IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

"WEAK GRID INTEGRATION OF A SINGLE STAGESOLAR ENERGY CONVERSION SYSTEM WITH POWER QUALITYIMPROVEMENT UNDER DIFFERENT OPERATING CONDITIONS"

Ms. TANJORE RAMESH CHANDNI, ASSISTANT PROFESSOR (Department of Electrical and Electronics Engineering, RVR&JC College, Chowdavaram, Guntur, India)

Mr. POTHUGANTI SHAKEEM MOULALI (Department of Electrical and Electronics Engineering, RVR&JC College, Chowdavaram, Guntur, India)

Mr. MADINA JITENDRA (Department of Electrical and Electronics Engineering, RVR&JC College, Chowdavaram, Guntur, India)

Mr. KAPPI NITHINTEJA (Department of Electrical and Electronics Engineering, RVR&JC College, Chowdavaram, Guntur, India)

Ms. KUNCHAPU MARY (Department of Electrical and Electronics Engineering, RVR&JC College, Chowdavaram, Guntur, India)

Abstract: A three-phase single-stage solar energy conversion system (SECS) integrated into a weak distribution network is presented. The grid integration and maximum powerpoint operation of the photovoltaic (PV) array are achieved by a voltage source converter.The SECS is capable of feeding distortion-free and balanced grid currents with power factor correction, even at adverse grid side, PV array side, and load side operating conditions. The integration of SECS into the weak grid having distorted, unbalanced, and varying grid voltages is achieved while maintaining the power quality. The DC offsetintroduced in the sensed grid voltages is also effectively eliminated. For swift system response to changes in load currents, their fundamental weights are swiftly extracted. In the absence of solar irradiance, the power is imported from the utility to supply the local loads, and the system continues to execute its power quality improvement functions. In case of loss of PV power or large voltage deviations, the DC-link voltage isadaptively varied according to the grid voltage changes, increasing system reliability, and reducing operating losses. The efficacy of the SECS is validated through test resultsin different operating scenarios.

Index Terms **-Matlab, solar panels, energy storage system, grid interface equipment, power quality improvement, control and monitoring systems, communication system**

I. INTRODUCTION

Electric power quality may be defined as a measure of how well electric power service can be utilized by customers. When wave shapes are irregular, voltage is poorly regulated, harmonics and flicker are present, or there are momentary events that distort the usually sinusoidal wave, and the power utilization is degraded. This is referred to as the degradation of power quality. Custom power devices are increasingly being used in custom power applications. The widespread use of high-power semiconductor switches at the utilization, distribution, and transmission levels has made non-sinusoidal load currents more common. Power quality is certainly a major concern in the present era; it becomes especially important with the introduction of sophisticated devices, whose performance is very sensitive to the quality of the power supply. Modern industrial processes are based on a large amount of electronic devices such as programmable logic controllers and adjustable speed drives. Electronic devices are very sensitive to disturbances and thus industrial loads become less tolerant to power quality problems.

II POWER QUALITY

Together with technological developments, maintaining power quality is one of the major requirements that electricity consumers are demanding. The reason is modern technology demands an uninterrupted, high-quality electricity supply for the successful operation of voltage-sensitive devices such as advanced control, automation, and precise manufacturing techniques. Power quality may be degraded due to both the transmission and the distribution side abnormalities. The abnormalities in the distribution system are load switching, motor starting, load variations, and non-linear loads. The power quality has serious economic implications for customers, utilities, and electrical equipment manufacturers. Modernization and automation of industry involve increasing the use of computers, microprocessors, and power electronic systems such as adjustable speed drives. Integration of non-conventional generation technologies such as fuel cells, wind turbines, and photo-voltaic with utility grids often requires power electronic interfaces. The power electronic systems also contribute to power quality problems. This chapter discusses power quality problems and the influence of power quality problems the devices of power electronics are mainly used for operating and controlling the flow of electric energy since they can detect the change of the voltages and currents and supply them in an optimal form that suitable for user loads. Figure 2.1 showsa block diagram form of a typical power electronic system. Generally, the electric utility provides the power input to the power processor, at a line frequency of 50 or 60 Hz, single phase or three phases. The power processed output, such as voltage, current, frequency, andthe number of phases, is given by the power processor, although the case to determine it should be the load. In this case, a feedback controller will be installed at the output side of the power processor to compare the power output with a reference (or desired) value and it also will reduce the error between two values to a minimum rate.

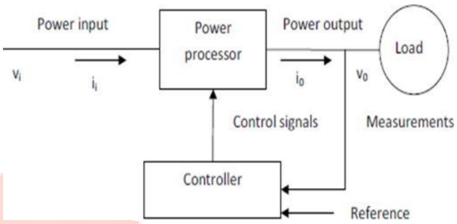

Fig: Block Diagram of a Power Electronic System.

The traditional knowledge of power electronics is based on low-frequency technology. With the large growth in the field of power electronics which has been experiencedin recent years, high-frequency technology is used for modern power electronics nowadays. As power semiconductor devices improve in performance and decline in cost, more systems will undoubtedly use power electronics.

III PROPOSED SYSTEM

There are many kinds of generation technologies for microgrids. Among them are internal combustion engines, gas turbines, micro-turbines, photovoltaic, fuel cells, and wind-power technologies. Besides them, many new technologies have emergedduring the latest years. The most common new-generation technologies are gathered in this chapter. A wind-electric turbine generator converts wind energy to electric energy. The main part of the wind-electric system is a blade, usually called the rotor. The wind-electric turbine generator uses air to move the blades. The air pressure is small therefore the diameter of the blades should be large. In normal environments, a 1kW wind turbine blade's diameter is approximately 2.6 meters. The wind-electric turbine generator also comprises a gearbox, generator, control electronic equipment, grounding, and interconnection equipment. The rotor is placed on a high tower. Nowadays wind electric systems are widely spread in theworld. It is enough to find a windy area to generate electricity economically.

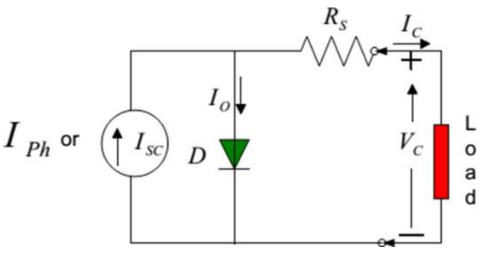

Fig: Photo Voltaic Cell Model

Micro-hydro power plants are also widely used in micro generation. There aretwo types of turbines in the micro-hydro generation. In high-head power plants, the mostcommon turbine type is a so-called wheel, where a lot of cups are attached to theturbine, the water presses down to the cups and as a result, the turbine revolves on its axis. The other type of micro-hydro turbine suitable for low-head plants is the so-called axial flowKaplan turbine, where the hub of the turbine lies in the same direction as the water flow. The main advantage of hydropower turbines is that they generate power permanently although, of course, the water flow changes a little bit during the seasons. The problem of the micro-hydro plants is in the construction phase: how to construct the turbine with minimal price and minimum environmental damage. Generating stations using natural gas are, due to their low air emission, lower price, and availability, the most suitable in micro-grid systems. But diesel-fueled generating systems still dominate in short-run applications or as reserve energy resources. Natural gas system's emissions have decreased permanently by improving the design and control of the combustion process. Advanced natural gas applications achieved nitrogen oxide producing levels lower than 50 *ppmv* which is a huge step forward in protecting the environment, but most of these systems still require using the exhaust catalyst which decrease significantly system's efficiency. Unfortunately, it is still impossible to have high efficiency and low emission simultaneously in those systems. Micro-turbines are power plants where the generator is a rotating field machine, often a permanent magnet machine that operates at a high inconstant speed. It is a very important new-generation technology. Micro-turbines consume different types of fuel including natural gas, gasoline, and other liquid or gaseous fuels. But due to the very variable speed of the microturbines complicated power electronic methods are required to interface those systems to the grid. On the other hand, the electricity-producing efficiency of microturbinesis low, typically in the range of 20 % of fuel efficiency. If expensive and sophisticated recuperate technology is used the efficiency may rise significantly. Anyway, 70 to 80 % of the fuel energy is converted to heat and there has to be a need for this heat to operate micro-turbines lucratively.

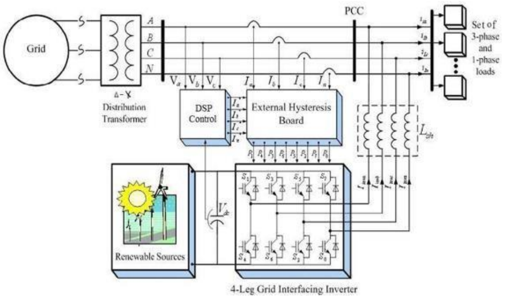

Fig: Schematic Diagram of Grid Connected Renewable Energy System

IV PHOTO VOLTANIC INVERTER

The inverter is the heart of the PV system and is the focus of all utility-interconnection codes and standards. A Solar inverter or PV inverter is a type that is made to change the (DC) electricity from (AC) for use with home appliances and possibly a Since the PV array is a dc source, an inverter is required to convert the dc power to normal AC power that is used in our homes and offices. To save energy they run only when the sun is up and should be located in cool locations away from direct sunlight. The PCU is a generalterm for all the equipment involved including the inverter and the interface with the PV (and battery system if used) and the utility grid. It is very important to point out that inverters areby design much safer than rotating generators. Of particular concern to utility engineers is how much current a generator can deliver during a fault in their system. Inverters generallyproduce less than 20% of the fault current as a synchronous generator of the same nameplate capacity. This is a very significant difference. Stand-alone inverters are used in isolated systems where the inverter draws its DC energy from batteries charged by photovoltaic arrays and/or other sources, such as wind turbines, hydro turbines, or engine generators. Many stand-alone inverters also incorporate integral battery chargers to replenish the battery from an AC source, when available. Normally these do not interface in any way with the utility grid, and as such, are not required to have anti-islanding protection. When the batteries in an off-grid system are full and PV production exceeds local loads, an MPPT can no longer operate the array at its peak power point as the excess power has nowhere to go. The MPPT must then shift the array operating point away from the peak power point until production exactly matches demand. (An alternative approach commonlyused in spacecraft is to divert surplus PV power into a resistive load, allowing the array to operate continuously at its peak power point.)

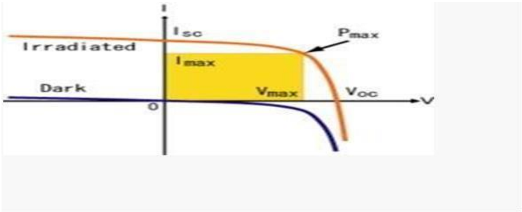

Fig: I-V curve for a solar cell, showing the maximum power point Pmax

Maximum power point tracking is a technique that solar inverters use to get the mostpossible power from the PV array. Any given PV module or string of modules will havea maximum power point: essentially, this defines the current that the inverter should draw fromthe PV to get the most possible power (power is equal to voltage times current).

V RENEWABLE POWER GENERATION SYSTEMS

The increasing energy demand, increasing costs exhaustible nature of fossil fuels, and global environmental pollution have generated huge interest in renewable energy resources. Other than hydroelectric power, wind and solar are the most useful energy sources to satisfy our power requirements. Wind energy can produce huge amounts of power, but its availability can't be predicted. Solar power is available during the whole day,but the solar irradiance levels change because of the changes in the sun's intensity and shadows caused by many reasons. Generally solar and wind powers are complementary. Therefore, the hybrid photovoltaic and wind energy system has higher dependabilityto give steady power than each of them operating individually. Another benefit of the hybrid system is that the amount of battery storage can be decreased as the hybrid system is more reliable compared to their independent operation.

Photovoltaic systems are classified according to the diagram in Figure 4.1. The two main general classifications as depicted in the figure are the stand-alone and the grid-connected systems. The main distinguishing fact tor between these two systems is that in stand-alone systems the solar energy output is matched with the load demand. To cater to different load patterns, storage elements are generally used and most systems currently use batteries for storage. If the PV system is used in conjunction with another power source like a wind or diesel generator then it falls under the class of hybrid systems. The balances of system (BOS) components are a major contribution to the life cyclecosts of a photovoltaic system. They include all the power conditioning units, storage elements, and mechanical structures that are needed. They especially have a huge impact onthe operating costs of the PV system.

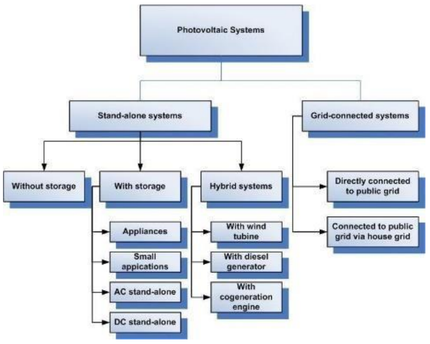

Fig: Classification of Photo Voltaic Systems

PVs generate electric power when illuminated by sunlight or artificial light. To illustrate the operation of a PV cell the p-n homo junction cell is used. PV cells contain a junction between two different materials across which there is a built-in electric field. The absorption of photons of energy greater than the band gap energy of the semiconductor promotes electrons from the valence band to the conduction band, creating hole-electron pairs throughout the illuminated part of the semiconductor. These electrons and whole pairs will flow in opposite directions across the junction thereby creating DC power.

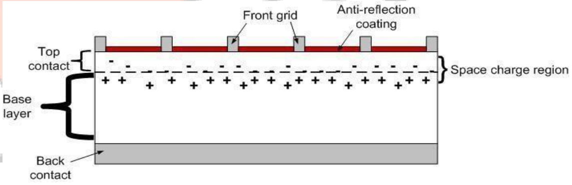

Fig: Structure of Photo Voltaic cell

For most applications, multiple solar cells need to be connected in series or in parallel to produce enough voltage and power. Individual cells are usually connected into a series string of cells (typically 36 or 72) to achieve the desired output voltage. The completeassembly is usually referred to as a module and manufacturers sell modules to customers. The modules serve another function of protecting individual cells from water, dust, etc. as the solar cells are placed into an encapsulation of single or double glasses. It is, therefore, very critical for the cells to be well matched in the series string so that all cells operate at the maximum power points. When modules are connected in parallelthe current will be the sum of the individual cell currents and the output voltage will equal that of a single cell. An array is a structure that consists of several PV modules, mounted on the same plane with electrical connections to provide enough electrical power for a given application. Arrays range in power capacity from a few hundred watts to hundreds of kilowatts. The connection of modules in an array is like the connection of cells in a single module. Toincrease the voltage, modules are connected in series and to increase the current they are connected in parallel.

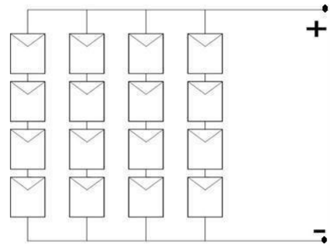

Fig: Structure of a Photo Voltaic Array

Integration of bypass diodes in some large modules during manufacturing is not uncommon and reduces the extra wiring required. It must be pointed out though that it becomes very difficult to replace the diode if it fails. The equivalent circuit of a PV cell is It includes a current source, a diode, a series resistance, and a shunt resistance.

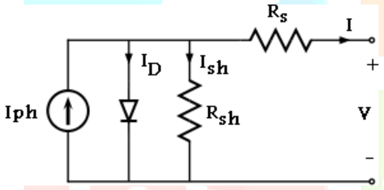

Fig: Photo Voltaic Cell Equivalent

VI SHUNT ACTIVE POWER FILTER PERFORMANCE

The maximum power is harvested from the PV array and fed to a capacitor at the DC-link of the VSC. A three-phase VSC injects the generated PV array power at the point ofcommon coupling (PCC), via interfacing inductors, and also supplies the reactive power andthe harmonics currents of local loads.

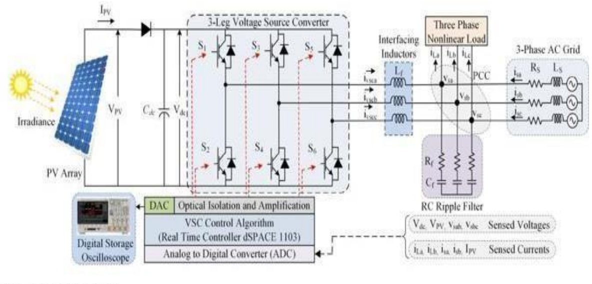

Fig. 1. System configuration.

Fig: Block Diagram of System

In weak grid conditions, the phase voltages obtained above may be distorted or unbalanced. Moreover, a DC offset may be present either due

Voltage and Instantaneous Reactive

to it being inherently present atthe PCC or due to a malfunction in the sensor circuit. These anomalies would thus be reflected in the reference grid currents obtained by the control. To eliminate such undesirable effects on the grid currents, the voltages in (1) are filtered via a GVP stage, which generates the positive sequence components from the input voltages. These are balanced and free from distortionsand dc offset. The Postage and the unit template generation for grid synchronization do not require any computationally heavy PL.

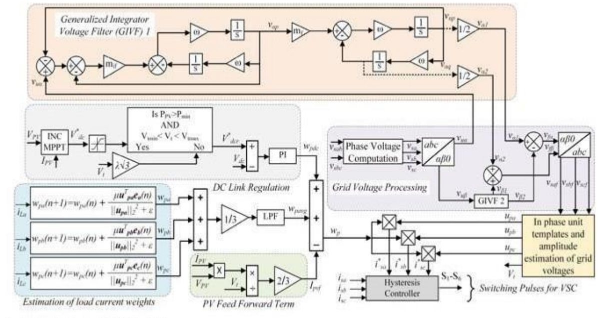

Fig. 2. Control strategy for VSC switching.

Fig: Control Algorithm

If the PV array power is absent or very low, the reference voltage value obtained from the MPP technique is unsuitable for proper VSC operation. In a two-stage system, an adaptive method to regulate the DC-link voltage is discussed in [9] and [28]. Rather than taking a constant reference, an adaptive voltage computation is applied in this single-stage system. If the available PV array power is very small or there are large variations in the grid voltages, the value derived in (16) is used. It helps to optimize the SEC's operation, improves stability, and reduces losses under a wide range of grid voltages, enabling effective DSTATCOM operation.

VII RESULTS

the increasing application of nonlinear loads, the appearance of power quality problems is inevitable. In recent years, the rapidly increasing use of nonlinear power- electronics devices (e.g., Thyristor, diode, adjustable speed drives, and programmable logiccontrollers) has brought many power-quality problems. Therefore, in 1996, a novel device named Unified Power Quality Conditioner integrated a series APF and a shunt APF througha common DC-link capacitor. Where the main function of the MLI is compensating the current distortion generated by nonlinear load, correcting power factor, and regulating the DC-link voltage and the main function of the series CONVERTER is compensating system voltage and isolating the load from the distribution system. In this Project, Four Wire UPQC for Power Quality Improvement in Microgrid is developed. The control strategy used here is Reference Theory for Reference Current and with these references, D- STATCOM is

Compensating the Power Quality Problems. All the Simulation work is carried out on MATLAB/SIMULINK.

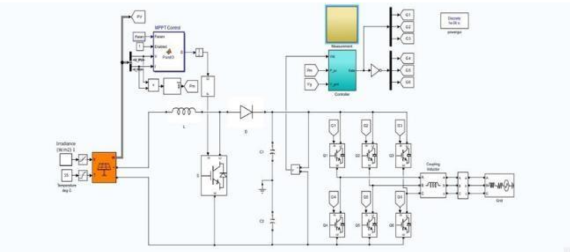

Fig: ***Simulink*** **Implementation of SystemConfiguration**

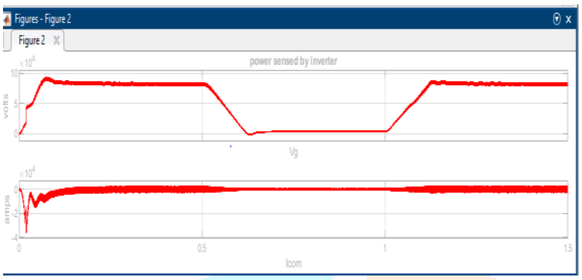

Fig: Voltage and Current Waveforms of theSystem power by inverter

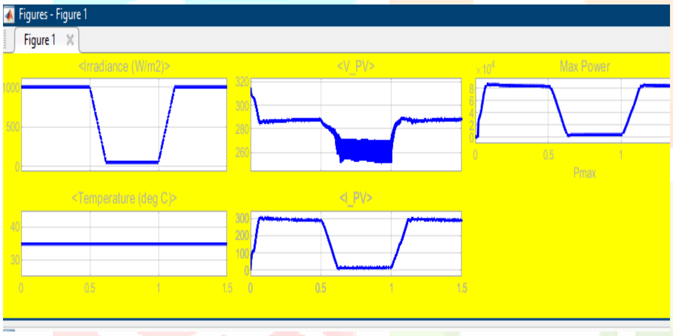

Fig: ***Simulink*** **Implementation of PV output, Pmax, irradiation, temperature, current**

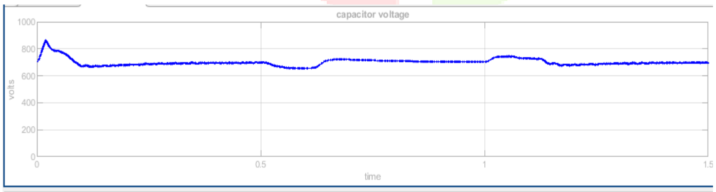

Fig: capacitor Voltage Waveforms

The above figure consists of voltage on the y-axisand time on the x-axis. The load current is acontinuously variable quantity with linear and non-linear unbalanced loading conditions. The main approach of this system is to reduce the harmonics in the source current. The load current is continuously variable with multiple frequencies, this waveform is compared with source voltage, it is a pure sinusoidal t

harmonic percentage in the current waveform. The compensation current and voltage are injected into the system by pv inverter to reduce the voltage sags in the source current. To compensate for the current in the source current pv supportsthe dc link voltage. The controller circuit gives the compensation current throughthe switches. When nonlinear load is connected to the system the harmonics are produced in thesystem.

VIII REFERENCES

[1] A. J. Waldau, I. Kougias, N. Taylor, and C. Thiel, “How photovoltaics can contribute to GHG emission reductions of 55% in the EU by 2030,” *Renewable Sust. Energy Rev.*, vol. 126, Jul. 2020, Art. no. 109836.

[2] A. A. Almeria, H. M. K. Al-Masri, and M. Ehsani, “Feasibility study of sustainable energy sources in a fossil fuelrichcountry,” *IEEE Trans. Indalo.*, vol. 55, no. 5, pp. 4433–4440, Sep./Oct. 2019.

[3] O. M. Akeyo, V. Talabani, N. Jewell, and D. M. Ionel, “The design and analysis of large solar PV farm configurations with DC- Connected battery systems,” *IEEE Trans. Ind. Appl.*, vol. 56, no. 3, pp. 2903–2912, May/Jun. 2020.

[4] F. Hafiz, M. A. Awal, A. R. d. Queiroz, and I. Husain, “Real-time stochastic optimization of energy storage management using deep learning-based forecasts for residential PV applications,” *IEEE Trans. Ind. Appl.*, vol. 56, no. 3, pp. 2216–2226, May/Jun. 2020. [5]M. A. Mahmud, T. K. Roy, S. Saha, M. E. Haque, and H. R. Pota, “Robust nonlinearadaptive feedback linearizing decentralized controller design for islanded DC microgrids,” *IEEE Trans. Ind. Appl.*, vol. 55, no. 5, pp. 5343–5352, Sep./Oct. 2019.M. Nasir, M. Anees,

H. A. Khan, I. Khan, Y. Xu, and J. M. Guerrero, “Integration and decentralized control of standalonesolar home systems for off-grid community applications,” *IEEE Trans. Ind. Appl.*, vol. 55, no. 6, pp.7240– 7250, Nov./Dec. 2019