"An Enhancement of Wind-Solar Hybrid Power Generation System"

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ABSTRACT: The recent upsurge in the demand of PV (AC/DC SMART GRID) systems is due to the fact that they produce electric power without hampering the environment by directly converting the solar radiation into electric power. However the solar radiation never remains constant. It keeps on varying throughout the day. The need of the hour is to deliver a constant voltage to the grid irrespective of the variation in multilevel inverter. We have designed a circuit such that it delivers constant and stepped up dc voltage to the load. We have studied the open loop characteristics of the PV array with variation in multilevel inverter levels. Then we coupled the PV array with the boost converter in such a way that with variation in load, the varying input current and voltage to the converter follows the open circuit characteristic of the PV array closely. At various isolation levels, the load is varied and the corresponding variation in the input voltage and current to the boost converter is noted. It is noted that the changing input voltage and current follows the open circuit characteristics of the PV array closely.

KEYWORD: PV panel, boost converter, DFIG, Smart grid.

I.INTRODUCTION

The Conventional sources of energy are rapidly depleting. Moreover the cost of energy is rising and therefore photovoltaic system is a promising alternative. They are abundant, pollution free, distributed throughout the earth and recyclable. The hindrance factor is it's high installation cost and low conversion efficiency. Therefore our aim is to increase the efficiency and power output of the system. It is also required that constant voltage be supplied to the load irrespective of the variation in solar irradiance and temperature. PV arrays consist of parallel and series combination of PV cells that are used to generate electrical power depending upon the atmospheric conditions (e.g solar irradiation and temperature). So it is necessary to couple the PV array with a boost converter. Moreover our system is designed in such a way that with variation in load, the change in input voltage and power fed into the converter follows the open circuit characteristics of the PV array. Our system can be used to supply constant stepped up voltage to dc loads.

As electric distribution technology steps into the next century, many trends are becoming noticeable that will change the requirements of energy delivery. These modifications are being driven from both the demand side where higher energy availability and efficiency are desired and from the supply side where the integration of distributed generation and peak shaving technologies must be accommodated [1].

Today electrical power demand is very much increasing. So to generate the required power, resources used for this purpose are also increase. Hence proper utilization of power is required whenever surplus power is available. This can be achieved by storing the surplus power through batteries in the form of DC and this stored energy can be re- utilized by the conversion device called it as "INVERTER" by converting DC power into AC power. The renewable energy sources have been tremendously increasing its production, out of all those renewable energy sources solar is popular and it needs an inverter for the conversion. The multilevel inverters are the advancement in power electronics. Now-a-days multilevel inverters in literature are updating according to the high power capability. Hence, multilevel inverters are capable of having good voltage spectrum and low voltage stress devices. Power electronic inverters are becoming popular for various industrial drives applications. In recent years, inverters have even become a necessity for many implementations such as motor controlling and power systems [2].

II.OBJECTIVES OF THIS WORK

- To propose and develop a hybrid AC/DC micro-grid (with combination of Photovoltaic PV and a hydrogen storage system as backup) that consists of both ac and dc networks connected together by bidirectional converter.

- The Proposed Hybrid micro-grid would improve the dynamic performance of the Grid connected PV System (GPV (AC/DC SMART GRID) S) in a day ahead market.

- This work deals with system integration and controller design for power management of a grid connected Micro grid system.

- A two level control system is implemented, comprising a supervisory controller, which ensures the power balance between intermittent PV generations, Hydrogen based energy storage, and dynamic load demand, as well as local controllers for the photovoltaic, electrolyze, and fuel cell unit.

- The coordination control algorithm is proposed for smooth power transfer between ac, dc links and Tie Line for stable system operation under various generation and load conditions.

- Profile of AC and DC bus voltages has been analyzed especially, when the operating conditions or load capacities change under the various modes of operation.

- The proposed Micro grid can be advantageous in a distribution system having voltage fluctuations in close vicinity to the solar Farm.

- The control strategy has been proposed for voltage regulation utilizing proposed Micro grid as static synchronous compensator (Hybrid).

- In grid connected mode, power can be imported from the grid to charge the electrolyze or it can be injected into the grid to boost the power supplied by the Micro grid to contribute the frequency stability.

MATLAB/ SIMULINK based simulations have been carried out and results are provided to show the effectiveness of the proposed control strategy. The main **objective** of this thesis is the development of a hybrid micro grid which will reduce the process of multiple reverse conversions associated with individual AC and DC grid by the combination of

- AC and DC sub-grid
- Photovoltaic PV system and

In order to analyze the operation of micro grid system both the modeling and controlling of the system are important issues. Hence the control and modeling (to be discussed detail in Chapter 4) are also the part of this thesis work. As a part of the thesis work the overall system is simulated using MATLAB environment. In simulation work the system is modeled using different state equations [3].

III. GENERAL INFORMATION REGARDING SMART GRID

As electric distribution technology steps into the next century, many trends are becoming noticeable that will change the requirements of energy delivery. These modifications are being driven from both the demand side where higher energy availability and efficiency are desired and from the supply side where the integration of distributed generation and peak-shaving technologies must be accommodated [4].

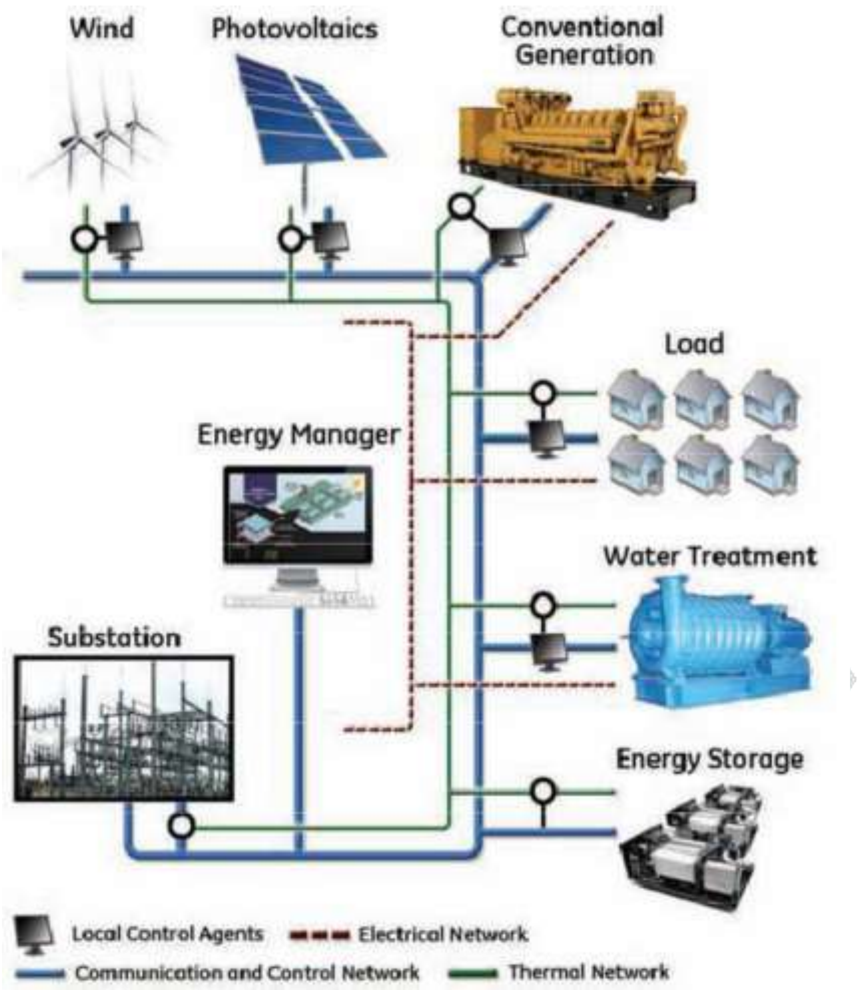

Fig 1.1. Smart grid power system

Power systems currently undergo considerable change in operating requirements mainly as a result of deregulation and due to an increasing amount of distributed energy resources (DER). In many cases DERs include different technologies that allow generation in small scale (micro sources) and some of them take advantage of renewable energy resources (RES) such as solar, wind or hydro energy. Having micro sources close to the load has the advantage of reducing transmission losses as well as preventing network congestions. Moreover, the possibility of having a power supply interruption of end-customers connected to a low voltage (LV) distribution grid (in Europe 230 V and in the USA 110 V) is diminished since adjacent micro sources, controllable loads and energy storage systems can operate in the islanded mode in case of severe system disturbances. This is identified nowadays as a micro grid. Figure 3.1 depicts a typical Smart grid. The distinctive Smart grid has the similar size as a low voltage distribution feeder and will rare exceed a capacity of 1 MVA and a geographic span of 1 km. Generally more than 90% of low voltage domestic customers are supplied by underground cable when the rest is supplied by overhead lines. The Smart grid often psupplies both electricity and heat to the customers by means of combined heat and power plants (CHP), gas turbines, fuel cells, photovoltaic (PV) systems, wind turbines, etc. The energy storage systems usually include batteries and flywheels [2].The storing device in the Smart grid is equivalent to the rotating reserve of large generators in the conventional grid which ensures the balance between energy generation and consumption especially during rapid changes in load or generation [5].

IV.PHOTOVOLTAIC SYSTEM

The photoelectric effect was first noted by French physicist Edmund Becquerel in 1839. He proposed that certain materials have property of producing small a mounts of electric current when exposed to sunlight. In 1905, Albert Einstein explained the nature of light and the photoelectric effect which has become the basic principle for photovoltaic technology. In 1954 the first photovoltaic module was built by Bell Laboratories.

A photovoltaic system makes use of one or more solar panels to convert solar energy into electricity. It consists of various components which include the photovoltaic modules, mechanical and electrical connections and mountings and means of regulating and/or modifying the electrical output [6].

Photovoltaic arrangements Photovoltaic cell

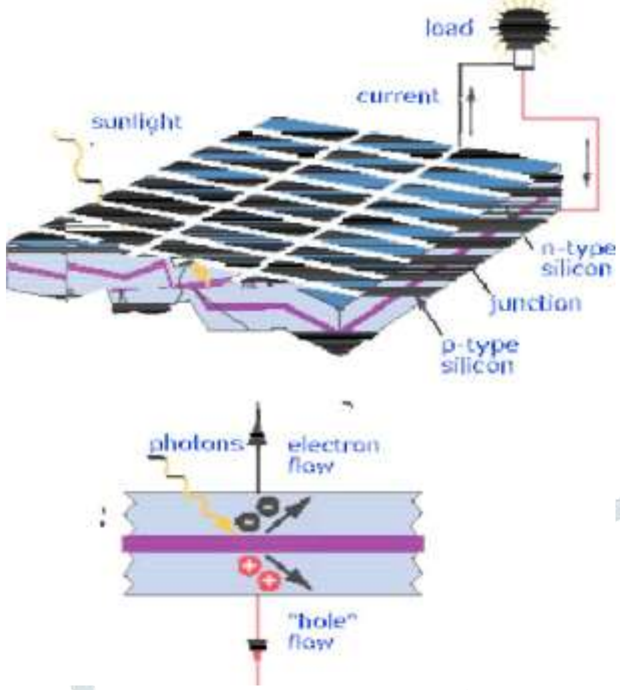

Fig 4.1. Basic structure of PV cell

Photovoltaic array

A photovoltaic array (PV system) is an interconnection of modules which in turn is made up of many PV cells in series or parallel. The power produced by single module is not enough to meet the requirements of commercial applications, so modules are connected to form array to supply the load. In an array the connection of the modules is same as that of cells in a module. 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. In urban uses, generally the arrays are mounted on a rooftop. PV array output can directly feed to a DC motor in agricultural applications [7-8-9].

V.WIND ENERGY

Wind energy is a converted form of solar energy which is produced by the nuclear fusion of hydrogen (H) into helium (He) in its core. The H and He fusion process creates heat and electromagnetic radiation streams out from the sun into space in all directions. Though only a small portion of solar radiation is intercepted by the earth, it provides almost all of earth's energy needs [10].

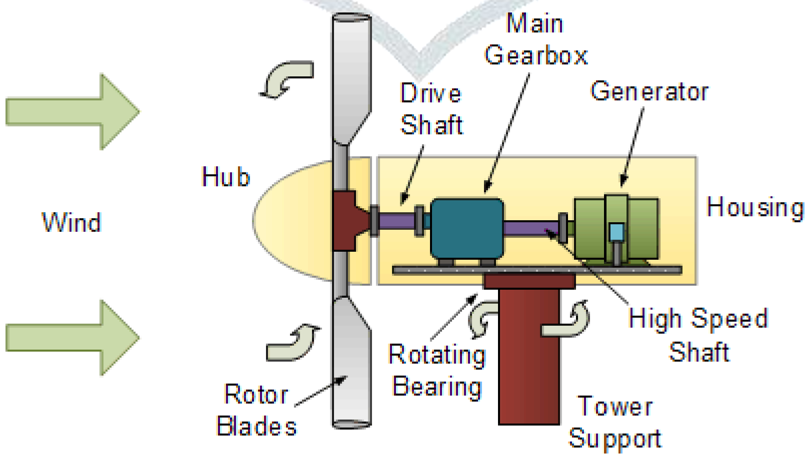

Figure 4.2 Wind based power generation.

Wind results from the movement of air due to atmospheric pressure gradients. Wind flows from regions of higher pressure to regions of lower pressure. The larger the atmospheric pressure gradient, the higher the wind speed and thus, the greater the wind power that can be captured from the wind by means of wind energy-converting machinery. The generation and movement of wind are complicated due to a number of factors. Among them, the most important factors are uneven solar heating, the Coriolis Effect due to the earth's self-rotation, and local geographical conditions

Wind energy characteristics:

Wind energy is a special form of kinetic energy in air as it flows. Wind energy can be either converted into electrical energy by power converting machines or directly used for pumping water, sailing ships, or grinding gain.

- **Wind power:**

Kinetic energy exists whenever an object of a given mass is in motion with a translational or rotational speed. When air is in motion, the kinetic energy in moving air can be determined as-

$$E_k = \frac{1}{2} m \bar{u}^2$$

…………………………………… (1)

- **Turbine power output :**

$$P_T = ½ * \rho * A * v^3 * Cp$$

Where *m* is the air mass and *u*– is the mean wind speed over a suitable time period, **Cp = 16/27**. The wind power can be obtained by differentiating the kinetic energy in wind with respect to time, i.e.:

$$P_w = \frac{dE_k}{dt} = \frac{1}{2} \dot{m} \bar{u}^2$$

………….. (2)

However, only a small portion of wind power can be converted into electrical power. When wind passes through a wind turbine and drives blades to rotate, the corresponding wind mass flow rate is

$$\dot{m} = \rho A \bar{u}$$

………………………… (3)

Where *r* is the air density and *A* is the swept area of blades. Substituting (3) into (2), the available power in wind *P* w can be expressed as

$$P_w = \frac{1}{2} \rho A \bar{u}^3$$

……………………….. (4)

An examination of eqn (4) reveals that in order to obtain a higher wind power, it requires a higher wind speed, a longer length of blades for gaining a larger swept area, and a higher air density. Because the wind power output is proportional to the cubic power of the mean wind speed, a small variation in wind speed can result in a large change in wind power.

VI.RESULT AND DISCUSSION

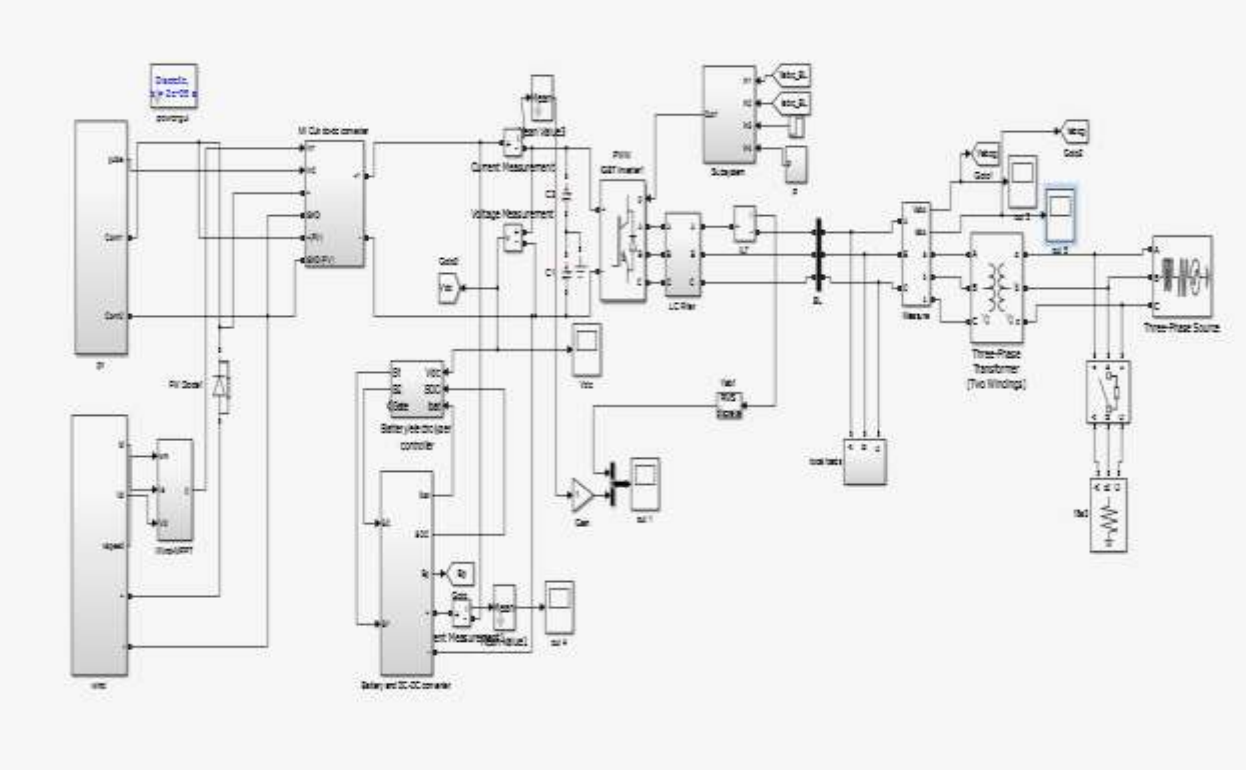

Fig (6.1) Complete Smart Grid Solar and WIND based power generation.

Fig (6.2) Complete Smart Grid Solar and WIND based power generation Output voltage.

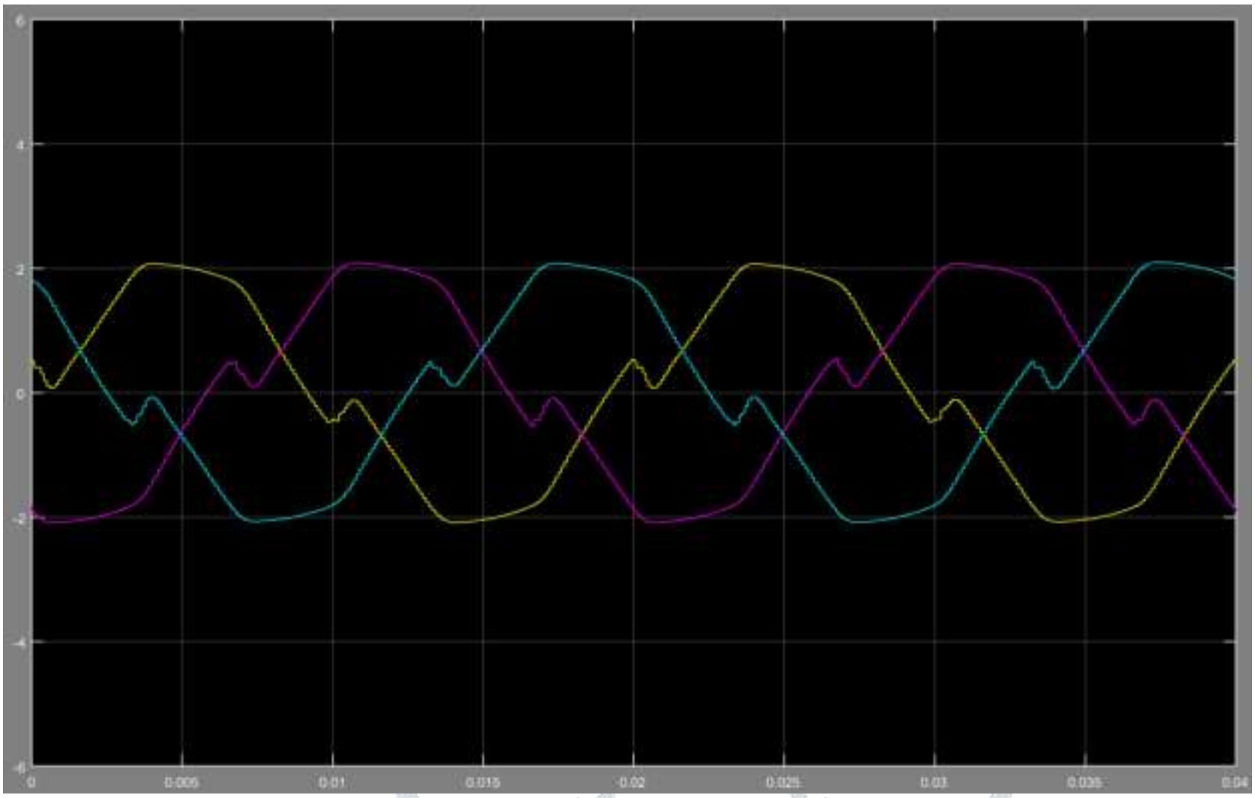

Fig (6.3) Complete Smart Grid Solar and WIND based power generation Current.

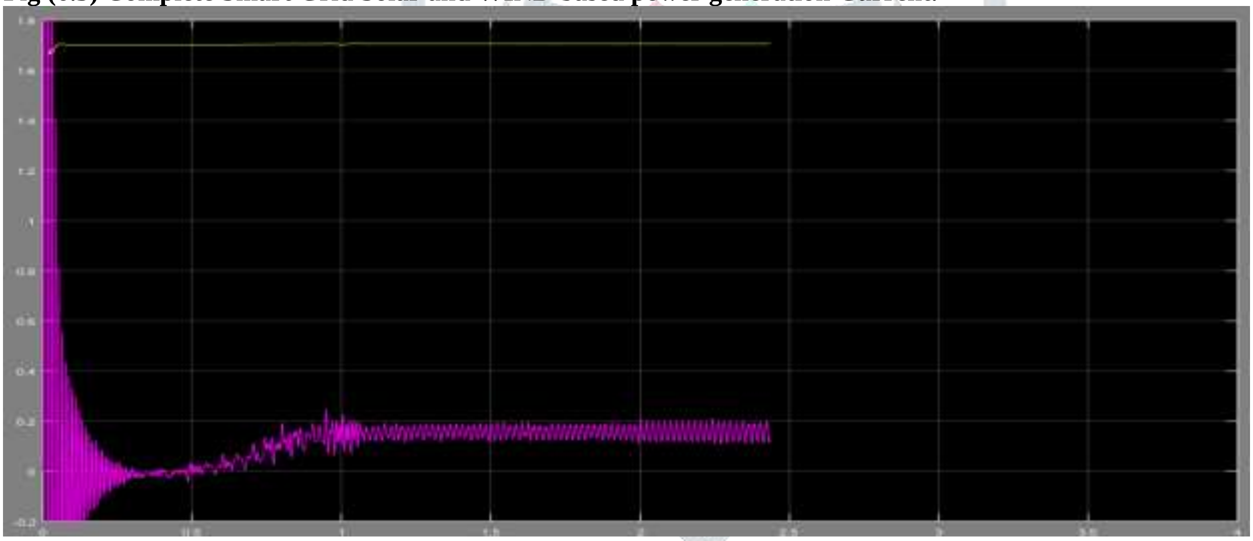

Fig (6.4) Complete Smart Grid Solar and WIND based power generation Converter across outputs.

VII. CONCLUSION

The modeling of hybrid Smart grid for power system configuration is done in MATLAB/SIMULINK environment. The present work mainly includes the grid tied mode of operation of hybrid grid. The models are developed for all the converters to maintain stable system under various loads and resource conditions and also the control mechanism are studied. MPPT algorithm is used to harness maximum power from DC sources and to coordinate the power exchange between DC and AC grid. Although the hybrid grid can diminish the processes of DC/AC and AC/DC conversions in an individual AC or DC grid, there are many practical problems for the implementation of the hybrid grid based on the current AC dominated infrastructure. The efficiency of the total system depends on the diminution of conversion losses and the increase for an extra DC link. The hybrid grid can provide a reliable, high quality and more efficient power to consumer. The hybrid grid may be feasible for small isolated industrial plants with both PV systems and wind turbine generator as the major power supply.

Scope of future work

a. The modeling and control can be done for the islanded mode of operation.

b. The control mechanism can be developed for a Smart grid containing unbalanced and nonlinear loads.

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