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Study on Voltage Controlling Techniques In Grid Connected PV System

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ABSTRACT

The energy is the very important parameter for survival or today's growth we can transfer the energy from one form to other. The mainly wind and solar energies are the most available among other renewable energy sources in all over the world. In the present years, because of the rapid advances of power electronic systems the production of electricity from wind and photovoltaic energy sources have increased significantly. This paper proposed hybrid system is using of controlling power.

Keywords: Grid Integration, PV Cell, controller.

I. INTRODUCTION

Worldwide renewable energy resources, especially solar energy, are growing dramatically in view of energy shortage and environmental concerns. Large-scale solar photovoltaic (PV) systems are typically connected to medium voltage distribution grids, where power converters are required to convert solar energy into electricity in such a grid-interactive PV system. To achieve direct medium-voltage grid access without using bulky medium-voltage transformer, cascaded multilevel converters are attracting more and more attraction due to their unique advantages such as enhanced energy harvesting capability implemented by distributed maximum power point tracking (MPPT), improved energy efficiency, lower cost, higher power density, scalability and modularity, plug-N-power operation, etc.

Although cascaded multilevel converters have been successfully introduced in medium- to high-voltage applications such as large motor drives, dynamic voltage restorers, reactive power compensations, and flexible ac transformation system devices, their applications in PV systems still face tough challenges because of solar power variability and the mismatch of maximum power point from each converter module due to manufacturing tolerances, partial shading, dirt, thermal gradients, etc. In a cascaded PV the output voltage from each converter module in one phase leg, which must fulfill grid codes or requirements, synthesizes system the total ac output voltage. Ideally, each converter module delivers the same active power to grid; hence, symmetrical voltage is distributed among these modules. In serious scenario, the synthesized output voltage may not be enough to meet the system requirement. As a result, the active power mismatch may not only result in losses in energy harvesting but also system instability and unreliability due to the inadequate output voltage or over modulation issues.

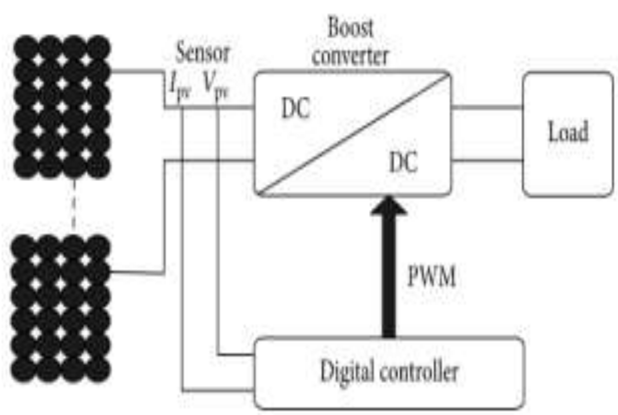

Figure 1 Block Diagram of PV Generation System

II. LITERATURE REVIEW

YeqinWang et al. [1] In this paper, a bounded-voltage power flow control is proposed for grid-tied PV systems with the improvement of the existing UDE-based robust power flow control to provide AC voltage protection. With the bounded-voltage design, the output voltage of the DC/AC converter always stays within the given range, which avoids the integrator windup caused by the saturation unit with the inappropriate setting of reactive power reference. Both simulation and experimental results are provided to demonstrate the effectiveness the proposed strategies. An uncertainty and disturbance estimator (UDE)-based robust power flow control for grid-tied DC/AC converters was reported in the literature to achieve accurate power delivery in the presence of various types of model uncertainties and external disturbances.

Beibei Ren et al. [2] In this paper, a new control structure is proposed for grid-tied photovoltaic (PV) systems where the dc bus voltage is regulated by the dc/dc converter controller, whereas the maximum power point tracking (MPPT) function and the power flow control are embedded into the dc/ac converter controller. A PV voltage-regulation is designed to build the linkage between MPPT function and power flow control. In this way, the dc/dc converter controller and the dc/ac converter controller are decoupled, which naturally provides the dc bus voltage protection. In particular, an uncertainty and disturbance estimator (UDE)-based current-mode controller (CMC) is proposed for accurate voltage regulation of the dc/dc converter. And a bounded-voltage power flow control strategy is proposed for the dc/ac converter to improve the existing UDE-based robust power flow control for ac voltage protection. The effectiveness of the proposed method is experimentally validated in a lab-environment grid-tied PV system platform with the fault ride-through capabilities. In addition, simulation studies are also provided to demonstrate the need of the PV voltage-regulation between MPPT and power flow control, and the advantages of the bounded-voltage design in the power flow control.

Deo, S et al [3] this paper proposes a single-phase double-stage scheme for grid interfaced load compensating solar photovoltaic (PV) generating system. The scheme serves twofold objectives of alleviating power quality issues such as power factor correction and harmonics mitigation, while simultaneously extracting the maximum power generated by the PV unit. A simple notch filtering control algorithm is designed to facilitate extraction of the real component of load current, exempting the services of a phase locked loop (PLL). The absence of a PLL reduces the system dependence on the proportional-integral (PI) controller tuning, which in turn improves the dynamic response and makes the system quite robust. The proposed solar PV generation system retains its ability of mitigating harmonics on cloudy days and also provides opportunity for night time utilization of available resources.

Qing-Chang Zhong et al. [4] In this paper, an uncertainty and disturbance estimator (UDE)-based robust power flow control is developed for grid-connected inverters to achieve accurate power delivery to the grid. The model of power delivering with both frequency dynamics and voltage dynamics is derived at first. The UDE method is introduced into the controller design to deal with model uncertainties (e.g., output impedance and power angle), coupling effects, and external disturbances (e.g., the fluctuation of the dc-link voltage, the variation of output impedance/line impedance, and the variations of both frequency and amplitude in the grid voltage). Also, this controller does not need a voltage regulator or a current regulator and is easy for the implementation and parameter tuning through the design of the desired tracking error dynamics and the UDE filters.

Jie Liu et al. [5] This paper addresses these issues, explores the effects of reactive power compensation and optimization on system reliability and power quality, and proposes coordinated active and reactive power distribution to mitigate this issue. A vector method is first developed to illustrate the principle of power distribution. Accordingly, the relationship between power and voltage is analyzed with a wide operation range. Then, an optimized reactive power compensation algorithm (RPCA) is proposed to improve the system operation stability and reliability, and facilitate MPPT implementation for each converter module simultaneously. Furthermore, a comprehensive control system with the RPCA is designed to achieve effective power distribution and dynamic voltage regulation. Simulation and experimental results are presented to demonstrate the effectiveness of the proposed reactive power compensation approach in grid-interactive cascaded PV systems.

Aneesh S.L et al. [6] this paper solves the issue and proposes improved PV system with cascaded modular multilevel converters using FLC in DC-DC converter controller. A newly derived vector diagram is used to find the relation between output voltage component of each module and power generation which illustrates the proposed power distribution principle. Index Terms—cascaded photovoltaic (PV) system, power–voltage distribution, and the reactive power compensation, unsymmetrical active power.

III. REACTIVE POWER COMPENSATION

Reactive power compensation is defined as the management of reactive power to improve the performance of alternating-current (ac) power systems. In general, the problem of reactive power compensation is related to load and voltage support. In load support the objectives are to increase the value of the system power factor, to balance the real power drawn from the ac supply, to enhance voltage regulation, and to eliminate current harmonic components produced by large and fluctuating nonlinear industrial loads. Voltage support is generally required to reduce voltage fluctuation at a given terminal of a transmission line. Reactive power compensation in transmission systems also improves the stability of the ac system by increasing the maximum active power that can be transmitted.

IV. REACTIVE POWER COMPENSATION PRINCIPLES

There are two ways of the implementation of the reactive power compensation: series connection or parallel (shunt) connection. Parallel connected systems are generally used for reactive power compensation and to filter current harmonics whereas serial connected systems are used to filter voltage harmonics, voltage regulation and harmonic isolation.

A. Shunt Compensation

The shunt compensation system can be developed basically with a voltage source, nonlinear load and a shunt connected power system.

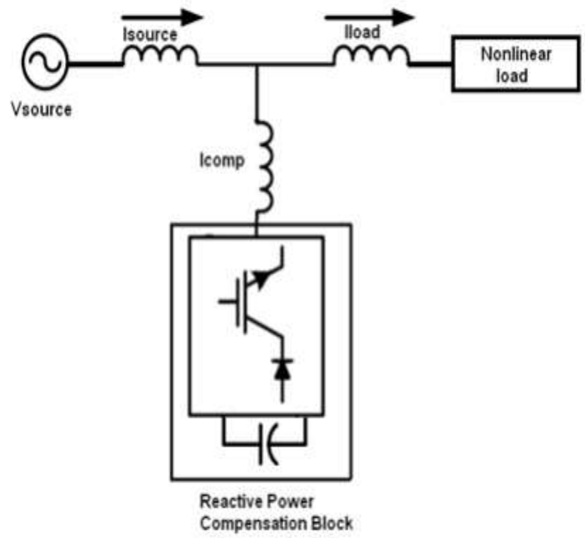

Figure 2 Parallel (shunt) connection

In this system, if the nonlinear load is inductive load, the power system need reactive power for precise operation as a consequence this demand should be delivered by the voltage source. By connecting the shunt system, compensating current (Icomp) is injected with opposite direction at equivalent magnitude to the system and hence the reactive current of the load is compensated, voltage regulation is improved and the unity power factor can be reached.

B. Series Compensation

The series compensation system can also be developed basically with a voltage source, nonlinear load and a series connected power system.

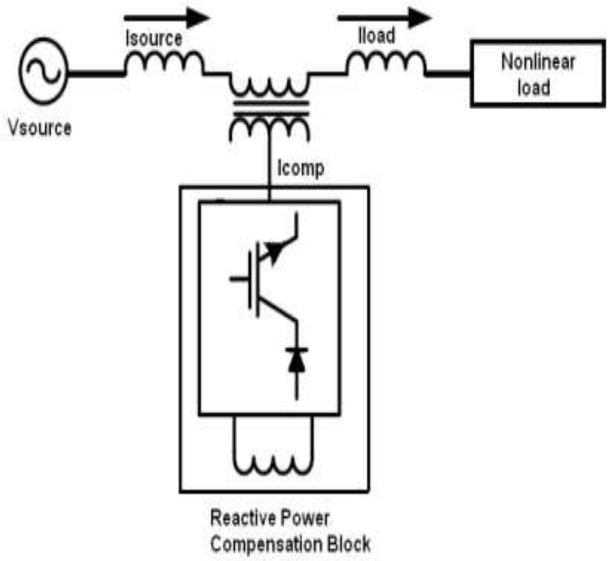

Figure 3 Series connection

C. Grid Interface Topology of SOFC

Fuel cells are electrochemical energy conversion devices similar to batteries. They generate variable and low output voltage (current). Thus, they are unable to connect to the utility directly. However, they can be interfaced and can supply power to the utility by means of power electronic converters system integration of fuel cell and power electronics unit which comprises of a solid oxide fuel cell stack associated with a DC –DC converter and a widely used DC–AC pulse width modulation (PWM) inverter with RL output filter connected to the utility grid. In this chapter of the work, the case of a SOFC based DG connected to a grid is considered wherein the capacity of power supply by the DGs is less than the load demand i.e., the active power demand of load is more than DG capacity and hence grid and DG both will supply active power to the load. Thus, in this mode of operation a certain amount of power is scheduled to the load from the fuel cell DG and remaining power to load is supplied from the utility grid.

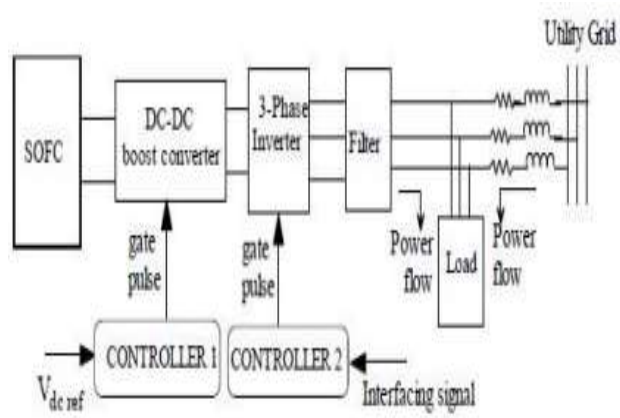

Figure 4. Schematic diagram of grid connected DGs

The DGs autonomously operate with load until it reaches the steady-state. The phase difference between the DGs output voltage and the grid voltage decreases until the DGs output voltage is in phase with the grid voltage. After the DGs output voltage is synchronized with the grid voltage, the grid is connected to DGs and then the grid starts providing electric power to the load. There are various control strategies for interfacing DGs to the distribution system. The DG is operated either to control DG output current, active power and voltage at the point of common coupling (P-V mode) or active and reactive power output of DG.

V. CONTROL SYSTEM FOR GRID-CONNECTED PV SYSTEMS

Grid-connected PV systems need a power-conditioning unit to be connected between the PV array and the grid. These systems are designed to operate in parallel with the grid .An MPPT scheme, the power converter, the grid interface, and the control system compose the power conditioning. For grid-connected PV applications, the control system is designed to obtain a good performance of the PV system with maximum power point operation and low total harmonic distortion of the grid current with unity power factor on the grid side. The MPPT scheme finds the voltage or current at maximum power point at which the PV array should work to extract the maximum power despite the atmospheric conditions. The power converter changes the DC current generated by the PV array to AC current. In the two-stage topology, a DC-DC converter generally performs the MPP operation and sometimes voltage boosting, and a DC-AC converter changes the DC current to AC current with unity power factor for grid-connected systems. In a single-stage topology, a DC-AC converter is utilized to track the MPP, to change the DC current generated by the PV array to AC current, and to control the active and reactive power supplied to the grid. The grid interface is utilized to filter the high frequency components of the AC inverter current and obtain an AC current with low total harmonic distortion to be injected into the grid.

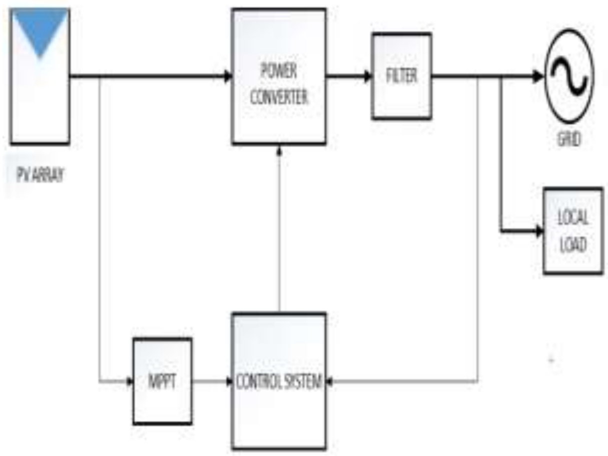

Figure 5: diagram of grid-connected PV systems

VI. CONCLUSION

In grid-connected mode, the voltage and frequency are controlled by the grid. Thus, the DG units are controlled to provide a specified amount of real power depending upon the rating of the units. A control strategy has been discussed using artificial intelligence methods to control the active and reactive powers independently from the hybrid system.

This paper has provided a review of challenges and opportunities for integrating solar PV and wind energy sources for electricity generation. The main challenge for the grid-connected system as well as the stand-alone system is the intermittent nature of solar PV and wind sources.

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