ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

Smart Electrical Grid Technologies: "Communicative Grids with Penetration of Wind and PV Energy, Stabilization by using Matlab Powersim Model"

Maid Santosh C[1], Syed Suhail Daimi [2] ,Ubed ur Rehman[3]

Sr. Lecturer, Dept. of E&TC, Gramin Polytechnic Vishnupuri Nanded, Maharashtra, India[1]

Sr. Lecturer, Dept. of E&TC, Gramin Polytechnic Vishnupuri Nanded, Maharashtra, India[2]

Lecturer, Dept. of E&TC, Gramin Polytechnic Vishnupuri Nanded, Maharashtra, India[3]

ABSTRACT: The necessitated creation of high capacity 'Transmission Highways', so that, constraints in RoW do not become bottleneck in harnessing natural resources. Power Grid is strengthening its transmission network to establish inter-state and inter-regional links for enhancing the capacity of National Grid in a time-bound manner to ensure optimal utilization of uneven distribution of energy resources. National Grid with inter-regional power transfer capacity of about 46,450 MW was established. This proposes a hybrid ac/dc micro grid to reduce the processes of multiple dc–ac–dc or ac–dc–ac conversions in an individual ac or dc grid. The hybrid grid consists of both ac and dc networks connected together by multi-bidirectional converters. AC sources and loads are connected to the ac network whereas dc sources and loads are tied to the dc network. Energy storage systems can be connected to dc or ac links. The proposed hybrid grid can operate in a grid-tied or autonomous mode. The coordination control algorithms are proposed for smooth power transfer between ac and dc links and for stable system operation under various generation and load conditions. Uncertainty and intermittent characteristics of wind speed, solar irradiation level, ambient temperature, and load are also considered in system control and operation.

A small hybrid grid has been modeled and simulated using the Simulink in the MATLAB. The simulation results show that the system can maintain stable operation under the proposed coordination control schemes when the grid is switched from one operating condition to another.

KEYWORDS: Smart grid, renewable energy, solar, ac/dc/ac converters, BTB, power electronics, transmission lines.

I.INTRODUCTION

India's natural resources are unevenly distributed as, coal resources are abundant in Bihar/Jharkhand, Odessa, West Bengal and hydro resources are mainly concentrated in northern and North-Eastern Region, etc., far away from the demand centre's. Further, acquiring Right-of-Way (ROW) for constructing transmission system is increasingly becoming difficult. To support a high penetration of intermittent solar and wind power generation, many regions are planning to add new high capacity transmission lines. These additional transmission lines strengthen grid synchronization, but will also increase the grid's short circuit capacity, and furthermore will be very costly. With a highly interconnected grid and variable renewable generation, a small grid failure can easily start cascading outages, resulting in large scale blackout. We introduce the "Smart grid," where large synchronous grids are divided into smaller segmented grids which are connected asynchronously; via multi leg IP addressed ac/dc/ac converters called digital grid routers. These routers communicate with each other and send power among the segmented grids through existing transmission lines, which have been repurposed as digital grid transmission lines. The digital grid can accept high penetrations of renewable power, prevent cascading outages, accommodate identifiable tagged electricity flows, record those transactions, and trade electricity as a commodity New and Renewable Energy.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

Ministry of New and Renewable Energy (MNRE) is the Nodal Ministry at the federal level for all matters relating to new and renewable energy. The ministry has been facilitating the implementation of broad spectrum programmers' including harnessing renewable power, renewable energy to rural areas for lighting, cooking and motive power, use of renewable energy in urban, industrial and commercial applications and development of alternate fuels and applications Power from Renewable, The gross installed capacity of grid interactive renewable power in the country stood at about 33.8 GW as on December 31, 2014 . India occupies the fifth position in the world with a wind power installed capacity of 22.5 GW. During the year 1,333 MW wind power projects were commissioned. The generation from wind power projects during the year was around 30 billion units. The ministry has taken up a new initiative for implementation of wind resource assessment in uncovered / new areas with an aim to assess the realistic potential at 100 m level in 500 new stations across the country under the National Clean Energy Fund (NCEF). An MoU was signed in October, 2014 for setting up a joint venture company towards undertaking the first demonstration offshore wind energy project. Wind energy generators of unit sizes between 250kw and 2.50 megawatt have been deployed across the country. Biomass power projects including through bagasse cogeneration with an aggregate surplus power generation capacity of about 152 megawatt have been successfully commissioned. Biomass gasifier based 1megawatt power plant has been commissioned in Haryana to meet the captive power needs and installation of 50 biomass gasifier and combustion based power projects with cumulative installed capacity of 6.20 megawatt, to meet the captive demand for electricity and thermal applications are under installation in different states. Small hydro projects with a capacity of 187.22 megawatt have been commissioned during the year. Solar power projects installations grown by 431 megawatt capacity by using solar photovoltaic's and solar thermal technologies being commissioned during the year.

II. MOTIVATION AND PROBLEM DEFINATION

AC micro grids have been proposed to facilitate the connection of renewable power sources to conventional ac systems. However, dc power from photovoltaic (PV) panels or fuel cells has to be converted into ac using dc/dc boosters and dc/ac inverters in order to connect to an ac grid.

In an ac grid, embedded ac/dc and dc/dc converters are required for various home and office facilities to supply different dc voltages. AC/DC/AC converters are commonly used as drives in order to control the speed of ac motors in industrial plants.

Recently, dc grids are resurging due to the development and deployment of renewable dc power sources and their inherent advantage for dc loads in commercial, industrial and residential applications. The dc micro grid has been proposed to integrate various distributed generators. However, ac sources have to be converted into dc before connected to a dc grid and dc/ac inverters are required for conventional ac loads. Multiple reverse conversions required in individual ac or dc grids may add additional loss to the system operation and will make the current home and office appliances more complicated.

The smart grid concept is currently prevailing in the electric power industry. The objective of constructing a smart grid is to provide reliable, high quality electric power to digital societies in an environmentally friendly and sustainable way. One of most important futures of a smart grid is the advanced structure which can facilitate the connections of various ac and dc generation systems, energy storage options, and various ac and dc loads with the optimal asset utilization and operation efficiency. To achieve those goals, power electronics technology plays a most important role to interface different sources and loads to a smart grid.

A hybrid ac/dc micro grid is proposed in this paper to reduce processes of multiple reverse conversions in an individual ac or dc grid and to facilitate the connection of various renewable ac and dc sources and loads to power system. Since energy management, control, and operation of a hybrid grid are more complicated than those of an individual ac or dc grid, different operating modes of a hybrid ac/dc grid have been investigated. The coordination control schemes among various converters have been proposed to harness maximum power from renewable power sources, to minimize power transfer between ac and dc networks, and to maintain the stable operation of both ac and dc grids under variable supply and demand conditions when the hybrid grid operates in both grid-tied and islanding modes. The advanced power electronics and control technologies used in this paper will make a future power grid much smarter.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

III. APPROACH

The proposed approach utilizes minutia as features along with number of ridges as features for Achieving modernization of present grid system.

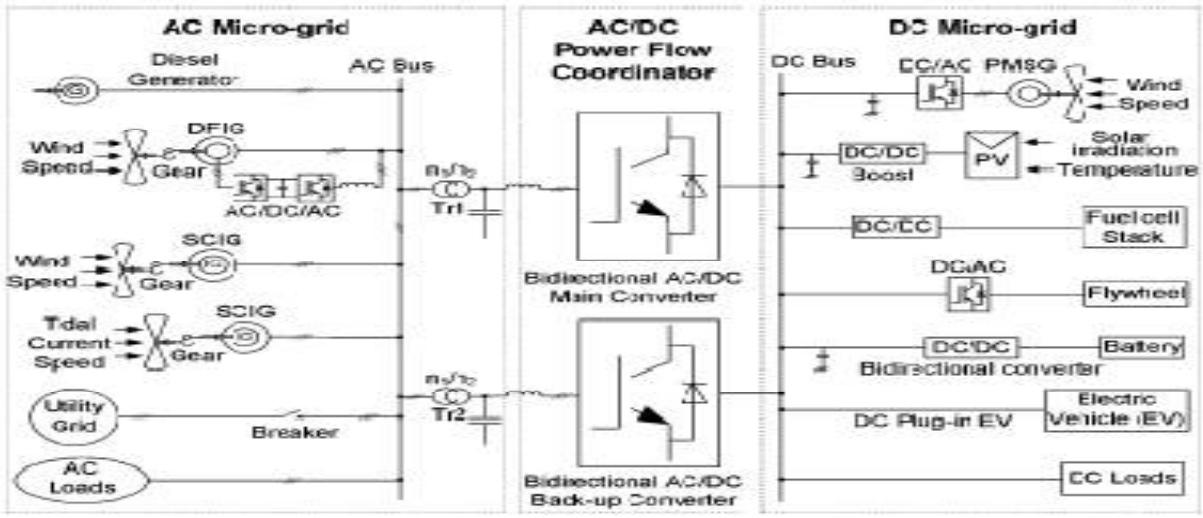

Fig 1. A hybrid ac/dc micro grid system.

IV. MAIN OBJECTIVE OF GRID SYSTEM

A. Higher Customer Satisfaction: The combination of lower costs, improved reliability and better customer control will raise satisfaction among all types of customers.
B. Improved Reliability: The Advanced Transmission Operations (ATO) and Advanced Distribution Operations (ADO) inherent in the digital grid will reduce and shorten outages and improve the quality of power.
C. Shorter Outages: The incorporation of advanced sensors and measurement (PMU), communication networks and smart systems will allow a more degree of system visibility and situational.
D. Customer Energy/Cost Savings :As pricing becomes more transparent and is aligned with the underlying economics of generation and distribution, customers' decisions to save money will benefit society as well.
E. Highest Securities: Security will be incorporated into the design of the smart grid and will require the implementation of practices and procedures by individual stakeholders. In this way, the physical and cyber security risks can be managed to the highest standards possible
F. Timely renewable Smart grid is the enabler of more renewable energy

V. PROPOSED SYSTEM

Electric grid and its benefits ,The level of demand for electricity in any one area is so variable that it is more efficient to combine demand from many sites into an overall regional load. The grid also allows generators to be located closer to resources(e.g., fuel supply, water, available land) and ship electricity over the transmission and distribution network to different load centers. Utility-scale solar and wind power. Concept of Smart Grid System , Automated, widely distributed energy delivery network characterized by a two-way flow of electricity and information, capable of monitoring and responding to changes in everything from power plants to customer preferences to individual appliances. Electricity delivery system (from point of generation to point of consumption) integrated with communications and information technology. System using Renewable and Non Renewable Energy sources , If we can envision a future world where higher penetration of renewable energy is expected Increasing proportions of renewable and variable energy generation because increasing fluctuations which will become, at some point, unmanageable use the current grid architecture

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

A. Wind energy

The conventional ways of generating electricity using non renewable resources such as coal, natural gas, oil and so on Which great impacts on the environment as it contributes vast quantities of carbon dioxide to the earth's atmosphere Kinetic energy from the wind is used to turn the generator inside
the wind turbine to produce electricity There are several factors that contribute to the efficiency of the wind turbine in extracting the power from the wind Power available in wind can be computed by the formula below -

$$pa = \frac{1}{2}AV$$

(Available Wind Energy is proportional to the cube of the wind speed)

where
p is power available in Watts
ρ is density of air
A is area swept by rotor in sq. meters.
V is wind speed in m/s
However the actual power available at the generator shaft is explained Power Co-efficient (Cp) describes that fraction of Power in the wind that may converted by the wind turbine in to mechanical work

$$\text{cp} = \frac{Pawer\ wind\ from\ turbine}{Power\ avalable\ in\ wind}$$

$$Pe = \frac{1}{2}\rho A v^3$$

Control System for wind turbine

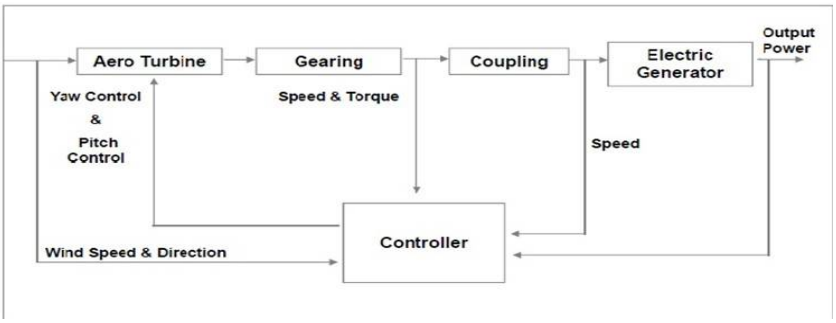

Fig 2 Wind Turbine Line Diagram Solar Energy

B. Solar Energy

The photovoltaic effect was first reported by Edmund Becquerel in 1839 when he observed that the action of light on a silver coated platinum electrode immersed in electrolyte produced an electric current The photoconductivity depend on fact that the current produced was proportional to the intensity of the incident light

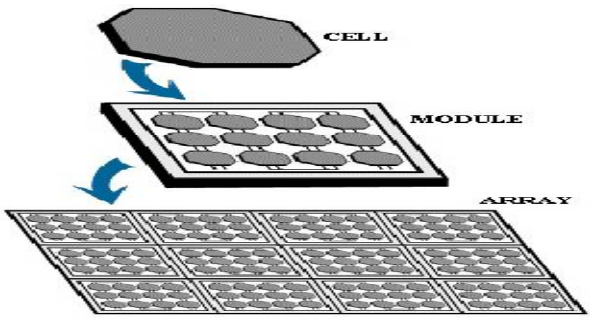

Fig 3 Solar Array

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

A number of solar cells electrically connected to each other and mounted in a single support structure or frame is called a photovoltaic module Modules are designed to supply electricity at a certain voltage, such as a common 12 volt system The current produced is directly dependent on the intensity oflight reaching the module. Several modules can be wired together to form an array The current from the cell group is equivalent to the addition of the current from each cell , but the voltage remains equivalent to that of a single cell.

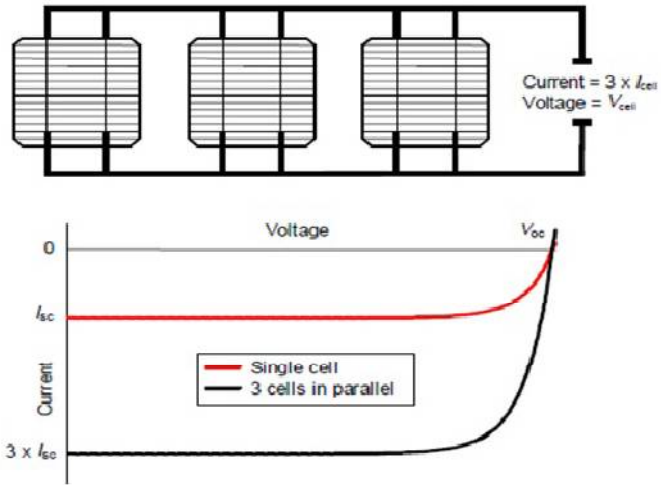

Fig 4 Parallel connection of cells, with resulting current voltage characteristic

The photo voltaic array A PV array consists of a number of PV modules, mounted in the same plane and electrically connected to give the required electrical output for the application mounting structure The main purpose of the mounting structure is to hold the modules in the required position without undue stress Tilt angle and orientation The orientation of the module with respect to the direction of the Sun determines the intensity of the sunlight falling on the module surface Power Evacuation of PV System.
There are two main system configurations

a] stand-alone
b] grid-connected

a] Stand-alone PV

The stand-alone PV system operates independently of any other power supply and it usually supplies electricity to a dedicated load or loads. It may include a storage facility (e.g. battery bank) to allow electricity to be provided during the night or at times of poor

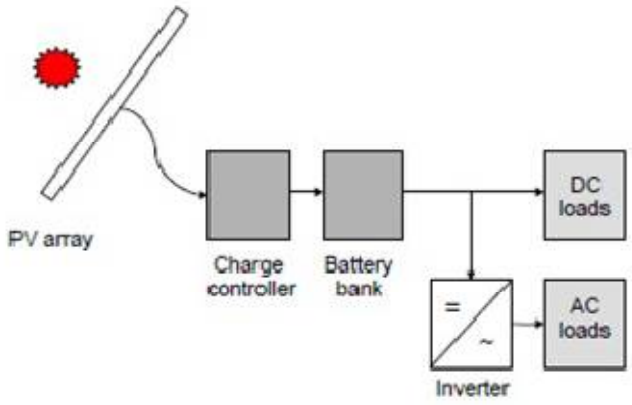

Fig 5 Schematic diagram of a stand-alone photovoltaic system

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

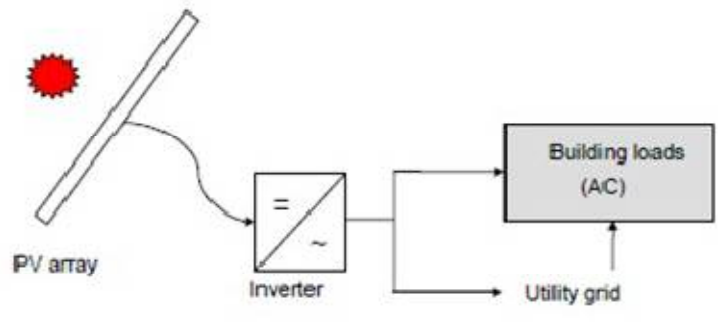

Fig 6 Schematic diagram of grid-connected photovoltaic system

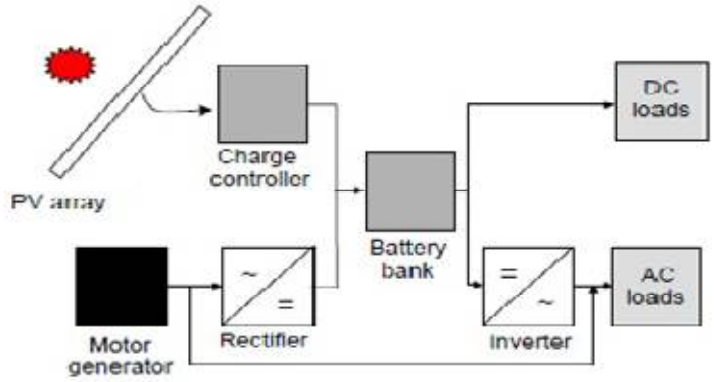

Fig 7 Schematic diagram of hybrid system incorporating a photo voltaic array and a motor generator

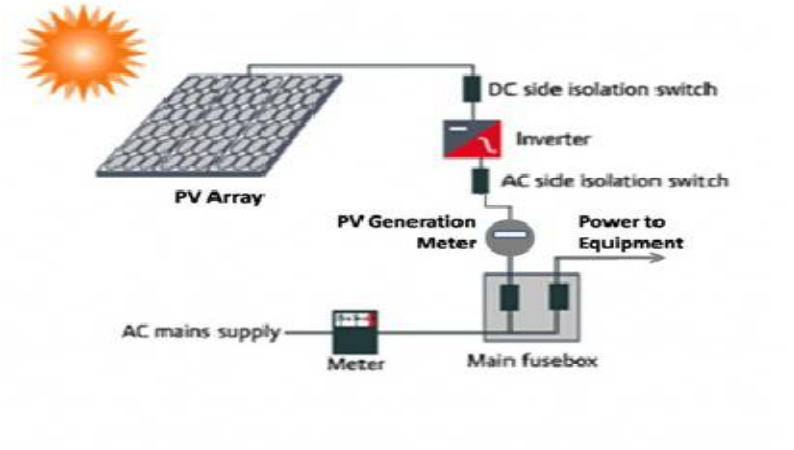

Fig 8 PV System

AC/DC/AC Micro grid

This proposes a hybrid ac/dc micro grid to reduce the processes of multiple dc ac dc or ac dc ac conversions in an individual ac or dc grid The proposed hybrid grid can operate in a grid-tied or autonomous mode. The coordination control are proposed for smooth power transfer between ac and dc links and for stable system operation under various generation and load conditions The simulation results show that the system can maintain stable operation under the proposed coordination control schemes when the grid is switched from one operating condition to another AC micro grids have been proposed to

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

facilitate the connection of renewable power sources to conventional ac systems However, dc power from photo voltaic (PV) panels or fuel cells has to be converted into ac using dc/dc boosters and dc/ac inverter's in order to connect to an ac grid AC/DC/AC converters are commonly used as drives in order to control the speed of ac motors in industrial plants Multiple reverse conversions required in individual ac or dc grids may add additional loss to the system operation and will make the current home and office appliances more complicated A hybrid ac/dc micro grid is proposed in this to reduce processes of multiple reverse conversions in an individual ac or dc grid and to facilitate the connection of various renewable ac and dc sources and loads to power system The advanced power electronics and control technologies used in this paper will make a future power grid much smarter.

VI. MATLAB IMPLIMENTATION

A compact hybrid grid as shown in is modeled using the Simulation in the MATLAB to simulate system operations and controls. Forty kW PV arrays are connected to dc bus through a dc/dc boost converter to simulate dc sources. A capacitor Cpv is to suppress high frequency ripples of the PV output voltage. A 50 kW wind turbine generator (WTG) with doubly fed induction generator (DFIG) is connected to an ac bus to simulate ac sources. The rated voltages for dc and ac buses are 400 V and 400 V rms respectively. A three phase bidirectional dc/ac main converter
with R-L-C filter connects the dc bus to the ac bus through an isolation transformer Grid Operation The hybrid grid can operate in two modes. In grid-tied mode, the main converter is to provide stable dc bus voltage and required
reactive power and to exchange power between the ac and dc buses. The boost converter and WTG are controlled to provide the maximum power When the output power of the dc sources is greater than the dc loads, the converter acts as an inverter and injects power from dc to ac side. When the total power generation is less than the total load at the dc side, the converter injects power from the ac to dc side In the grid tied mode, the battery converter is not very important in system operation because power is balanced by the utility grid

VII. RESULT AND DISCUSSION

CASE 1

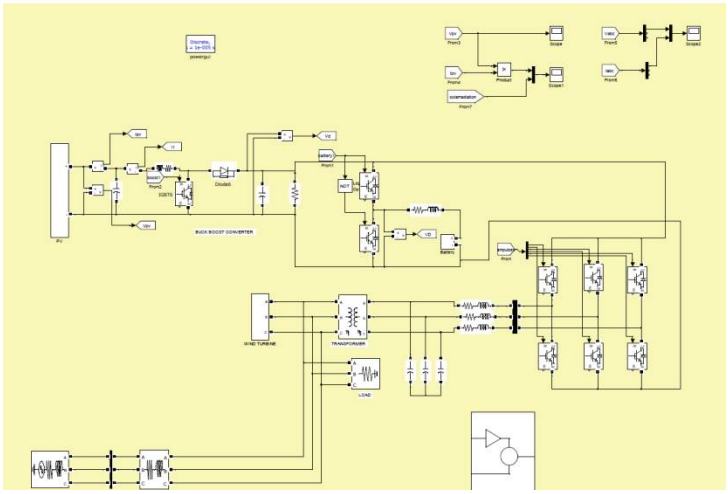

Fig 9 the main converter operates Power is balanced by the utility grid.

In this mode, the main converter operates Power is balanced by the utility grid. The battery is fully charged and operates in the rest mode in the simulation. AC bus voltage is maintained by the utility grid and dc bus voltage is maintained by the main converter.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

RESULT OF CASE 1

a) AC side voltage and current of the main converter with variable solar.
b) PV output power versus solar irradiation.
c) The terminal voltage of the solar panel.

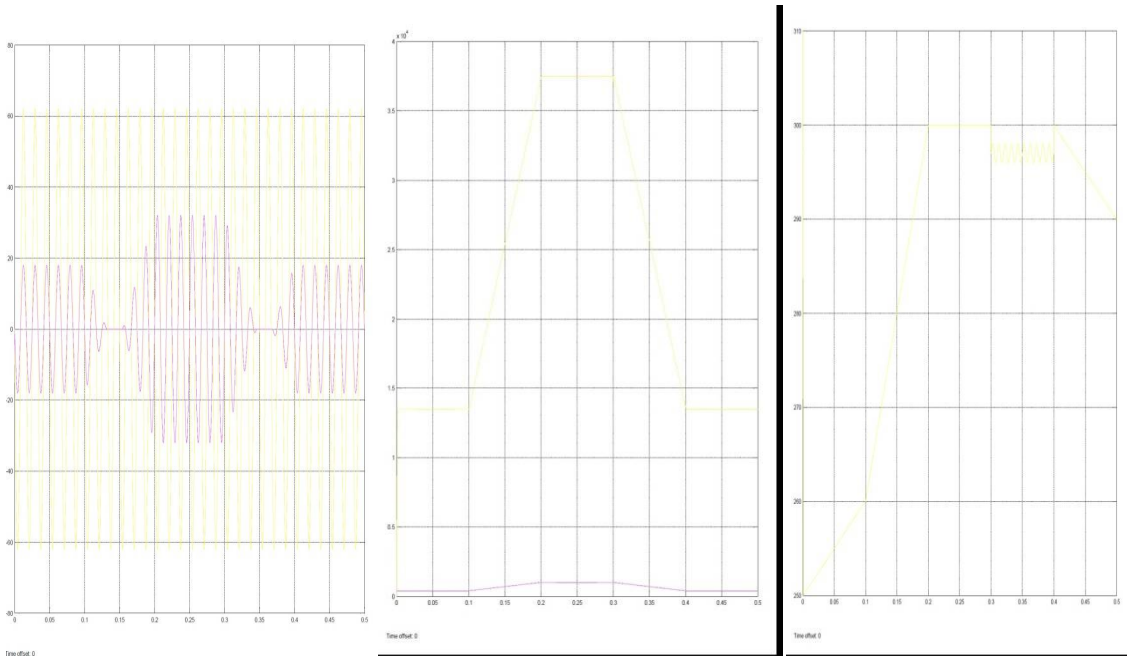

Fig a AC side voltage and current Fig b PV vs. solar irradiation Fig C The terminal voltage of the solar

CASE 2

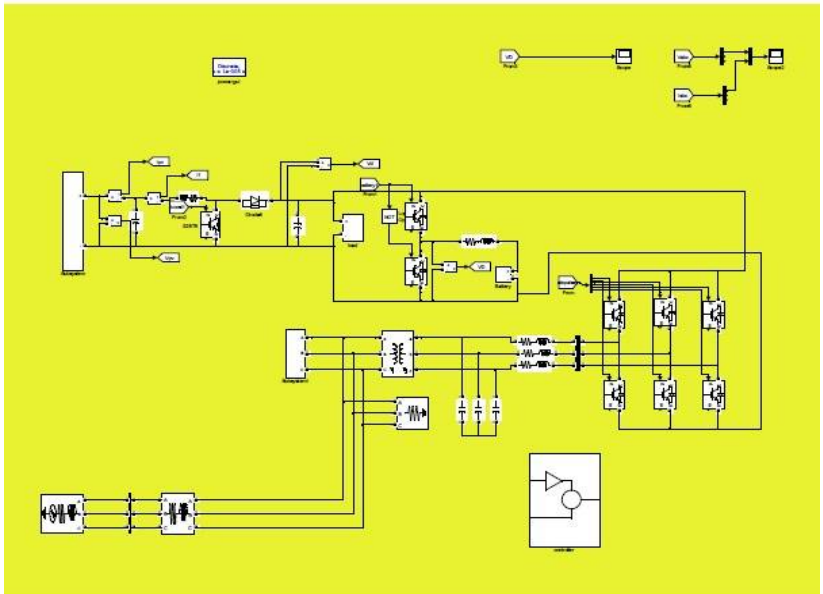

Fig 10 AC side voltage versus current and DC bus voltage transient response

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

RESULT OF CASE 2

a)AC side voltage versus current.

b) DC bus voltage transient response.

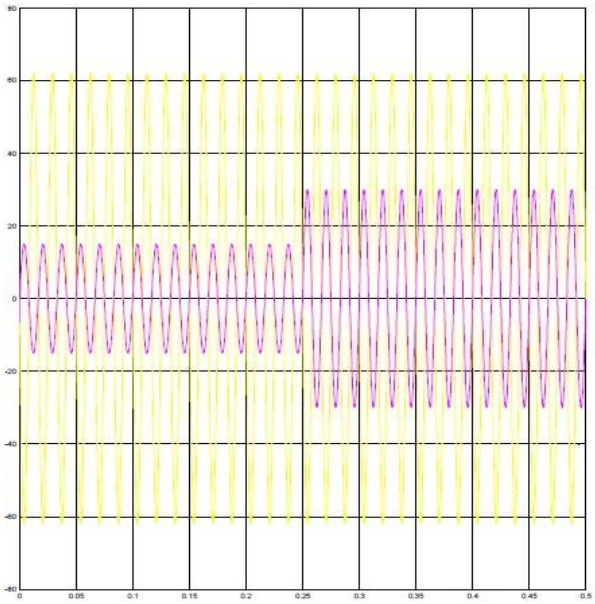

Fig a AC side voltage versus current

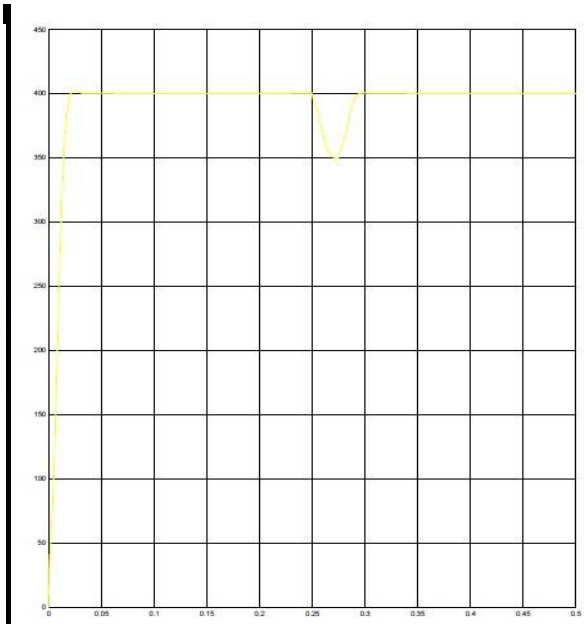

Fig b DC bus voltage transient response

VIII. CONCLUSION

A hybrid ac/dc micro grid is proposed and comprehensively studied in this paper. The models and coordination control schemes are proposed for the all the converters to maintain stable system operation under various load and resource conditions. The coordinated control strategies are verified by MATLAB/Simulink. Various control methods have been incorporated to harness the maximum power from dc and ac sources and to coordinate the power exchange between dc and ac grid. Different resource conditions and load capacities are tested to validate the control methods. The simulation results show that the hybrid grid can operate stably in the grid-tied or isolated mode. Stable ac and dc bus voltage can be guaranteed when the operating conditions or load capacities change in the two modes. The power is smoothly transferred when load condition changes.

Although the hybrid grid can reduce the processes of dc/ac and ac/dc conversions in an individual ac or dc grid, there are many practical problems for implementing the hybrid grid based on the current ac dominated infrastructure. The total system efficiency depends on the reduction of conversion losses and the increase for an extra dc link. It is also difficult for companies to redesign their home and office products without the embedded ac/dc rectifiers although it is theoretically possible. Therefore, the hybrid grids may be implemented when some small customers want to install their own PV systems on the roofs and are willing to use LED lighting systems and EV charging systems. The hybrid grid may also be feasible for some small isolated industrial plants with both PV system and wind turbine generator as the major power supply.

REFERENCES

[1] Rikiya Abe and David McQuilkin, ***"Digital Grid: Communicative Electrical Grids of the Future"*** Member, IEEE, Hisao Taoka, Senior Member, IEEE, VOL. 2, NO. 2, JUNE 2011

[2] R. H. Lasseter, ***"Micro Grids,"*** in Proc. IEEE Power Eng. Soc. Winter Meet., Jan. 2002, vol. 1, pp. 305–308.

[3] Y. Zoka, H. Sasaki, N. Yorino, K. Kawahara, and C. C. Liu, ***"An interaction problem of distributed generators installed in a Micro Grid,"*** in Proc. IEEE Elect. Utility Deregulation, Restructuring. Power Technol., Apr. 2004, vol. 2, pp. 795–799.

[4] M. E. Ropp and S. Gonzalez, "Development of a MATLAB/Simulink model of a single- phase grid-connected photovoltaic system," IEEE Trans. Energy Conv., vol. 24, no. 1, pp. 195–202, Mar. 2009.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

[5] K. H. Chao, C. J. Li, and S. H. Ho, ***"Modeling and fault simulation of photovoltaic generation systems using circuit-based model,"*** in Proc. IEEE Int. Conf. Sustainable Energy Technol., Nov. 2008, pp. 290–294.

[6] N. Ginot, M. A. Mannah, C. Batard, and M.Machmoum, **"Application of power line communication for data transmission over PWM network,"***IEEE Trans. Smart Grid*, vol. 1, no. 2, pp. 178–185, Sep. 2010.

[7] J. Liu, B. Zhao, J. Wang, Y. Zhu, and J. Hu, **"Application of power line communication in smart power consumption,"** in *Proc. IEEE Int. Symp. Power Line Commun. Its Appl.*, Mar. 2010, pp. 303–307.

[8] Nasrudin A. Rahim**," Single-Phase Seven-Level Grid-Connected Inverter for Photovoltaic System**" Senior Member, IEEE, Krismadinata Chaniago, Student Member, IEEE, VOL. 58, NO. 6, JUNE 2011

[9] Mukhtiar Singh, Vinod Khadkikar, Ambrish Chandra***," Grid Interconnection of Renewable***

[10] Energy Sources at the Distribution Level With Power-Quality Improvement Features" Senior Member, IEEE VOL. 26, NO. 1, JANUARY 2011

[11] Maid Santosh C. and Dr.S.G.Kahaleka***r "Electrical Grid Modernization": State of the Art and Future Trends.*** International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. *2, Issue 5, May 2013* ISSN (Online): 2278 – 8875

[12] India year Book 2016 INDIA 2016 A Reference Annual