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Co-ordination of Distributed Generation in Microgrid System

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***Abstract*— The requirement of the energy is going to increases drastically in future years for that Micro-grid is a good solution for providing energy gap, which is not able to fulfill by the fossil sources. After generation, society is required to control that energy optimally as maximum utilization of Distributed Generation for the future requirement. and retrieve stored energy whenever require. This paper shows simple co-ordination between Grid and Solar power plant. In co-ordination Islanded and Grid connected mode between Solar Power Plant and Grid are simulated in MATLAB.**

Keywords*— *Solar plant, PCC, Grid connected mode, Islanded mode;

I. Introduction

Microgrid can able to operate in grid connected as well as in isolated mode. Small capacity of hydro, ocean, wind, solar and biomass plants with various energy storage elements are used in micro-grid. This concept is mostly applicable in rural areas fir power supply and for local load. It can also assist main grid by producing power. Main advantages of micro-grid are it reduces transmission lost, tower cost by placing micro-source, and also high efficiency. In Micro-grid through PCC (Point Of Common) point MG(Micro-Grid) can operate in grid connection or isolated mode[1]. In Grid connection mode PCC switch is closed so that grid and micro-source can operate parallel. In Isolated mode only Micro-source is connected to the load due to that it has limited power excess[2]. In Grid connected mode though transformer main grid is supplying power to grid, And near to the micro-source inverter is used for the power feeding to load. For economical operation grid is in standby mode, when load increase more that Micro-source Grid come in picture and supply extra load or in any abnormal condition.

II. Design of Solar Power Plant

The solar energy that hits the earth's surface in one hour is equivalent to the energy consumed by all human activities in a year. The sunlight is converted into electricity by using the photovoltaic effect[3]. Photovoltaic effect is a phenomenon through which a collection of light-generated carries by the P-N junction causes a movement of electron to the N-type side and holes to the P-type side of junction. This acts as a source of current. Due to the high cost of PV modules, optimal utilization of the available solar energy is imperative. This requires an accurate, reliable and comprehensive that affects the output of the PV cell[4]. Temperature (T), irradiance(G) have influence on the open circuit current(Isc). Which determine the power generation. A PV system directly converts sunlight into electricity. Solar cell is main device of the solar system. Cells are arranged in panel. Power electronics converters are used to convert generated DC electricity into AC electricity. Converter also used for the regulating voltage and current at the load, to control power flow in grid connected system. The electrical energy produced by a solar cell at any time instant depends on its intrinsic properties and the incoming solar radiation. The solar radiation is composed of photons of different energies, and some are absorbed at the *p-n* junction. Photons with energies lower than the band-gap of the solar cell are useless and generate no voltage or electric current. Photons with energy superior to the band-gap generate electricity, but only the energy corresponding to the band-gap is used. The remainder of energy is dissipated as heat in the body of the solar cell.

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A. Modeling of PV Cell

The parameters required are short circuit current (Isc), open circuit voltage (Voc) and the diode ideality factor (m). The ideality factor of a diode is a measure of how closely the diode follows the ideal diode equation. Due to the presence of recombination losses, ideality factor other than ideal are produced[5] .The basic model is improved for accuracy y by introducing the series resistance (Rs).It does not prove to be efficient under temperature variations. To overcome this drawback, an additional shunt resistance (Rp) is included. This increases the parameters to a considerable level and the computations are increased. Although Rp is added, the model fails under low irradiation conditions.

B. Main Component of Solar Cell

Two main component of solar cell

- ✓ PV Array and
- ✓ MPPT and Buck Converter

III. PV Array

A. Photovoltaic cell

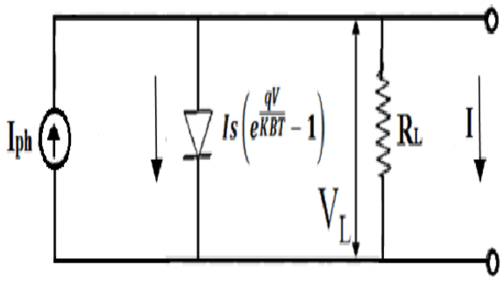

Figure:1 Equivalent model of the solar cell

A single PV cell is realized as a current source placed in parallel with a diode and the output current equation is given as:

$$I = Ipv - I0\left\{e^{\frac{q(v+IRs)}{mKT}} - 1\right\} - \{\frac{(v + I * Rs)}{Rp}\}$$

Where,

Ipv= photo voltaic current

Io=saturation current of the diode

q=electron charge in coulombs

=1.602*10-19C

K=Boltzmann constant

=1.380*10-23 J/K

m=diode ideality factor

Rs=series resistance

Rp=parallel resistance

T=Temperature in Kelvin

This array is formulated on following equation:

$$I = Io(e^{\frac{qV}{Kt}} - 1) - Iph$$

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$$Voc = \left(\frac{KBT}{q}\right) * \ln[\frac{Iph}{Io} + 1]$$

The photo voltaic current Ipv is a function of the irradiance (G) and is formulated as:

$$Ipv = \{Ipv_{stc} + Ki\Delta T\}\frac{G}{Gstc}$$

Where

Ipv_stc=light generated current under standard test conditions (STC)

ΔT= T-Tstc (in kelvin)

G= surface irradiance of cell (W/m2)

GSTC=1000W/m2 (Irradiance under STC)

Ki = short circuit current coefficient

IV. MPPT and BUCK Converter

This paper presents simulation and co-ordination of the solar plant.in simulation 230V, 100A, 3.5kW plant is simulated. and for co-ordination irradiance of sun is taken as control signal as condition that minimum solar irradiance from sun is less than 500 solar plant is shut down and grid power start to feed load. Fig below shows Output of solar plant in form of AC.

B. Necessity of maximum power point tracking

In the power versus voltage curve of a PV module there exists a single maxima of power, i.e. there exists a peak power consistent to a specific voltage and current. The efficiency of the solar PV module is low about 13%. Since the module efficiency is low it is desirable to operate the module at the peak power point so that the maximum power can be delivered to the load under fluctuating temperature and irradiation circumstances. This maximized power helps to rally the use of the solar PV module. A maximum power point tracker (MPPT) citations maximum power from the PV unit and transfers that power to the load [6]. As an interfacing device DC/DC converter transfers this maximum power from the solar PV module to the load. By shifting the duty cycle, the load impedance is varied and corresponding at the point of the peak power with the source so as to transfer the maximum power. There are altered algorithms which help to trajectory the peak power point of the solar PV unit automatically [7]. The procedures can be written as

a. Perturb and observe
b. Incremental conductance
c. Parasitic Capacitance
d. Voltage Based Peak Power
e. Current Based Peak Power Tracking

A. PERTURB AND OBSERVE

In this procedure a minor perturbation is introduced in the system. The power of the unit variations due to this perturbation. If the power rises due to the worry then the perturbation is constant in that direction. When power achieves its peak point, the next instant power decreases and so also the perturbation reverses. During the steady state condition the procedure fluctuates nearby the peak point. The perturbation size is kept very small to retain the power difference small. It is examined that there is some power loss because of this perturbation and also it fails to track the power under fast varying atmospheric conditions. But still this algorithm is very popular and humble [08], [09].

In the existing work this procedure is chosen. Figure 2 represents the flow chart of the algorithm. The algorithm observes output power of the array and perturbs the power based on increment of the array voltage. The algorithm constantly augmentations or decrements the locus voltage based on the value of the earlier power illustration.

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Coordination of Solar and Grid

For Coordination when solar power is available throw breaker-1 power will be supplied . when solar power is not available throw grid - breaker-2 power will be supplied. Here for simulation purpose we have taken R_L load which has 5 kw value.

Here in simulation zero to 1.2 second solar power is available, show breaker-1 will be ON shown in figure 6. After 1.2 second solar power is not available due to that breaker-1 will be turn OFF and exactly at a time breaker-2 will be turn ON and supply power to the load. So, this way coordination between solar power plant and grid will be done. This can be shown from solar power plant and grid current.

When solar power plant is supplying that time breaker is OFF due to all load will be supplied from the solar power plant at that time current taking from grid is zero, which shown that grid is not supplying any power. After 1.2 second breaker-1 will be turn OFF due to in sufficient irradiation. Now as a solar power plant is not supplying any power grid will be come in to picture. As grid current is supplying that means that grid is supplying power that is after 1.2 second as a shown in a wave form figure 9. Voltage and Current waveform combine shown in figure 10 and figure 11. that show that continuous power is supplied to the load which means that whenever solar is interrupted grid will be supplied power to the load. This whole scenario is simulated.

However the method does not take account of the rapid change of irradiation level (due to which MPPT changes) and considers it as a change in MPP due to perturbation and ends up calculating the wrong MPP. To avoid this problem we can use incremental conductance method. Buck converter, that converters high voltage to low voltage by switching a thyrister. Theoretical arrangement of the buck converter is shown in fig.3

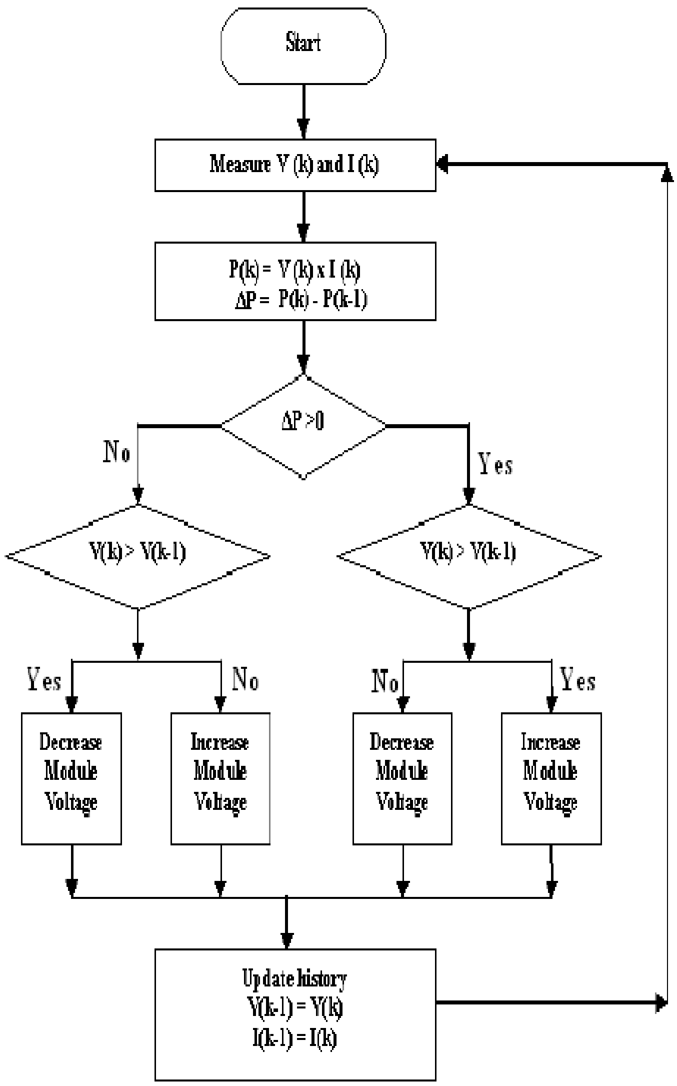

Figure 2. Flowchart Perturb and observe algorithm

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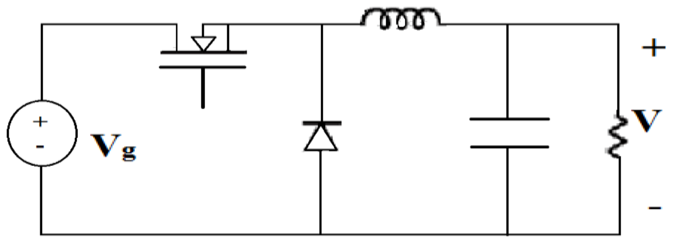

Figure: 3.buck converter circuit diagram

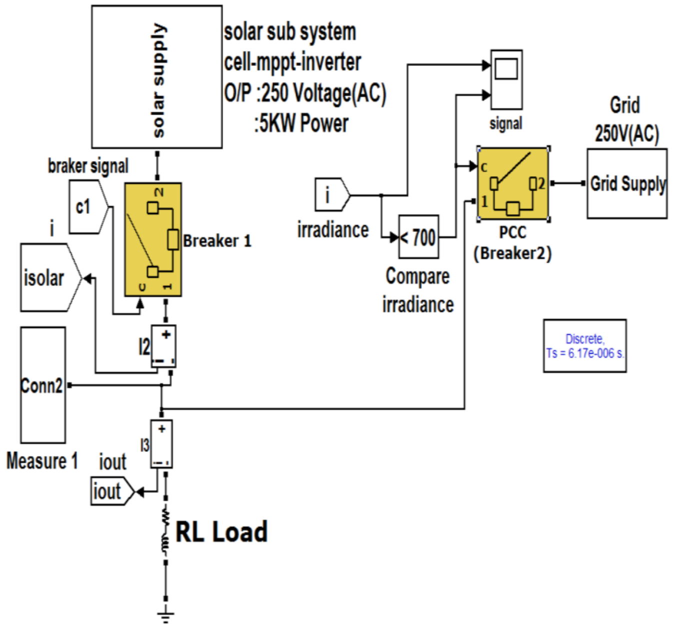

Figure 4, Simulation of the grid connected solar system

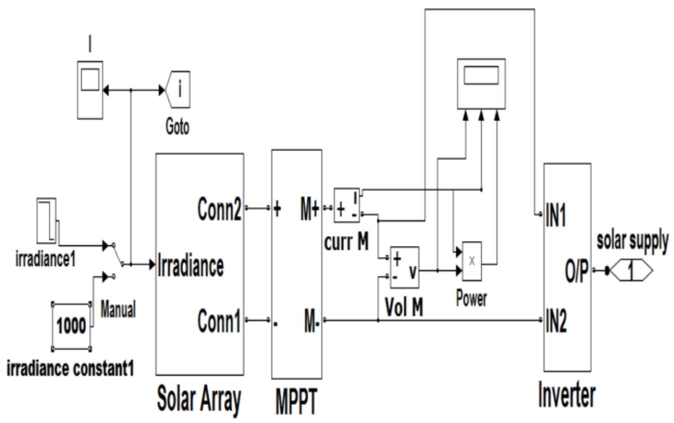

Figure 5, Solar sub system

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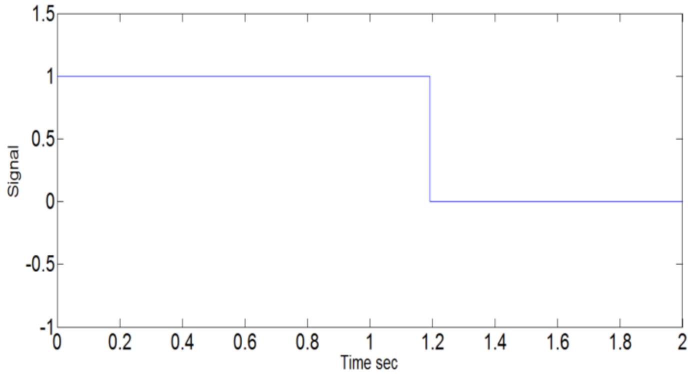

Figure 6, Control signal of breaker 1

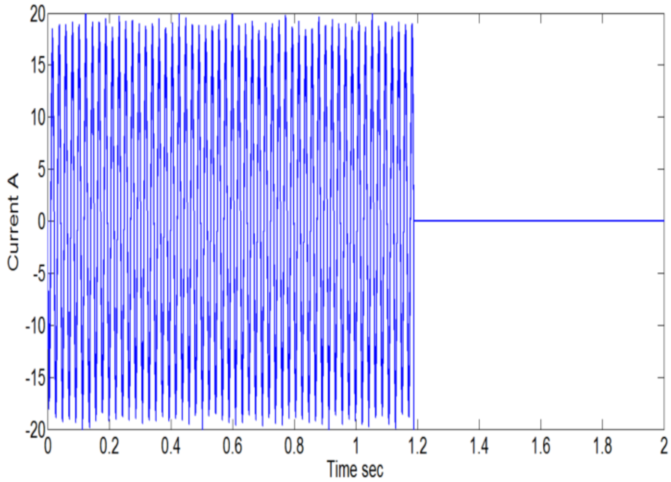

Figure 7, Solar plant output current

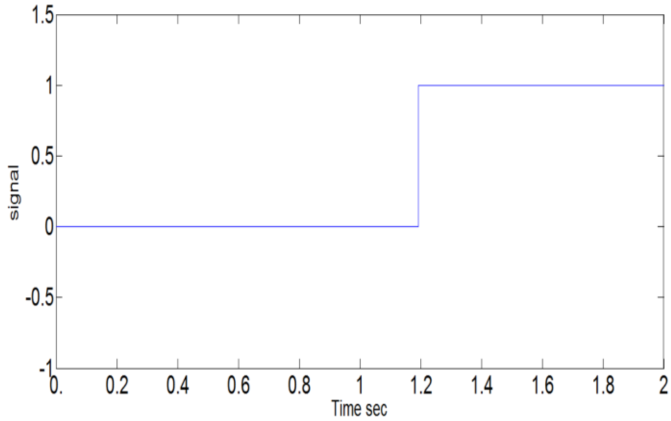

Figure 8, Signal of pcc (breaker2)

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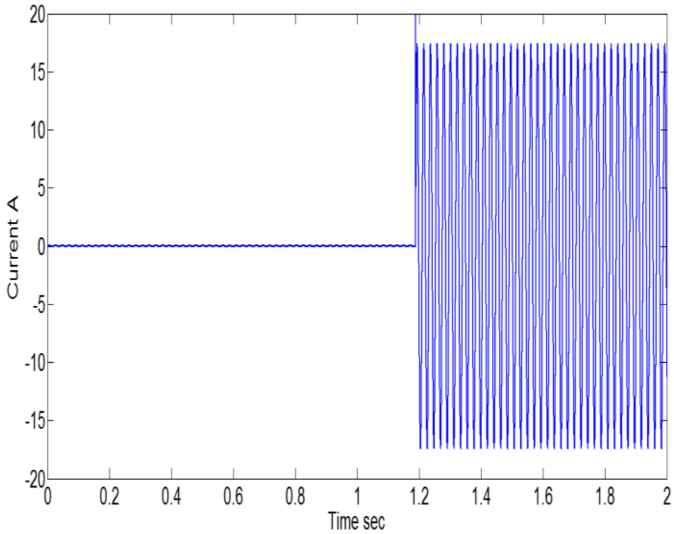

Figure 9, Current from source to load

IEEE Trans. Energy Conversion, vol. 20, no. 2, pp.406-414, June 2005.

Figure 10, Over all voltage across load

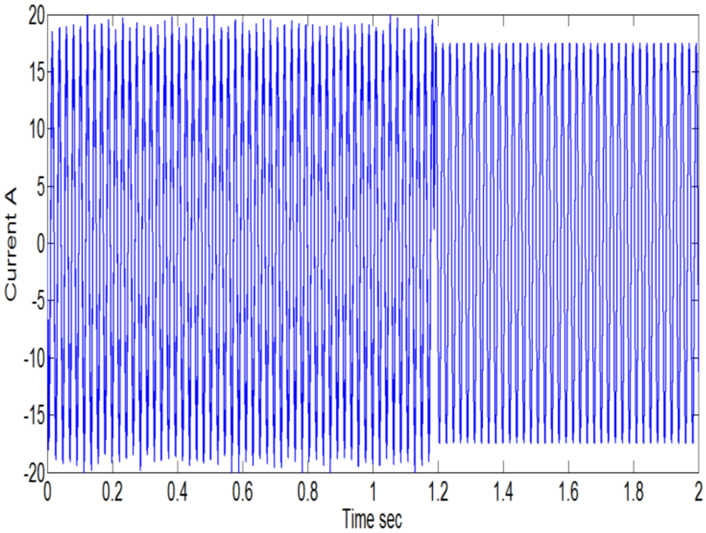

Figure 11, over all current across load

CONCLUSION

By modeling of the solar power plant, we get detail idea about how these Distributed Generation sources change its generation according to solar irradiance and wind speed at standard temperature and pressure. This paper has discussed Micro-grid technology playing a more several and significant part in the world's energy demand. Micro-grid safe procedure growth probabilities for achieve the supply and demand of the consumer. Automated load management technique using solar with MPPT Perturb and observe coordination implemented by smart controller network affords vision to surprised energy inconsistency.

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