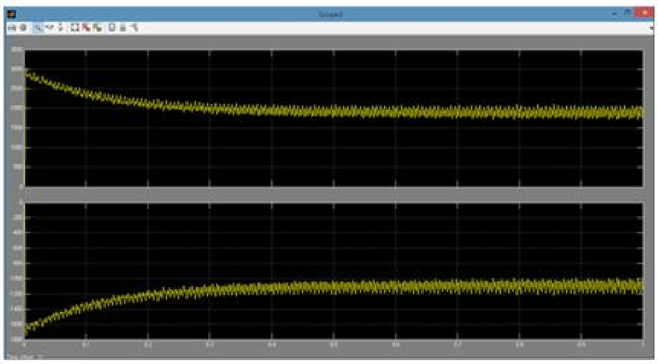

Fig 7. Active and reactive power after SEAF

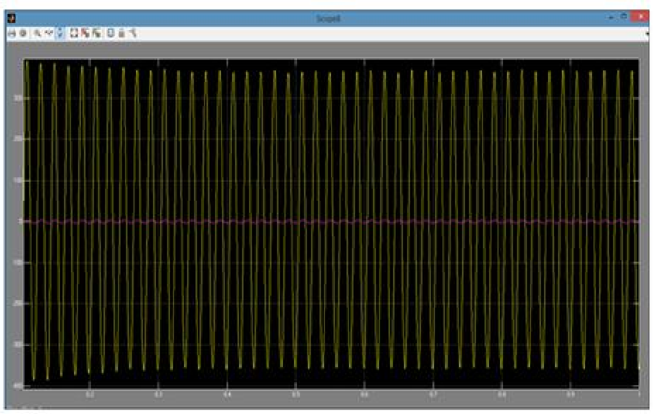

Fig 8. Voltage and current at load point

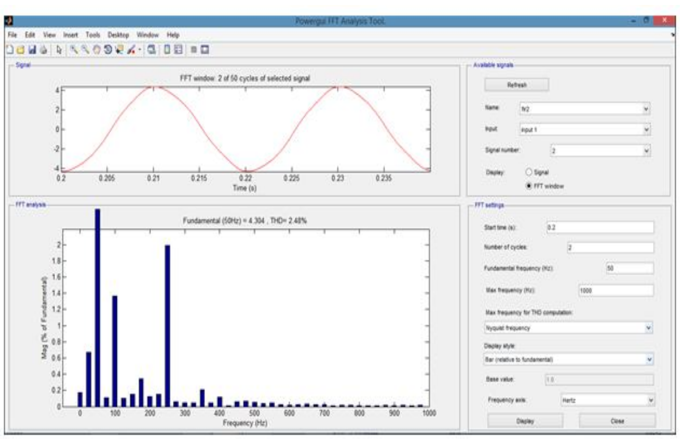

Fig 9.THD of voltage

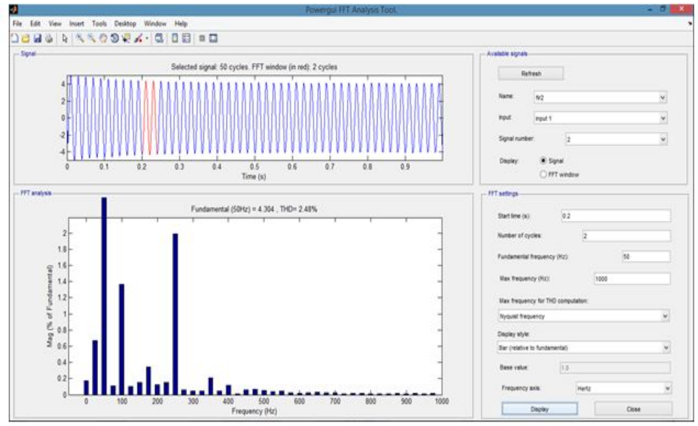

Fig 10. THD of current

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