WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Augmentation of Power System Stability and Maximum Power Point Tracking for PV Microgrid Application

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A B S T R A C T

This research paper will look at renewable sources. Renewable or Unconventional Energy-based Distributed Generators (DGs) play a leading role in generating electricity or electricity, with global warming escalating. DG (Distributed Generation) based on biomass, wind, mini-hydropower and fuel cells, solar energy and microturbines will provide important impulses in the near future. Benefits such as environmental compatibility, scalability and flexibility have made distributed generation, which operates with multiple unconventional and renewable micro-sources, a remarkable option for modern power grid setup. A microarray contains a number of loads and branches which function as an individually controllable scheme. As an integrated power supply system, the micro-grid can operate in parallel with the main power grid or isolated from the main power grid. The micro-grid idea becomes familiar with reducing various reverse conversions in a separate DC or AC grid, and also facilitates connection to flexible or unconventional renewable AC and DC sources and loads to power systems or systems. 'food.The interconnection of general directorates (decentralized energy production) with electricity suppliers / electrical networks via converters (power electronics) has raised concerns about the safety of procedures and the fixing of devices. For the consumer, the micro-network can be designed in such a way that it sees his special needs. For example, increasing local reliability, reducing power losses, maintaining local voltages, increasing efficiency through the use of heat (waste), eliminating voltage drops or electricity, or uninterruptible power supply. Recently, the performance of the hybrid AC-DC microarray scheme in linked grid mode has been studied. Here the photovoltaic scheme, battery and wind turbine generator are used to improve the microgrid. Control units are also used for the converters to correctly coordinate the AC subnet with the DC subnet. The consequences result from the SIMULINK / MATLAB environment.

Keywords:PV Microgrid, Photovoltaic (PV)systems; DC/Converter; Maximum power-point tracking (MPPT); Non-linear controller; Augmentation system

1. Introduction to Microgrid

With the introduction of power distribution technology in the next century, many styles will emerge which will vary the power distribution needs. These differences appear together on the demand side, where accessibility and energy efficiency are needed, and on the supply side, where the inclusion of distributed generation and peak reduction technologies should be considered.Currently, the energy count, size, overestimation and DER (Distributed Energy Resources) of power systems must be increased. Even if several technologies are used for smaller scale production (micro-sources) and some resources are used, it is solar, hydro or wind power. A start with tricky power load sources. In addition, low potential end users (230 volts and 110 volts in Europe) are less likely to disrupt the supply as manageable loads and micro-sources can be powered by micro-energy storage systems. In island mode for severe system problems. It is now called a micro network. Figure 1 shows an archetypal microarray.

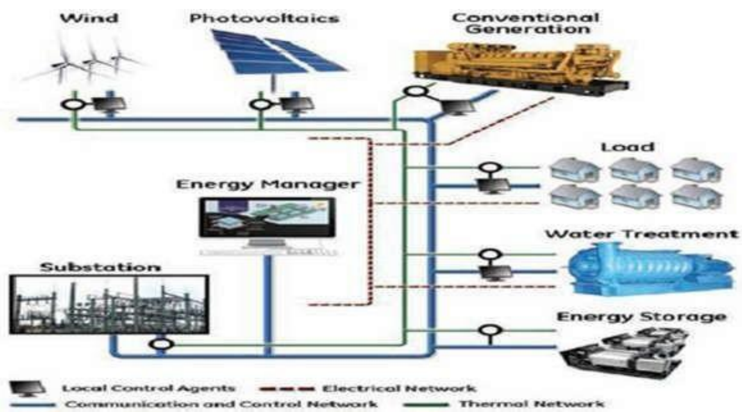

Fig 1 Microgrid Power Schemes

Archetypal microgrids are the size of a low potential distributor and have a capacity of 1 MVA and a topographic range of 1 km. Over 90% of low potential household consumers provide electricity in an archetypical way via underground cables and rest via overhead lines. Microgrids provide consumers with plenty of electricity and heat through combined thermal and power plants, fuel cells, gas turbines, wind turbines, photovoltaic (PV) systems and more.

MERIT:
• Ability to disconnect from the utility grid during the interruption time and work independently.
• It reduces the demand in the public power grid, which prevents grid failures.
• Use both thermal energy and electricity to increase overall efficiency.

DEMERITS:
• The frequency, voltage and quality of the power supply must be within acceptable limits.
• Requires storage of battery tanks, which requires space and repairs.
• Resynchronization with the public power grid is problematic.
• Security is tough.

2. Photovoltaic System

The photovoltaic effect was first discovered in 1839 by French scientist Edmund Becquerel. He suggested that some materials produce less electricity when exposed to the sun. In 1905, A. Einstein explained the nature of light and the photoelectric effect, which became the basic principle of photovoltaic. The first photovoltaic module was built in 1954 by Bell Laboratories.
A photovoltaic system uses one or more solar panels to convert solar energy into electricity. It is made up of several components including photovoltaic modules, electrical connections and mechanical adjustments and assemblies and means for regulating and / or adjusting the production of electricity.

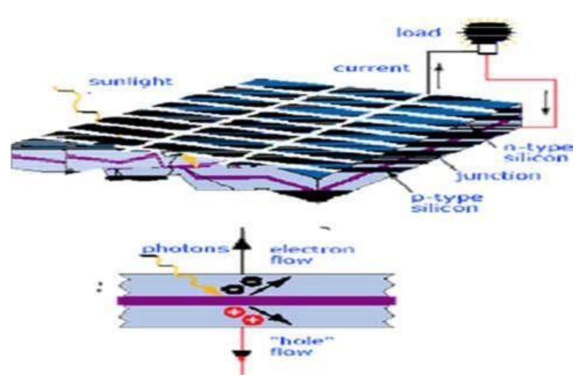

Fig 2 Basic Structure of Photovoltaic Cell

The basic elements of photovoltaic cells are semiconductor materials, for example silicon. A thin semiconductor wafer generates an electric field on the one hand positive (+ ve) and negative (-ve) on the other for solar cells. When sunlight or light energy reaches the solar cell, electrons are displaced by atoms in the semiconductor material. Once the electrical conductors are connected to the positive (+ ve) and negative (-ve) sides, an electrical circuit is created and the electrons are trapped in the form of an electrical current, namely electricity. A photovoltaic cell can be circular or square in the assembly.

3. Maximum Power Point Tracking (MPPT)

As an electronic scheme, MPPT (Maximum Power Point Tracker) works with PV (photovoltaic) modules in such a way that the PV (photovoltaic) modules can generate all the electricity they can control. It is not a mechanical tracking scheme in which the modules are physically transferred for more direct exposure to sunlight. Although MPPT (Maximum Power Point Tracking) is a fully electronic system, it differs from the function point of the module, so the modules are able to transmit the maximum power available. Since the performance of PV (photovoltaic) system depends on temperature, irradiation and load characteristics, MPPT (Maximum Power Point Tracking) cannot transmit the output potential without errors. For this reason, MPPT (Maximum Power Point Tracking) must be realized in the PV (photovoltaic) scheme in order to maximize the output potential of the PV (photovoltaic) field.

3.1 Need of Maximum Power Point Tracking (Mppt)

In the power / voltage curve of a PV module (photovoltaic module) there is only a maximum power, ie there is a peak power that corresponds to a certain potential and current. The efficiency of the solar PV module (photovoltaics) is around 13 percent low. Then the efficiency of the module is low, it is necessary to process the module at the point of peak performance so that the power supply can be routed to the load under changing temperature and irradiation situations. This maximizes the performance and helps improve the use of the solar PV module (photovoltaic). An MPPT (Maximum Power Point Tracker) extracts the maximum power from the PV module (photovoltaic) and transfers this electrical power to the load. As an interface device, the DC-DC converter transfers this maximum power from the solar PV module (photovoltaic) to the load. By varying the duty cycle, the load impedance is changed and matched to the peak power point by means of the source in order to achieve the maximum transmission power.

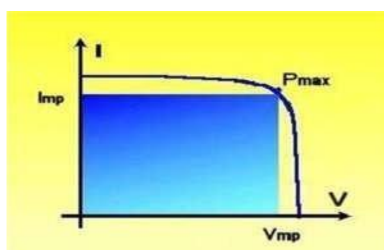

Fig 3 MPPT Characteristic

4. AC/DCMICROGRID

The design of the microgrid is deliberately thought of as a group of loads and micro-sources that act as a single controllable scheme that together provides electricity and heat to its local area. This term offers a new archetype for the definition of the DG (Distributed Generation) process. The supply microgrid can be seen as a controlled cell of the power supply system. For example, this cell can be measured as a single load that can be shipped and respond in seconds to meet the requirements of the transmission scheme. For consumers, the microgrid can be a strategy to meet their particular needs. For example, increase local reliability, reduce supply losses, maintain local voltages, increase efficiency by using the remaining heat and correct the voltage drop. The main objective of this idea is to accelerate the recognition of the benefits that the similar capacity of small general directorates (distributed generators) offers to provide the remaining heat during critical periods. The microgrid or distribution network subsystem does not cause as many problems to the distribution network as traditional microproduction when there is proper and intelligent coordination of microproduction and loads.
The micro-grid is considered a "grid-appropriate unit" and there is no adverse effect on the connection to the distribution grid.
i.e. There is no need to change the operational policy of the distribution network.

4.1 Configuration Of HybridMicrogrid

Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 9.5 pt. Here follows further instructions for authors.

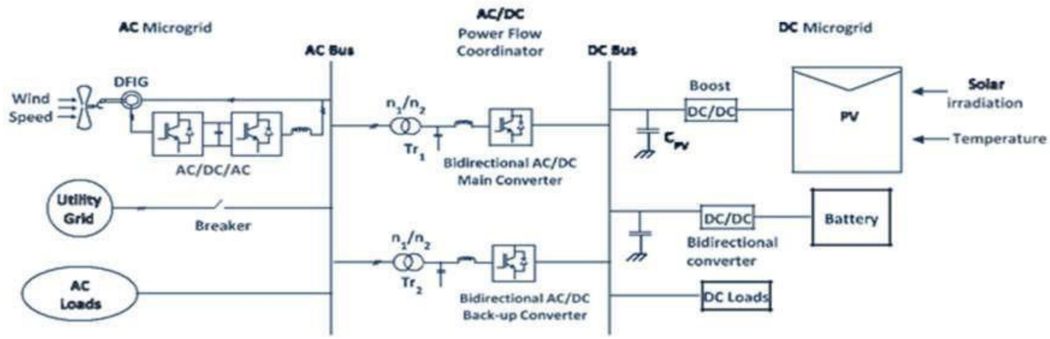

Fig 4 Hybrid AC/DC Microgrid Scheme

The configuration of the hybrid scheme is shown in Figure 4, in which many DC and AC sources and loads are assigned to the corresponding DC and AC networks. The DC and AC connections are interconnected via 2 transformers and two three-phase (multi-phase) converters which operate on four quadrants. The AC bus of the hybrid grid is connected to the public electricity grid.

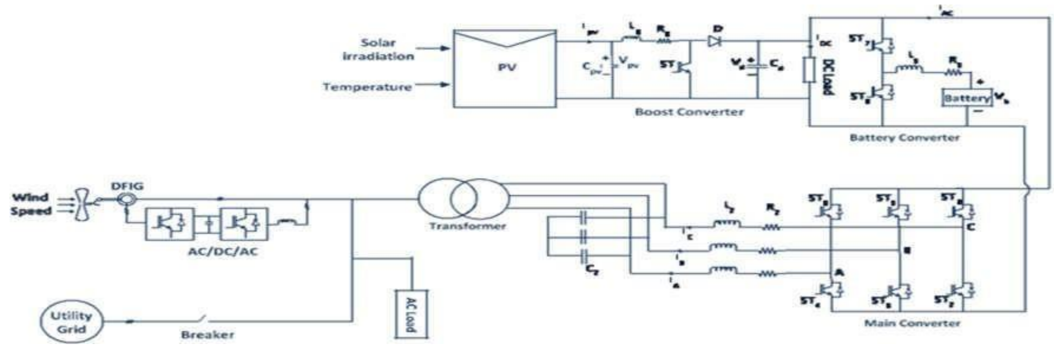

Fig 5 Representation of Hybrid Micro-grid

Figure 5 defines the hybrid schematic configuration that includes DC and AC networks. DC and AC networks have analog sources, loads and energy storage elements and are connected to one another by a three-phase converter. The AC bus is connected to the supply network via a circuit breaker and a transformer.

4.2 Modeling And Control Of Main Converter

The role of the main converter is to exchange power between the DC and AC buses. The important motive of the main converter is to maintain a stable intermediate circuit potential in grid connected mode. If the converter is operating in grid mode, it must provide a certain reactive and active power. Here, the PQ control arrangement is used to control the main converter. PQ control is performed using a current controlled voltage source. Two PI (proportional integral) controllers are used for reactive and active power control. If resource conditions or load capacities change, the intermediate circuit voltage is set to constant via the PI (proportional integral) control

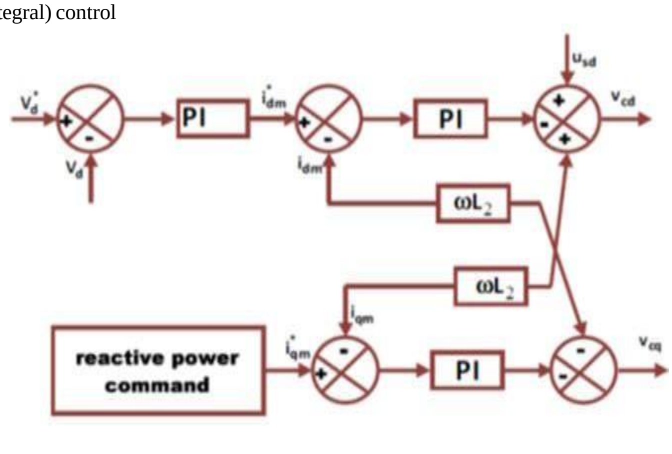

Fig. 6 Control Block Diagram of Main Converter

International Journal of Research Publication and Reviews Vol (1) Issue (8) (2020) Page 132-144

4.3 Modeling And Control of Grid Side Converter

When voltages in grid vicissitudes because of dissimilar unbalance conditions, it makes an effect on DC-link voltage.

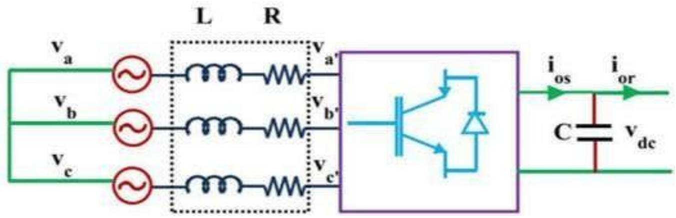

Fig 7 Schematic Diagram of Grid Side Converter

Meanwhile machine is grid allied grid-voltage along with stator voltage is same; there occurs a relation amid grid- voltage and DC-link voltage. The main goal or aim of grid-side converter is to sustain DC-link voltage constant for essential act. The voltage-oriented-vector control technique is approached to resolve this problem.

The detail mathematical demonstrating of grid-side converter is specified underneath. The control plans are made subsequent mathematical demonstrating .The PWM (Pulse Width Modulation) converter is current regulated by means of direct axis current is used to regulate the DC-link voltage however quadrature axis current element is used to regulate power (reactive). The power (reactive) demand is set to zero to confirm unit power factor process. Fig. 7 displays schematic diagram of grid-side converter.

The potential balance across line is specified , where L and R are the line reactance and resistance correspondingly. By means of use of d-q theory 3-phase quantities are transferred to 2-phase quantities.

4.4 Modeling And Control of Machine Side Converter

The control policy made for machine-side converter is revealed . The main motive of machine-side converter is to sustain rotor speed constant regardless of wind speed and too control policy has been executed to control reactive power and real power flow of machine using rotor current elements. The real power flow is controlled over idr and reactive power flow is controlled over iqr .To confirm unit power factor (CosΦ) operation like grid-side converter power (reactive) demand is too set to zero here. The mathematical demonstrating of machine- side converter is specified in subsequent equations.

Meanwhile stator is allied to utility-grid and impact of stator resistance is lesser, stator magnetizing current id can be deliberated as constant. Under potential orientation relationship amid torque and d-q axis potentials, fluxes and currents can be written as follows.

Ignoring leakage inductances stator flux Eqs can be written as;

$$h_{dc}=0 \quad (20)$$

$$h_{qc}=L_c i_{qc}+L_N i_{qr}$$
$$=(L_{1c}+L_N)i_{qc}+L_N i_{qr}$$
$$=L_{1c} i_{qc}+(i_{qc}+i_{qr})L_N \approx L_N i_N \quad (21)$$

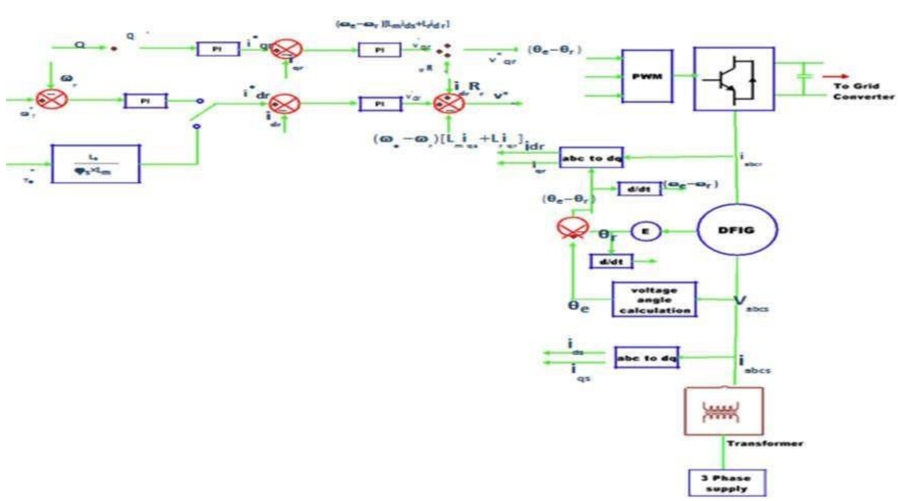

Fig 8 Control Block Diagram of Machine Side Converter

4.4 Modeling And Control Of Battery

The battery converter is a bi-directional DC-DC converter and main motive of battery converter is to provide guarantee of stable DC-link voltage.

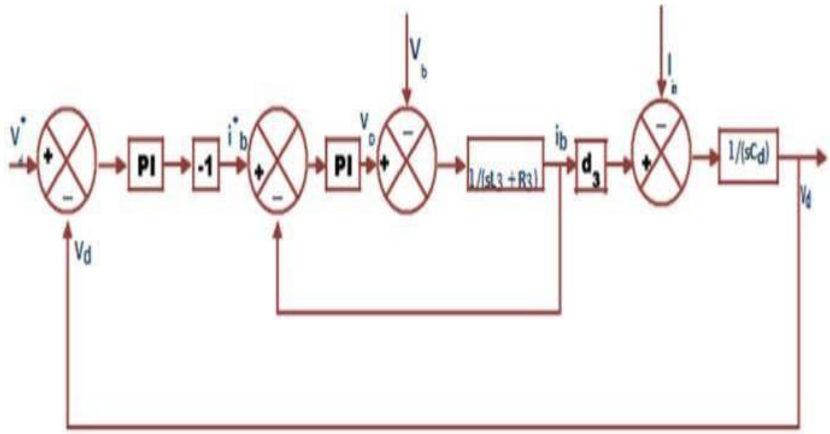

Fig 9 Control Block Diagram of Battery

5. Result and Discussion

A hybrid micro-grid whose parameters are specified in above table is simulated using MATLAB/SIMULINK situation or environment. The process is carried out for grid allied mode. Beside with hybrid micro-grid, performance of DFIG (Doubly Fed Induction Generator), PV (Photovoltaic) scheme is investigated. Thecelltemperature, solar irradiation and wind speed are too taken into consideration for study of hybrid micro-grid. The performance investigation is completed using simulated outcomes which are found using MATLAB/SIMULINK.

Figure (10)-(15) signifies I-V, P-V, P-I physiognomies with variation in temperature and solar irradiation. The non- linear nature of PV (Photovoltaic) cell is perceptible as revealed in figures, i.e., output current and power of PV (Photovoltaic) cell depend on cell's terminal working voltage and temperature, and solar irradiation too.Figures (10) and (11) confirm that with escalation of cell's working temperature, current output of PV (Photovoltaic) module growths, while maximum power output diminishes. Subsequently growths in output current are much less than diminution in voltage, total power diminutions at high temperatures.

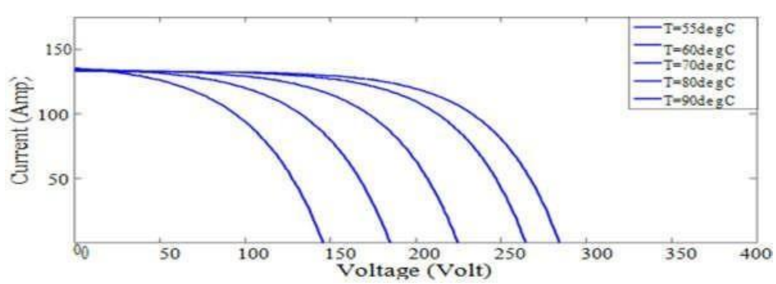

Fig 10 I-V Output Characteristics of PV (Photovoltaic) Array for DifferentTemperatures

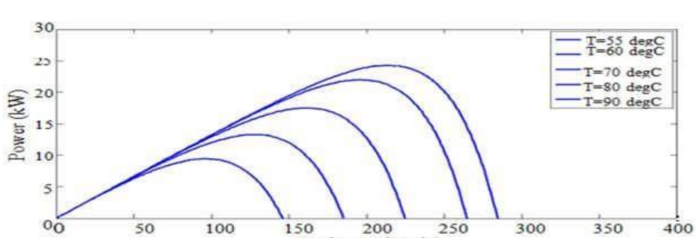

Fig 11 P-V Output Characteristics of PV (Photovoltaic) Array for DifferentTemperatures

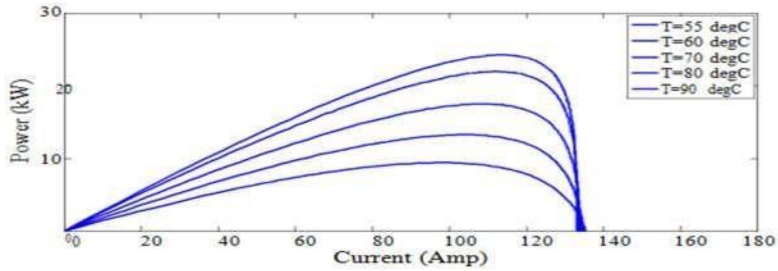

Fig12P-IOutputCharacteristicsofPV(Photovoltaic)ArrayforDifferentTemperatures

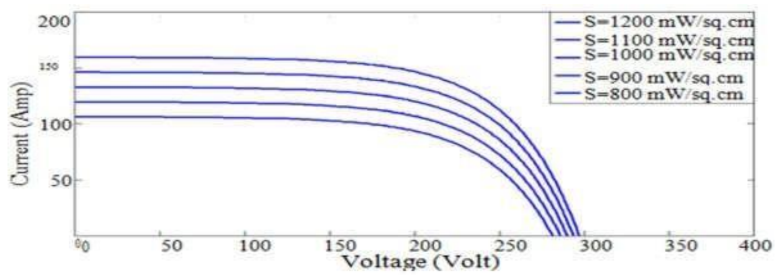

Fig 13 I-V Output Characteristics of PV (Photovoltaic) Array for Different Irradiance Levels

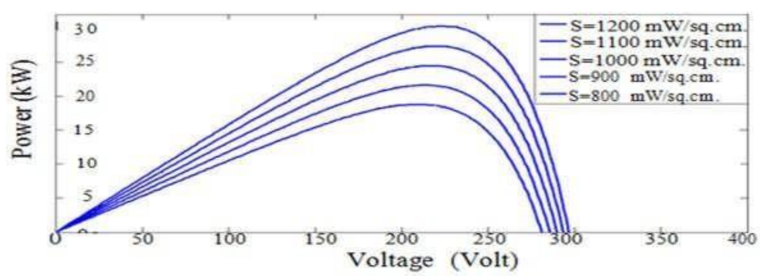

Fig 14 P-V Characteristics of PV (Photovoltaic) Array for Different IrradianceLevels

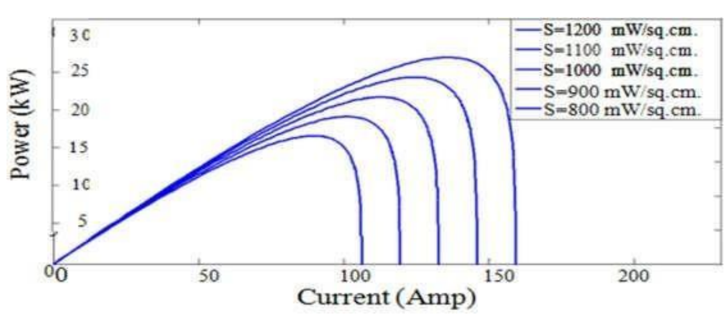

Fig 15 P-I Characteristics of PV (Photovoltaic) Array for Different IrradianceLevels

Figures (13) and (14) show that by means of growth of solar irradiation, current output of PV (Photovoltaic) module growths and also maximum output power. The reason behind it is open-circuit voltage is logarithmically dependent on solar irradiance, on the other hand short-circuit current is directly proportional to radiantintensity.

5.1Simulation Results of Hybrid Grid

The several physiognomies of hybrid micro-grid are signified by figures (16) – (21). Here micro-array functions in a network-bound mode. In this mode, main converter works in PQ mode and power is balanced by distribution network. The battery is fully charged. The DC-link potential is sustained by distribution network and DC-link voltage from main network.

Figure (16) shows solar radiation curve whose value is amid 0.0 W/m² from 0 to 0.1. Diminutions from 0.4 s to 950 W/m² and maintains this value of 1second. Figures (17) to (19) show output potential, current and power in relation to solar radiation signal.

The output power of PV (Photovoltaic) panel differs from 11.25 kilo-Watts to 13 kilo-Watts, which closely follows solar radiation when ambient temperature is fixed.

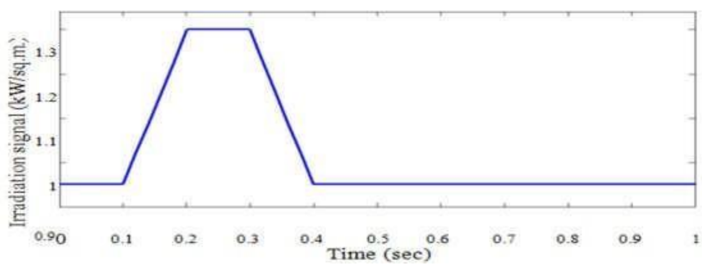

Fig 16 Irradiation Signal of the PV (Photovoltaic) Array

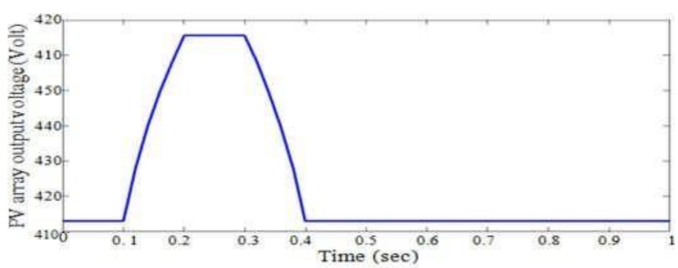

Fig 17 Output Voltage of PV (Photovoltaic) Array

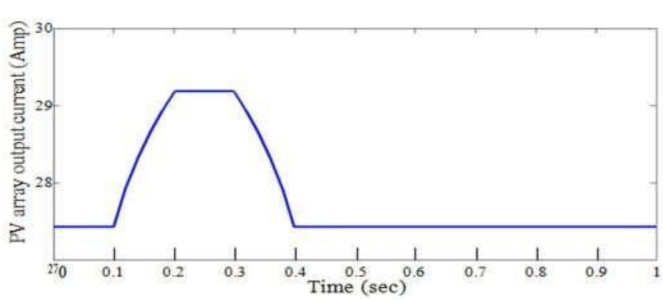

Fig 18 Output Current of PV (Photovoltaic) Array

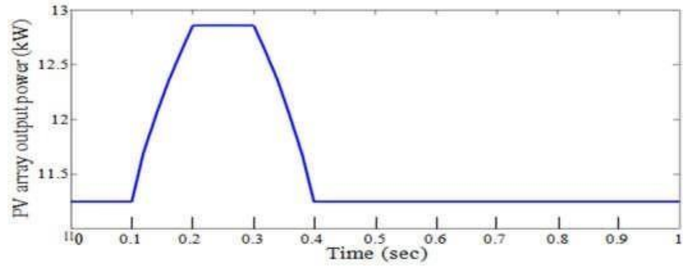

Fig 19 Output Power of PV (Photovoltaic) Array

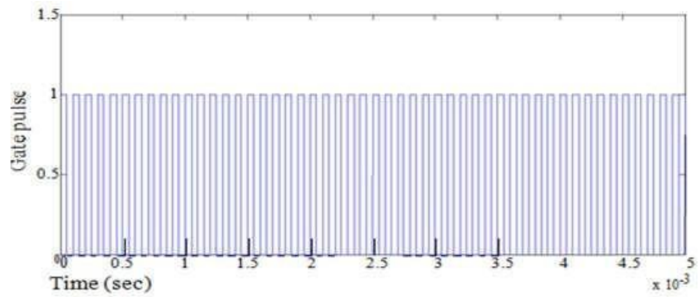

Fig 20 Generated PWM Signal for the Boost Converter

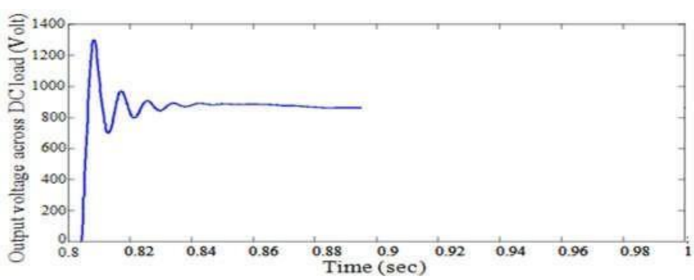

Fig 21 Output Voltage across DC Load

Figure (24) shows gate pulse signal which is fed to switch of boost converter. The output potential across DC-load is signified by figure (24) which is settled to approx. 820 Volt.

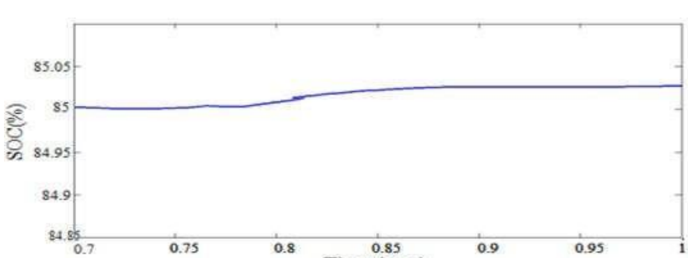

Fig 22 State of Charge of Battery

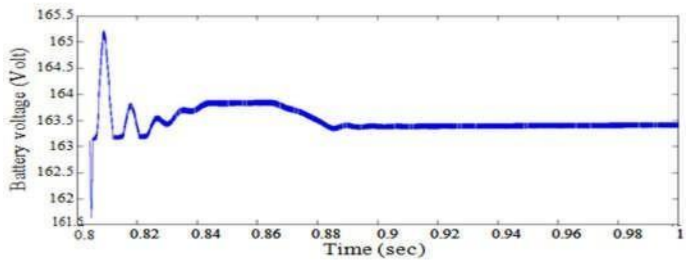

Fig 23 Voltage of Battery

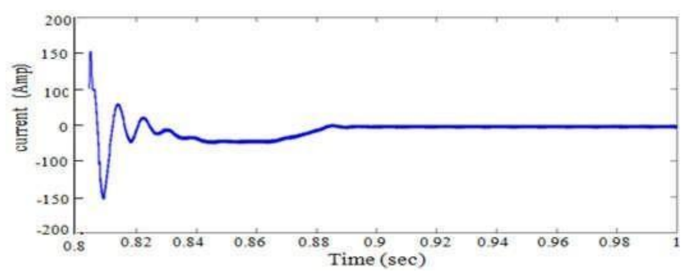

Fig 24 Current of Battery

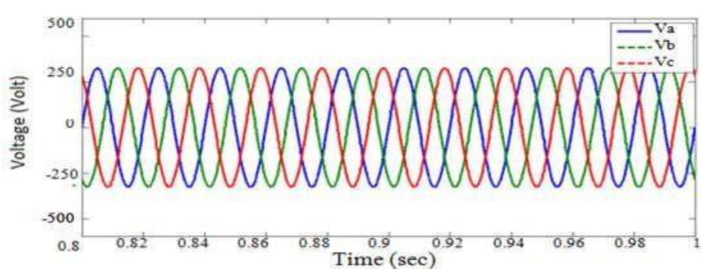

Fig 25 Output Voltage across ACLoad

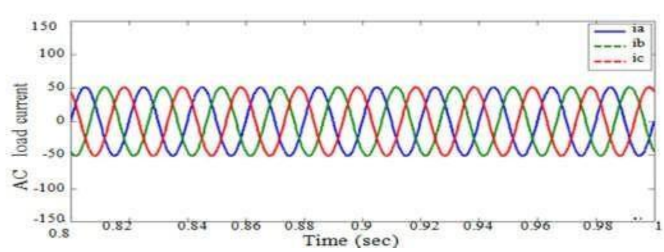

Fig 26 Output Current across ACLoad

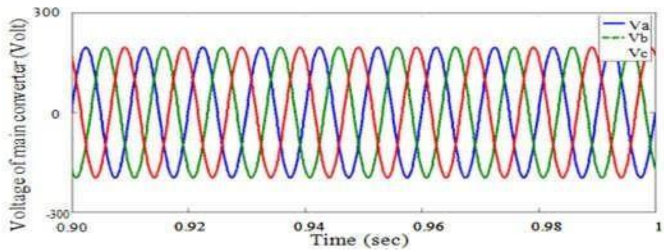

Fig 27 AC Side Voltage of the MainConverter

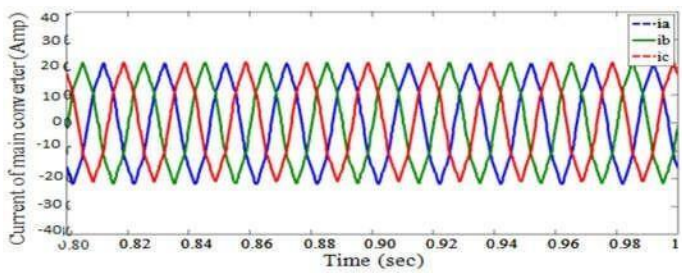

Fig 28 AC Side Current of the MainConverter

The battery physiognomies are shown in figures (21) - (23). The SOC (State of Charge) of battery is set at 85 percent while battery current differs between -50 ampere to 50 amperes and value of battery potential is nearly 163.5 volt.

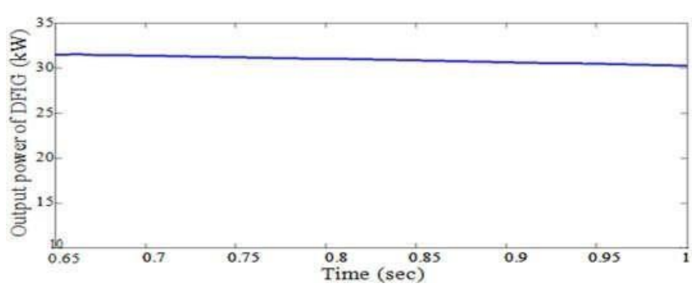

Fig 29 Output Power of DFIG

The output physiognomies of AC-load potential and current are signified by figures (24) and (25). Phase to phase voltage value of AC-load is 300 Volt and current value is 50 ampere. Figure (26) and (27) shows voltage and current responses at AC-side of main converter when solar radiation value differs amid 950 W/sq.m -1300 W/sq.m by means of a fixed DC-load of 25kilo-Watts.

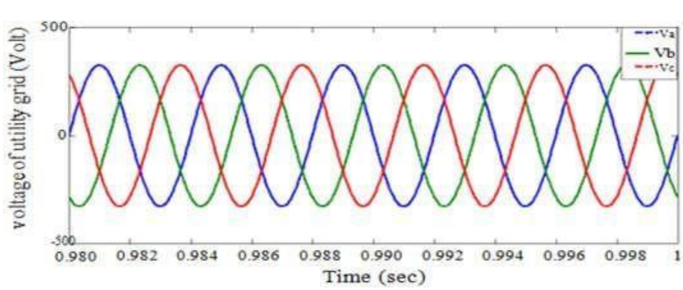

Fig 30 Three Phase Supply Voltage of Utility Grid

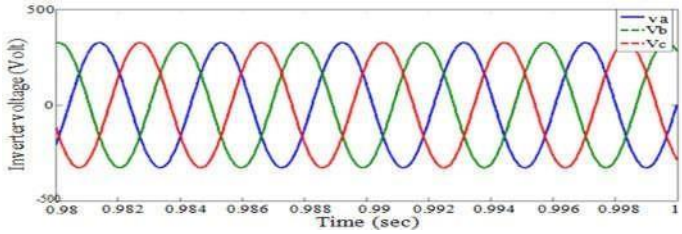

Fig 31 Three Phase PWM Inverter Voltage

Figure (30) and (31) signifies 3-phase supply voltage to utility grid and 3-phase PWM (Pulse Width Modulation) inverter output voltage correspondingly.

6. Conclusion

Hybrid microgrids for configuring power supply schemes are shown in MATLAB / SIMULINK environments. Current research generally includes network modes of hybrid networks. Models for all converters have been developed to confirm the stability of the system under various loads and processing conditions. Control mechanisms are also being examined. The MPPT (Maximum Power Point Tracking) algorithm is used to utilize the maximum power from DC sources and to coordinate the exchange of energy between DC and AC networks. While hybrid networks can reduce the process of converting DC-AC and AC-DC to a single DC or AC network, there are many practical challenges in implementing hybrid networks based on today's AC-dominant infrastructure. The efficiency of the overall scheme depends on the reduction in conversion losses and the scaling for an additional intermediate circuit. The hybrid network can provide the customer with reliable, high quality and efficient energy. The hybrid network is suitable for small, remote industrial systems with PV systems (photovoltaics) and a wind power generator as the main power source.

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