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Design and Analysis of Hybrid Nanogrid

Vijeta Pal
D.C.E.T, Sarahanpur, U. P
vijta.2021@gmail.com

Sourabh Maheshwari
D.C.E.T, Sarahanpur, U. P
smaheshwary@gmail.com

Ameer Faisal
K.I.E.T, Ghaziabaad
ameerfaisal12@gmail.com

***Abstract**: With the pace of time there is a huge development in technologies. In recent time there is a concern of energy as right now fossil fuel is used but as population increases in near future to meet demand it would be very tough that why we are focusing on renewable energy. Distributed energy resources based microgrid and Nano-grid framework is a most technically viable bottom-top approach to sustainably meet the ever-increasing demand of rural and urban communities. Recently the growth of DC operative home appliances like mobile and laptop chargers, ovens and hair dryer's etc. are increasing and therefore a DC/DC converter is an efficient way to meet the electricity need from the local DER and helps in improving the system efficiency. In our dissertation, we took three different section of the solar panel and after that simulation carried out with help of buck-boost converter and besides this MPPT algorithm (P & O method) for solar PV module and closed loop PI control system also used. The proposed methodology is to extract maximum DC power from solar PV system and it is directly fed to DC load or DC Nano grid. The simulation results demonstrate the buck-boost converter application for maintain constant voltage at DC bus irrespective of variation of solar PV generation. Also it improves the system efficiency by reducing no. of conversions. In our dissertation work analysis of poly crystalline, monocrystalline and thin film crystalline is done and got different simulation result.*

***Keywords:** Distributed Energy Resources (DERs), Maximum Power Point Tracking (MPPT) and Perturb & Observe (P&O).*

I. INTRODUCTION

With the pace of time rapid depletion of fossil fuels worldwide has also made it necessary to reduce dependency on these non-renewable energy resources. The One way of accomplishing this is to exploit the enormous potential of renewable energy sources to meet the continually increasing demands for energy. However, the periodic nature of renewable energy sources is the main issue of hindering their rapid implementation. Hybrid Renewable Energy Systems (HRES) are defined as an electric energy system which is made up of more than one renewable source or single renewable sources [1-2]. These sources could be conventional or renewable or mixed, that works in off-grid or grid connected mode. The main feature of hybrid renewable energy systems is a combination of more than 2 renewable power generations (RPG). In these days, consumption or we can say use of energy is enhancing, and the thought and technologies for various renewable energy sources through which they can find out or explored are also increasing. Due to these scarcity energy sources, renewable energy sources are only the future so that we can live smoothly [5]. Various significant processes are attempted successfully over the later years in development and research of the renewable power systems, for example, sea energy, wind energy, solar energy and wave systems. With these abundant resources, the solar energy can be used nowadays exponentially as an environmental friendly energy source and also very most reliable. Ac-nano grid is thus an electrical system backbone of the power electronics–based contemporary homes. Cells are manufactured using different materials which have multiple band gaps as per material specification. So, it will respond to multiple light wavelengths and some of the energy that would otherwise be lost to relaxation.For instance, if one had a cell with two band gaps in it, one resonance to red light and the other resonance to green, then the extra energy in green, cyan and blue light would be lost only to the band gap of the green-sensitive material, while the energy of the red, yellow and orange would be lost only to the band gap of the red-sensitive material [7]. Conveniently, the light of a particular wavelength does not interact strongly with materials which are not a multiple of that wavelength or frequency. It means that you can make a multi-junction cell by layering the different materials lying on each other, and shortest wavelengths on the "top" and increasing through the body of the cell.

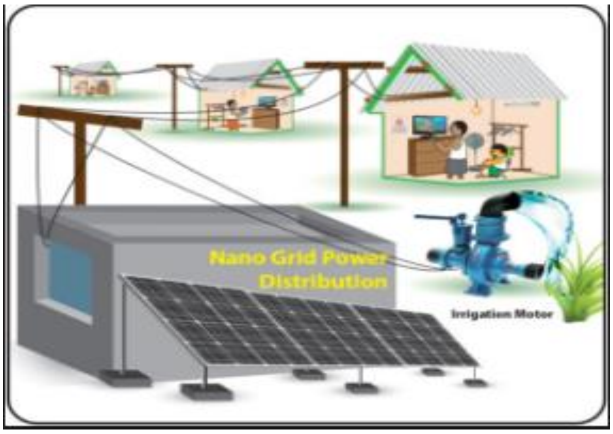

Figure 1 Nano grid power distributions

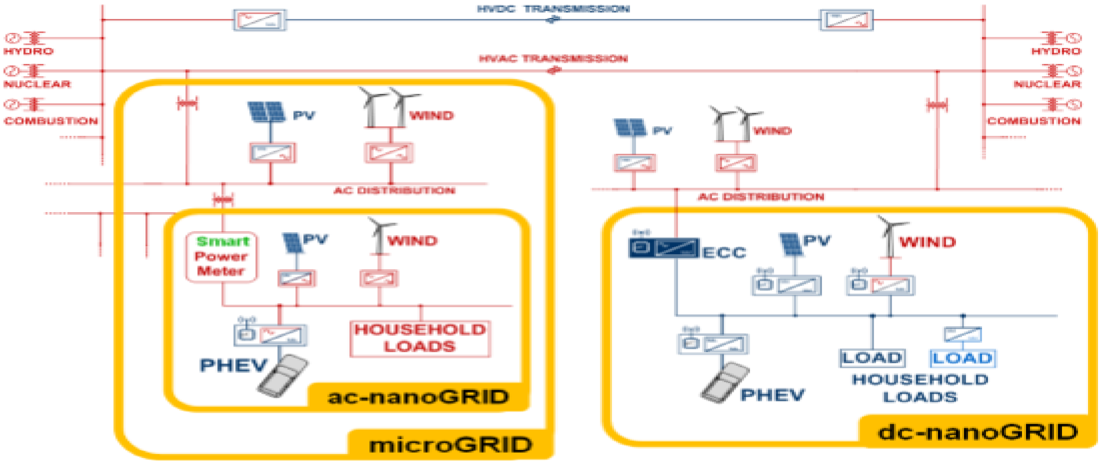

Figure 2 Illustration of the electric power system with defined subsystems

II. LITERATURE SURVEY

The electrical grid is interconnected networks which are used to deliver electricity from suppliers to consumers. Grid basically divided into Micro, Pico, and Nanogrid and further also classified into AC Nanogrid and DC Nanogrid [10-11]. Although its structure is more complex, and for the meantime a more expensive one, it provides unparalleled flexibility for the residential house applications.

Nanogrid

Nanogrid has the ability to separate a house from the micro-grid using PHEV. Intentiona1ly due to a fault and another grid conditions, work in a different mode like stand-alone mode, synchronize and reconnect to the microgrid, without any load power interruptions [3].

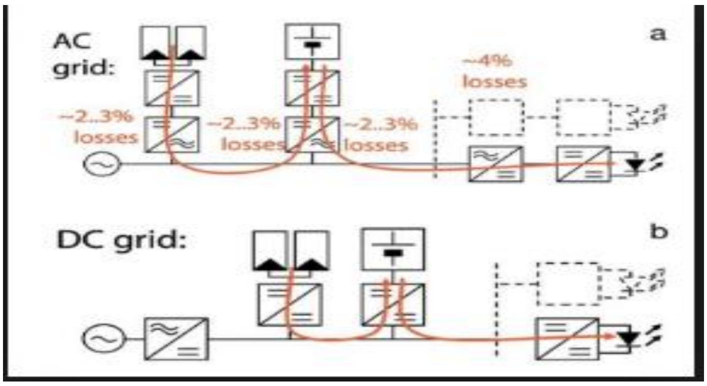

Figure 3 AC and DC Grid

The basic idea behind the vehicle to grid technology is that electric vehicles (EV) can provide power to the grid when parked. In order to function properly in V2G mode, PHEV must be equipped with devices which are bi-directional power converter and also additional battery pack. After installing this there is a two-way energy flow is possible;

1. When there is low demand for power in that case batteries are charged
2. When demand is high in that case storage energy of batteries can be used.

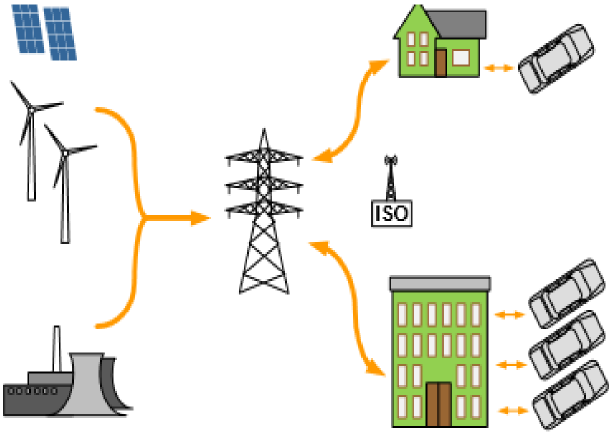

Figure:4 An illustrative schematic of the vehicle to grid implementation

Various MPPT (maximum power point tracking) strategies are acceptable for the fast dynamical environments which are square erasure projected in every analog and digital form. The discussion is concerned with merits and demerits of the analog MPPT ways can be presented in the Liu and Huang (2011). From Liu and Huang (2011), analog MPPT ways give faster response than digital as a result of metric of the analog loop may larger. However, most analog MPPT ways are required for analog multipliers which are the unit of power consumption and measurement expensive [9-10]. On opposite hand, various low-cost power microcontrollers come with integral hardware digital multipliers unit of the measurement out from integrated circuit vendors such as a microchip, TX Instruments that why the digital implementation of the MPPT has well known in the medium and high power PV-Hydro Diesel (PV) systems digital controllers unit of the measurement normally used. More so, digital implementation allows some options such as user interfaces and protection modes. Some researchers are worked on the digital MPPT schemes that are acceptable for fast dynamical environments [4].

III.PLANNING OF WORK/METHODOLOGY

(A) Polycrystalline silicon

Polycrystalline silicon also is known as polysilicon is a high purity, a polycrystalline form of Si, used as a raw material by the solar PV and electronics industry. Polysilicon is produced from metallurgical grade silicon by a chemical purification procedure, called the Siemens process. Following process have steps of distillation of volatile Si compounds, and their decomposition into silicon at very high temperatures. An emerging, alternative process of refinement uses a fluidized bed reactor. The photovoltaic industry also produces upgraded metallurgical-grade silicon, using metallurgical instead of chemical purification procedure. In our research work we simulate our result for three different solar PV modules and after that, we will analyze which will be better.

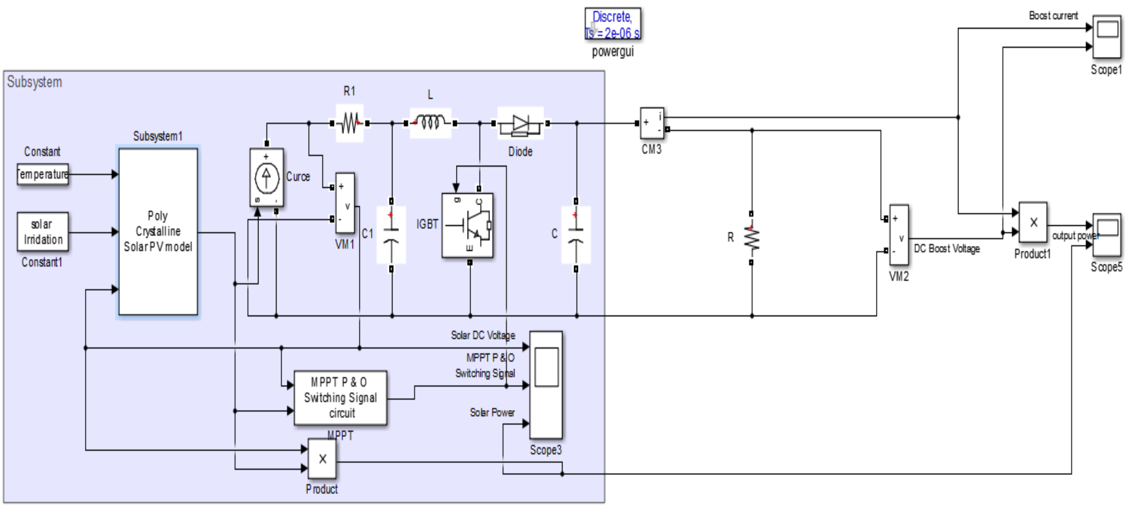

Figure 5 Block Diagram of Polycrystalline PV Solar Module

(B) Monocrystalline Photovoltaic

Monocrystalline PV electric solar energy panels have been the go-to choice for decades. They are among the oldest and most efficient and favourable & dependable ways to produce electricity from the sun. Each and every module is fabricated from a single Si crystal, and is more efficient, though it is more costly than the newer and cheaper polycrystalline and thin-film Photo Voltaic panel technologies [15]. You can recognize them by their color which is generally typically black or iridescent blue.

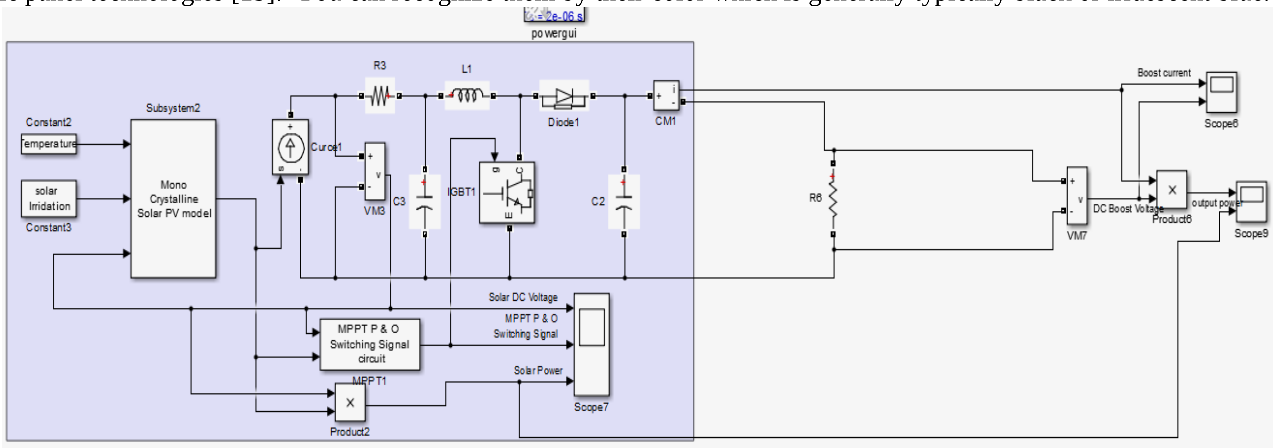

Figure 6 Block Diagram of Mono-Crystalline PV Solar Module

Next, a Si seed crystal is put into an apparatus known as Czochralski growth, where it is dipped into melted polycrystalline Si. The traditional way of adding boron (B), is to introduce a small amount of boron during the Czochralski procedure. The seed crystal rotates as it is withdrawn, forming a cylindrical ingot of very pure silicon [16]. Wafers are then sliced out of the ingot and after that sealed back to back and p1aced in a furnace to be heated to slightly below the melting point (MP) of silicon (1,410 deg Celsius) in the presence of phosphorous (P) gas.

(C)Thin-Film Solar Cell

A thin-film solar cell is a 2nd generation solar cell that is manufactured by depositing one or more thin layers on a substrate, for example, glass, plastic or metal. Thin-film solar cells are commercially used in several technologies, including CdTe, CIGS, and a-Si, TF-Si. Film thickness can vary from nanometers to 10 of micrometers, 1st -generation crystalline silicon solar cell that uses wafers of up to two hundred μm. This permit thin film cells to be very flexible, and low in weight [14]. It is used to manufacture integrated Photo Voltaic and as semi-transparent, PV glazing material which can be laminated onto doors and windows. Thin-film technology has always been cost effective but less efficient as compared to conventional c-Si technology. However, it has significant grown over the years. During testing in lab efficiency of CdTe and CIGS is approximately 21 %.

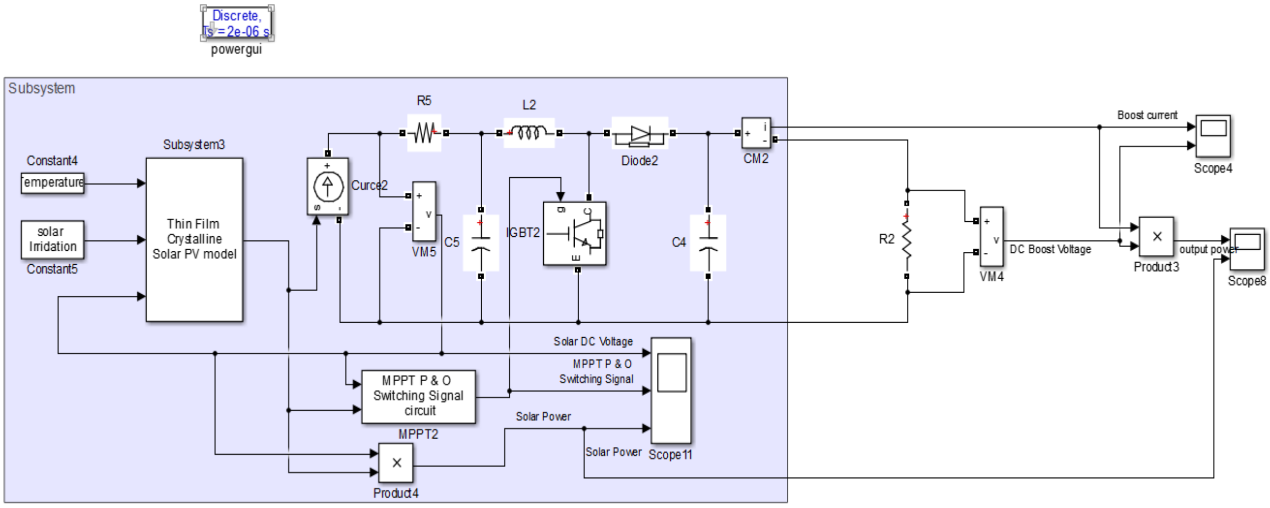

Figure 7 Block Diagram of Mono-Crystalline PV Solar Module

IV. SOFTWARE USED AND SIMULATION RESULT

Software: MATLAB Version R2015a: It is powerful software that provides an environment for numerical computation as well as a graphical display of outputs. In Matlab, the data input is in the ASCII format as well as binary format. It is a high-performance language for technical computing integrates computation, visualization, and programming in a simple way where problems and solutions are expressed in familiar mathematical notation.

- Acquisition, Data Exploration, Analysing &Visualization
- Engineering complex drawing and scientific graphics
- Analysing of algorithmic designing

- Mathematical and Computational functions
- Modeling and simulating problems prototyping
- GUI (graphical user interface) building environment.

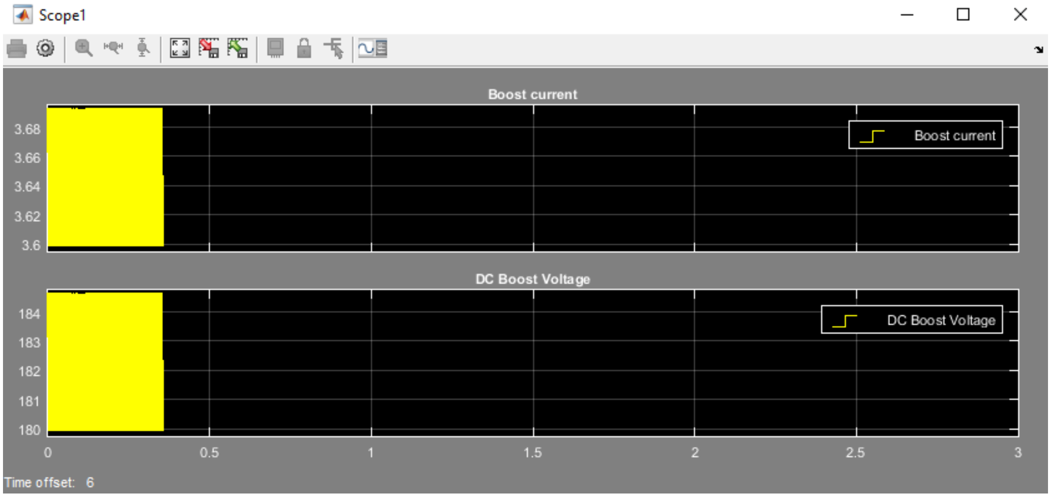

Figure 8 Poly Crystalline Module Boost current and DC boost voltage

Figure 8 Poly Crystalline Module Boost current and DC boost voltage represent the solar boost current come from MPPT controller and DC boost current is perfect DC current is 3.62A.
Similarly, the DC boost voltages also come from MPPT DC boost converter. The DC boost voltage is 182 volts.

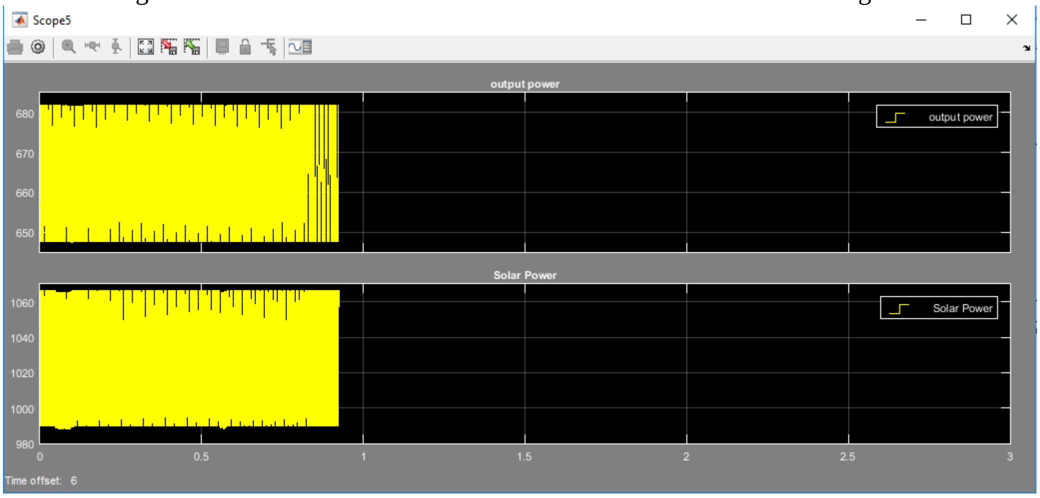

Figure 9 Poly Crystalline Module output solar power input solar power

Figure 9 represents the result of Poly Crystalline Module based solar output power and solar input power. Maximum power point tracking (MPPT) Pulse width modulation is used to reduce the harmonics and improve the efficiency and help to boost the Solar DC voltage.

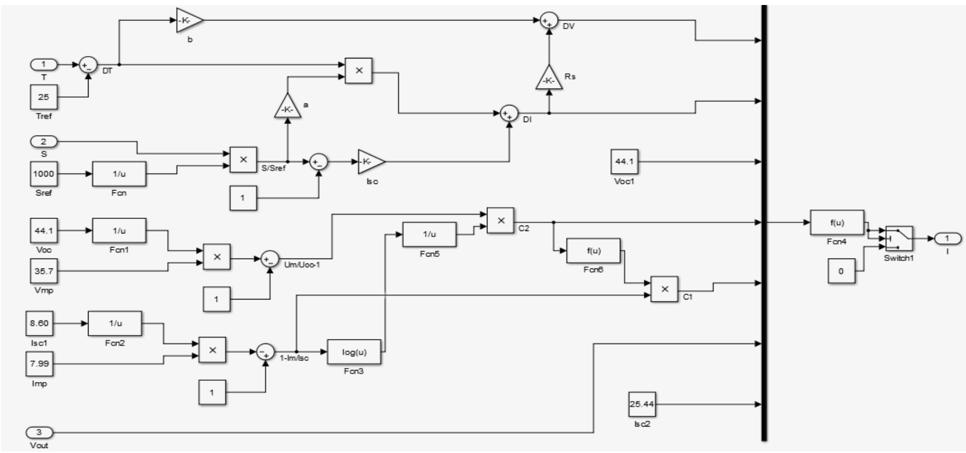

Figure 10 Mono Crystalline internal Diagram

Figure 10 is a Simulink diagram of Mono-Crystalline photovoltaic array (PV system) and it is an interconnection of modules which in turn is made up of many PV cells in series or parallel. The power produced by a single module is not enough for commercial use, so modules are connected to form array to supply the load. The Solar PV Cell, Module and Array Most PV arrays use an inverter to convert the DC power into alternating current that can power the motors, loads, lights etc. The modules in a PV array are usually first connected in series to obtain the desired voltages; the individual modules are then connected in parallel to allow the system to produce more current

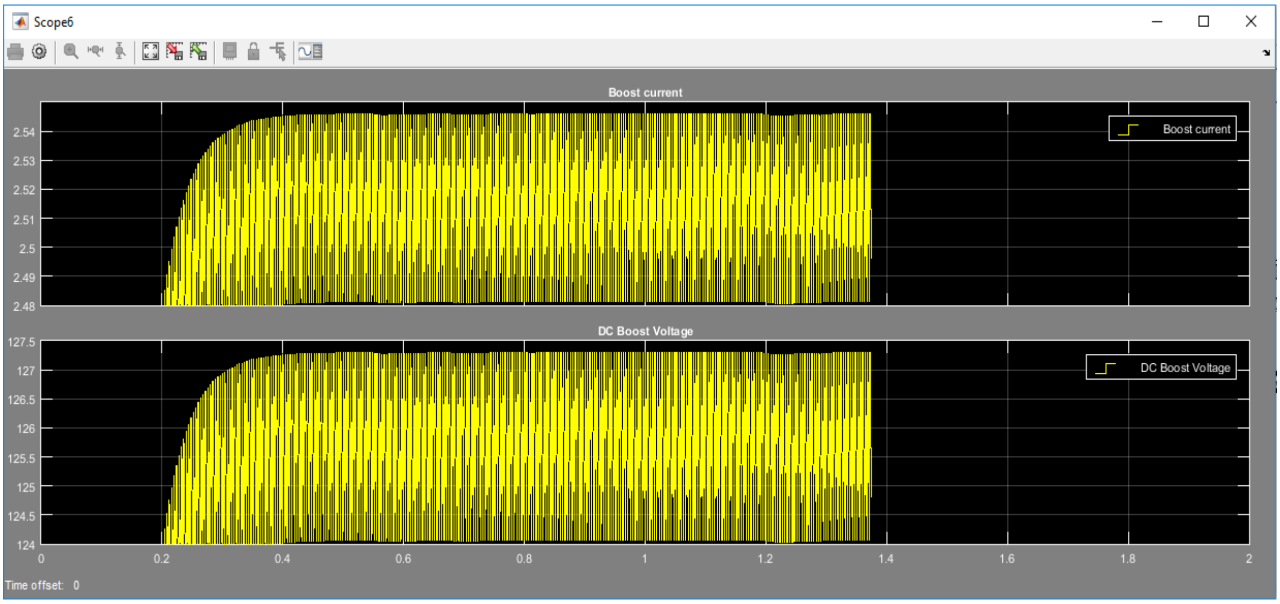

Figure 11 Mono Crystalline Module Boost current and DC boost voltage

Figure 11 Mono Crystalline Module Boost current and DC boost voltage are present the solar boost current come from MPPT controller and DC boost current is perfect DC current is 2.62A. Similarly, the DC boost voltage also comes from MPPT DC boost converter. The DC boost voltage is 250 volts

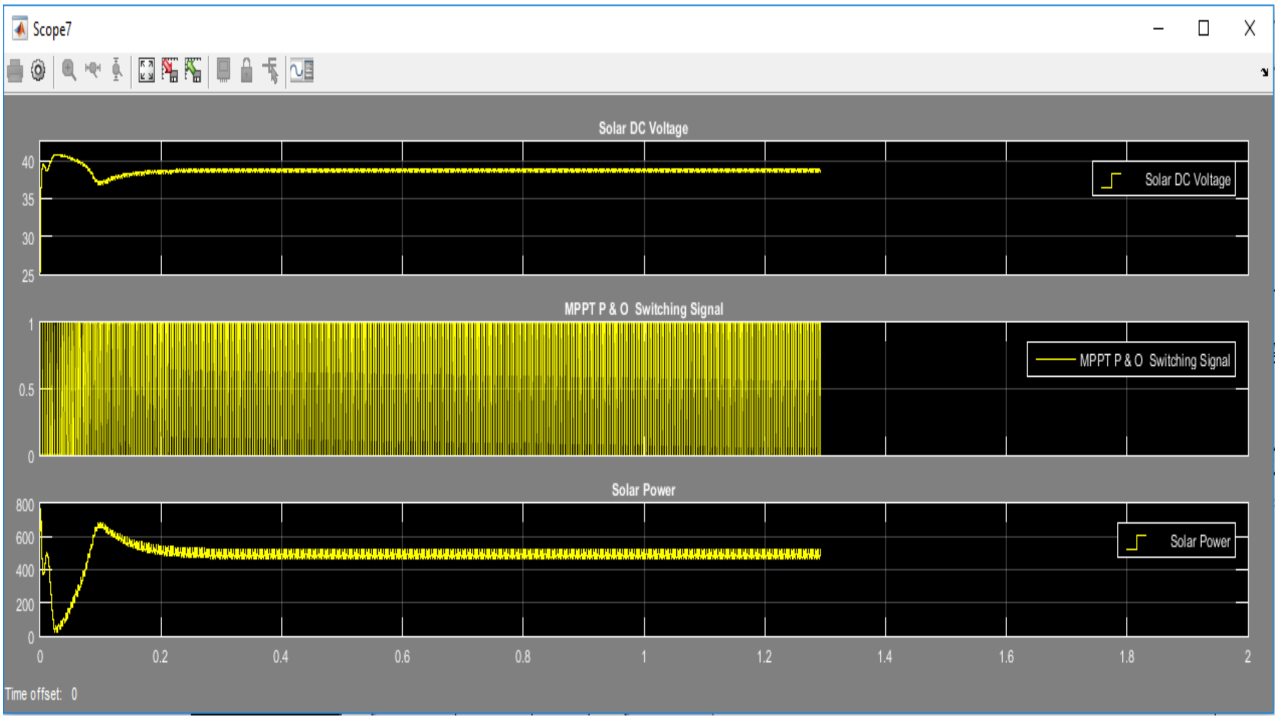

Figure 12 Mono Crystalline Module solar DC boost voltage, MPPT P & O switching and solar power

Figure 12 represents Mono Crystalline Module solar DC boost voltage which is required by MPPT and second result is MPPT switching signal for operating IGBT by Perturb and observe (P & O) and last is solar DC power which is Output DC solar power

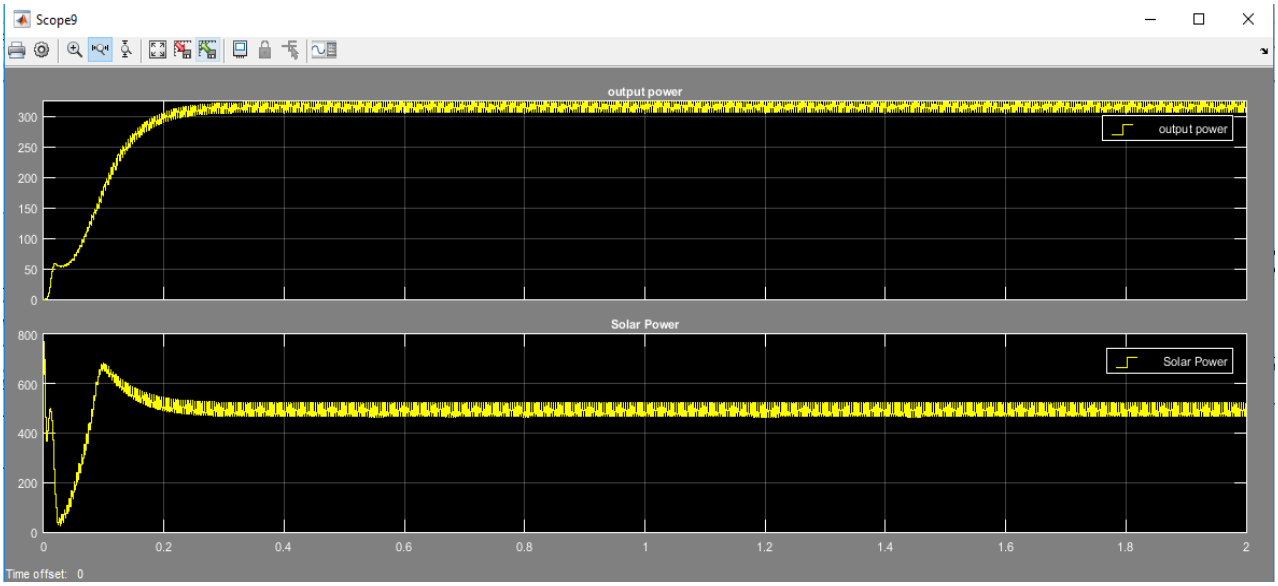

Figure 13 Mono Crystalline Module output and solar power

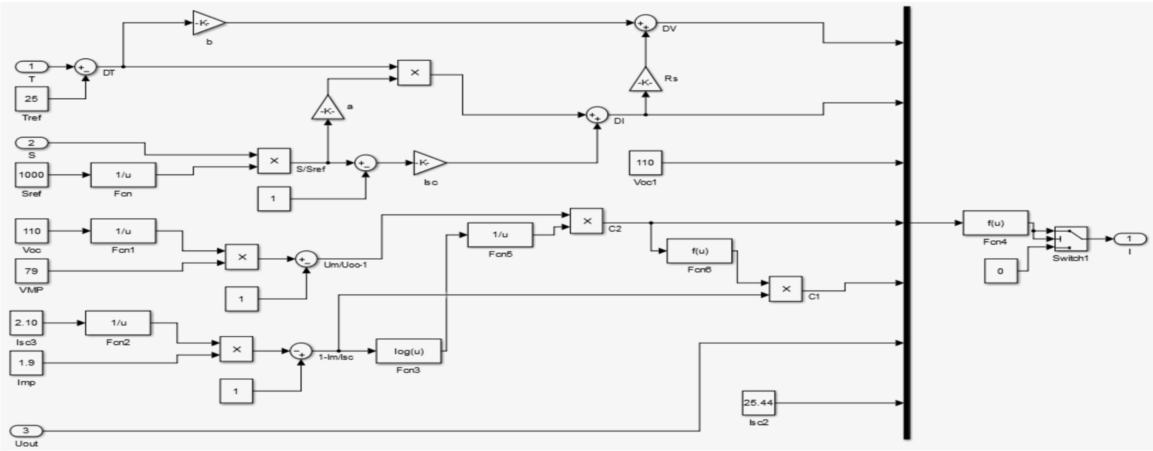

Figure 14 Thin Film Crystalline internal circuit diagram

Figure 14 Thin Film Crystalline internal circuit diagram photovoltaic array (PV system) and it is an interconnection of modules which in turn is made up of many PV cells in series or parallel. The power produced by a single module is not enough for commercial use, so modules are connected to form array to supply the load. The Solar PV Cell, Module and Array Most PV arrays use an inverter to convert the DC power into alternating current that can power the motors, loads, lights etc. The modules in a PV array are usually first connected in series to obtain the desired voltages; the individual modules are then connected in parallel to allow the system to produce more current

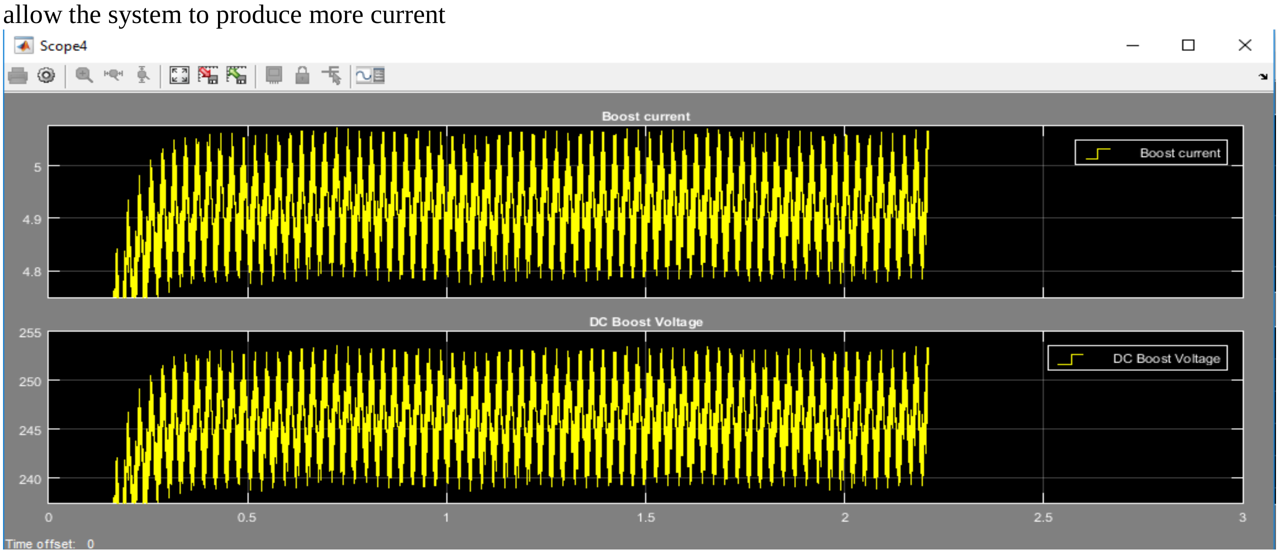

Figure 15 Thin Film Crystalline block diagram

Figure 15 Thin Film Crystalline block diagram Boost current and DC boost voltage represents the solar boost current come from MPPT controller and DC boost current is perfect DC current is 2.62A. Similarly, the DC boost voltages also come from MPPT DC boost converter. The DC boost voltage is 250 volts

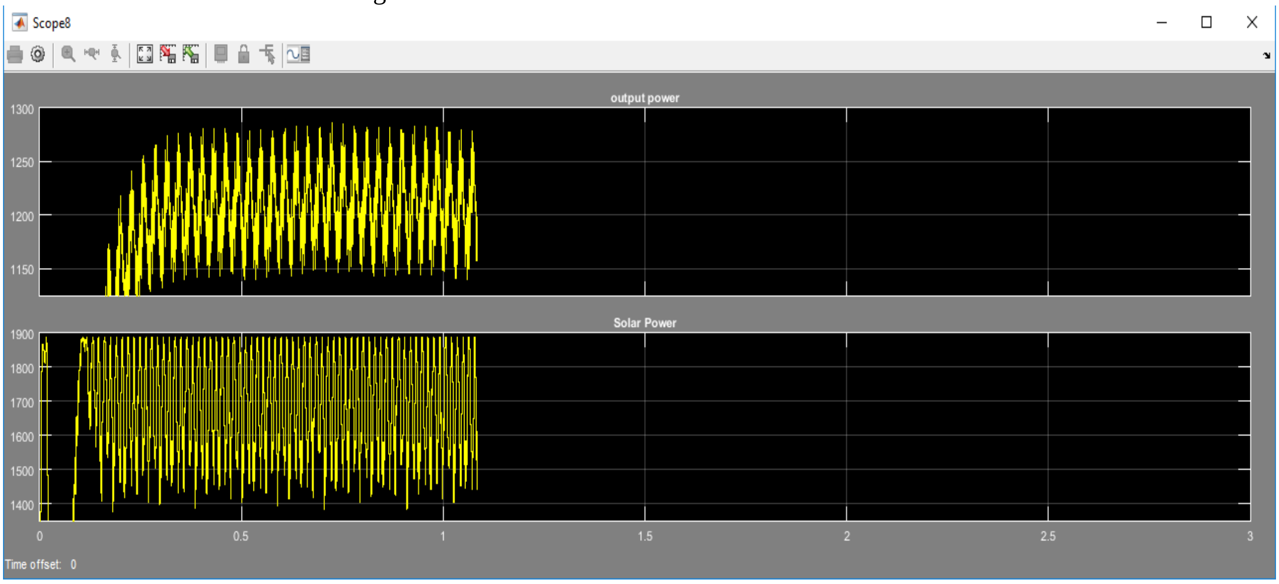

Figure 16 Thin Film Crystalline Module output and solar power

Figure 16 represents Thin Film Crystalline Module output solar power and input solar power

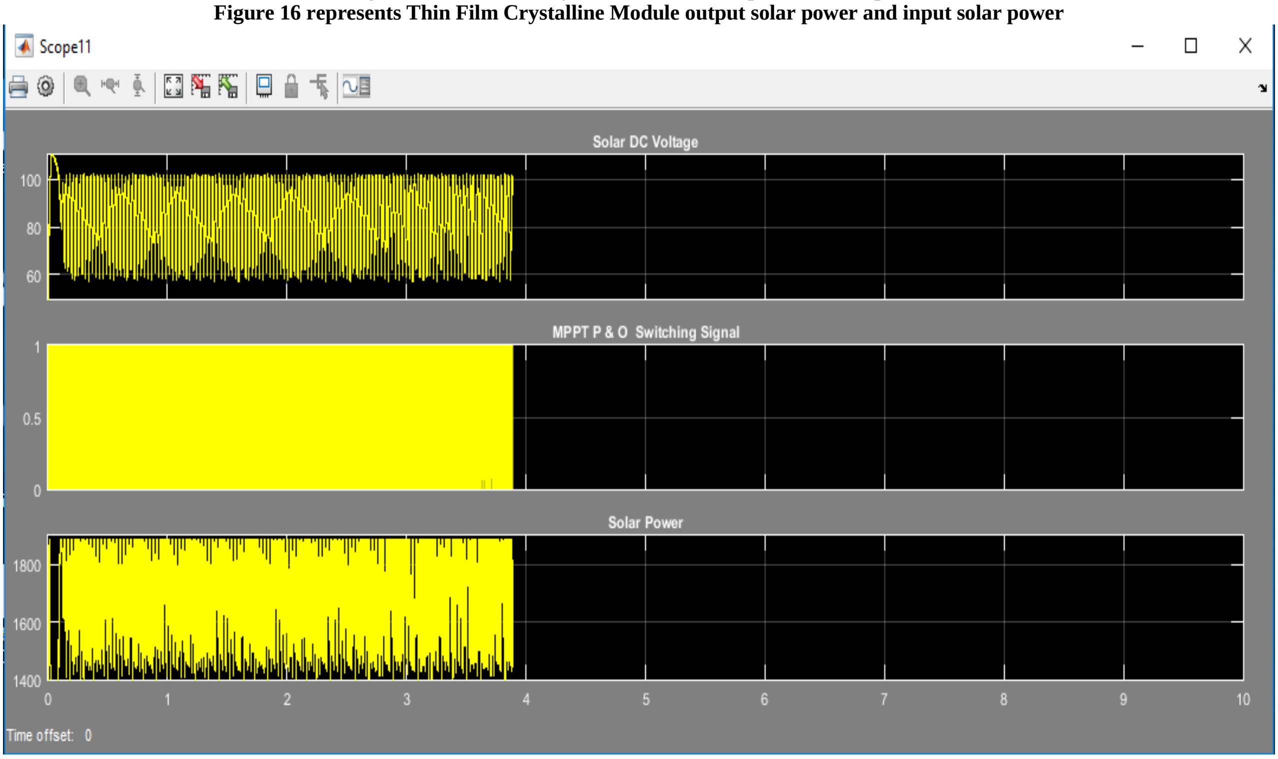

Figure 17 Thin Film Crystalline Module solar DC boost voltage, MPPT & O switching and solar power

Figure 17 Thin Film Crystalline Module solar DC boost voltage, MPPT & O switching and solar power represents Thin Film Crystalline Module solar DC boost voltage which is required by MPPT and second result is MPPT switching signal for operating IGBT by Perturb and observe (P & O) and last is solar DC power which is Output DC solar power

CONCLUSION

This dissertation simulates the DC-DC converter for application of DC Nano grid, at two voltage levels: 160 V &200 V DC output voltages from buck-boost converter. This small level DC output voltage is used for small home appliances load. The constant DC output voltage is obtained through two level using a PI controller and MPPT algorithm for tracking maximum power from solar PV module. The simulation results demonstrate the buck-boost converter application for maintaining constant voltage at DC bus irrespective of variation of solar PV generation. Also, it improves the system efficiency by reducing no. of conversions. The Simulation results validated that the Nano-grid achieves easily plug and play with the sources and loads with this method. Furthermore, the smooth transition between grid-connected and islanded modes can be achieved without variations of the control scheme under the proposed strategy. DC-Bus voltage can be stabilized both in the grid-connected. Improvement to this project can be made by tracking the maximum power point in changing environmental conditions. Such as variation in solar irradiance as well variation in temperature Environmental change can be changed in solar irradiation or change in ambient temperature or even both.

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