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Simulation of hybrid wind energy system using photovoltaic topology

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Abstract
The term Smart Grid has become a term to represent the benefits of a smart and sophisticated electrical grid, which can meet various social expectations related to sustainability and energy efficiency. The Smart Grid promises to enable a better power management for energy utilities and consumers, to provide the ability to integrate the power grid, to support the development of micro grids. The Smart Grid, regarded as the next generation power grid, uses two-way flows of electricity and information to create a widely distributed automated energy delivery network.
In this report, literatures have been studied on the enabling technologies for the Smart Grid till 2015. Performance analysis of smart grid and research paper on extended use of smart grid has been studied.

Keywords: hybrid energy system, photovoltaic system. Maximu power point tracking

1. Introduction
Due to the critical condition of industrial fuels which include oil, gas and others, the development of renewable energy sources is continuously improving. This is the reason why renewable energy sources have become more important these days. Few other reasons include advantages like abundant availability in nature, eco- friendly and recyclable. Many renewable energy sources like solar, wind, hydel and tidal are there. Among these renewable sources solar and wind energy are the world's fastest growing energy resources. With no emission of pollutants, energy conversion is done through wind and PV cells.

1.1. Photovoltaic energy system
In 1839, a French physicist Edmund Becquerel proposed that few materials have the ability to produce electricity when exposed to sunlight. But Albert Einstein explained the photoelectric effect and the nature of light in 1905. Photoelectric effect state that when photons or sunlight strikes to a metal surface flow of electrons will take place. Later photoelectric effect became the basic principle for the technology of photovoltaic power generation. The first PV module was manufactured by Bell laboratories.

1.2. PV cell
Photovoltaic cell is the building block of the PV system and semiconductor material such as silicon and germanium are the building block of PV cell. Silicon is used for photovoltaic cell due to its advantages over germanium. When photons hit the surface of solar cell, the electrons and holes are generated by breaking the covalent bond inside the atom of semiconductor material and in response electric field is generated by creating positive and negative terminals.

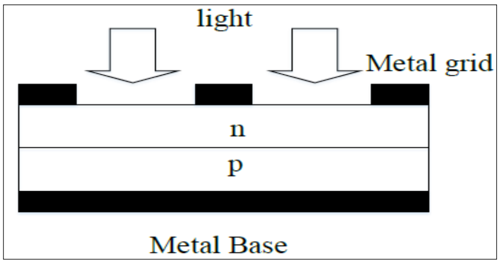

Fig 1: Structure of PV cell

1.3 PV module
Parallel or as a grid (both serial and parallel) to form a PV module as shown in fig.3.2. When pv need higher voltage, it connect PV cell in series and if load demand is high current then it connect PV cell in parallel. Usually there are 36 or 76 cells in general PV modules. Module which is used consist of 54 cells. The front side of the module is transparent usually buildup of low-iron and transparent glass material, and the PV cell is encapsulated. Efficiency of a module is not as good as PV cell, because the glass cover and frame reflects some amount of the incoming radiation**.**

1.4 PV array
A photovoltaic array is simply an interconnection of several PV modules in serial and/or parallel. The power generated by individual modules may not be sufficient to meet the requirement of trading applications, so the modules are secured in a grid form or as an array to gratify the load demand. In an array, the modules are connected like as that of cells connected in a module. While making a PV array, generally the modules are initially connected in serial manner to obtain the desired voltage, and then strings so obtained are

Connected in When a module or a part of it is shaded it starts generating less voltage or current as compared to unshaded one. When modules are connected in series, same current will flow in entire circuit but shaded portion cannot able to generate same current but have to allow the same current to flow, so shaded portion starts behaving like load and starts consuming power. When shaded portion starts to act as load this condition is known as hot-spot problem. Without appropriate protection, problem of hot-spot may arise and, in severe cases, the system may get damaged [5]. To reduce the damage in this condition model generally use a bypass diode [11]. Block diagram of PV array in shaded condition is shown below.
Hybrid wind energy system

2. Proposed Hybrid PV/Wind Energy System

Figure 6.2 show the configuration structure for hybrid system based solar and wind energy systems. A rotor in the wind turbine captures the wind's kinetic energy, it consists of two or more blades mechanically coupled to an electrical generator. The mechanical power captured from wind by a wind turbine can be formulated as:

$$Pm = 0.5\rho ACp\ V3 \qquad (1)$$

0.59 is the theoretical maximum value power coefficient value. It is based on two variables the pitch angle Tip Speed Ratio (TSR). With respect to longitudinal axis turbine blades are aligned at an angle that is the pitch angle. The linear speed of the rotor to the wind speed is TSR. Wind turbine "*C Vs. λ*" curve is shown in Figure 6.3. In practical designs, 0.4 to 0.5 is the maximum achievable range for high speed turbines and for slow speed turbines it is in the range of 0.2 to 0.4. At *λopt* its

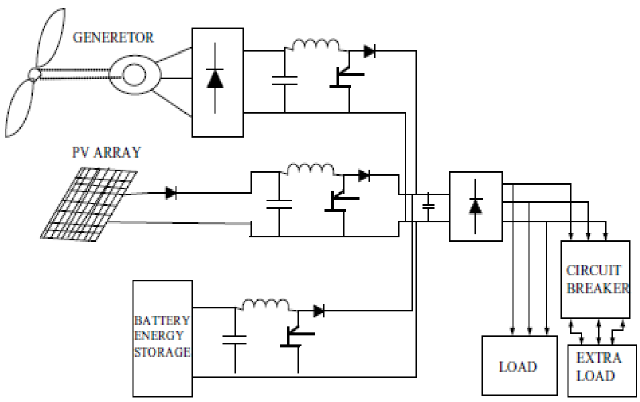

Fig 2: Configuration of Hybrid wind/PV Energy System.

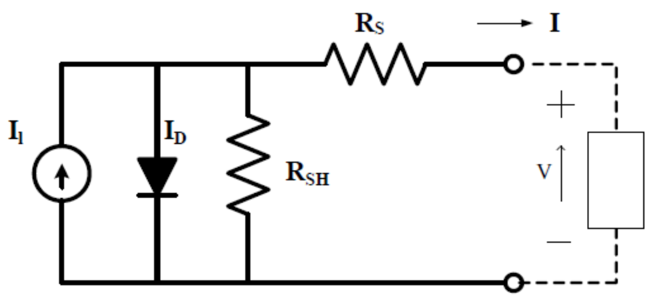

Fig 3

In Photovoltaic (PV) system, solar cell is the basic component. PV array is nothing but solar cells are connected in series or parallel for gaining required current, voltage and high power. Each Solar cell is similar to a diode with a p-n junction formed by semiconductor material. It produces the currents when light absorbed at the junction, by the photovoltaic effect. Figure 6.5 shows an insulation output power characteristic curves for the PV array. It can be seen that a maximum power point exists on each output power characteristic curve. The Figure 6.5 shows the (I-V) and (P-V) characteristics of the PV array at different solar intensities. The equivalent circuit of a solar cell is the current source in parallel with a diode of forward bias. Load is connected at the output terminals. The current equation of the solar cell is given below:

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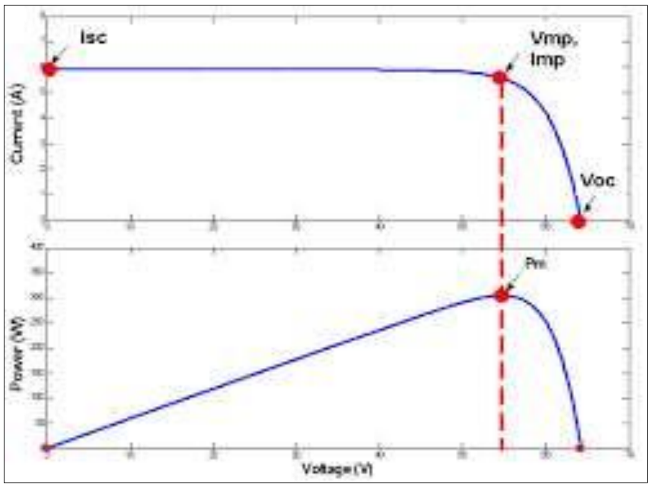

Fig 4

3. Simulation and modeling

3.1. Matlab

For implementing modeling and control of smart grid integration, software used is MATLAB It is a matrix laboratory, a multi paradigm numerical computing environment and fourth generation programming language developed by math works. MATLAB allows

3.2. Simulation of PV system

The number of unknown parameters increases when the equivalent circuit of the chosen model becomes more convenient and far from being the ideal form. But most of the manufacturer data sheets do not give enough information about the parameters which depend on weather conditions (irradiance and temperature). So, some assumptions with respect to the physical nature of the cell behavior are necessary to establish a mathematical model of the PV cell and the PV module, in Addition of course, to the use of that information given by the constructors. The objective of this project is to present useful work to those who want to focus their attention on the PV module or array as one device in a complex 'electro-energetic system'. So, the goal is to obtain at any time, the maximum power but also the more precise, therefore, the closest to the experimental value.

In below figure Simulink model of PV system is shown, which are obtain by constructing PV module. PV module of 600 V and 4 KW is connected to solar irradiance which acts as a source for system. Output comes as solar power and voltage which are calculated through scope.

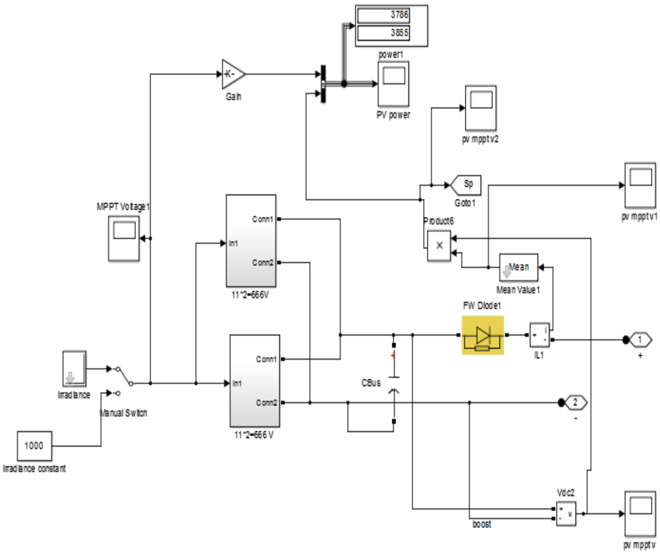

Fig 5

Simulated graphs

Figure shows the simulation result for output voltage across load terminals. From this result conclusion come that the voltage is constant with respect to change in either the wind or solar plants. This figure gives us idea that weather input changes, but this system give us constant output voltage.

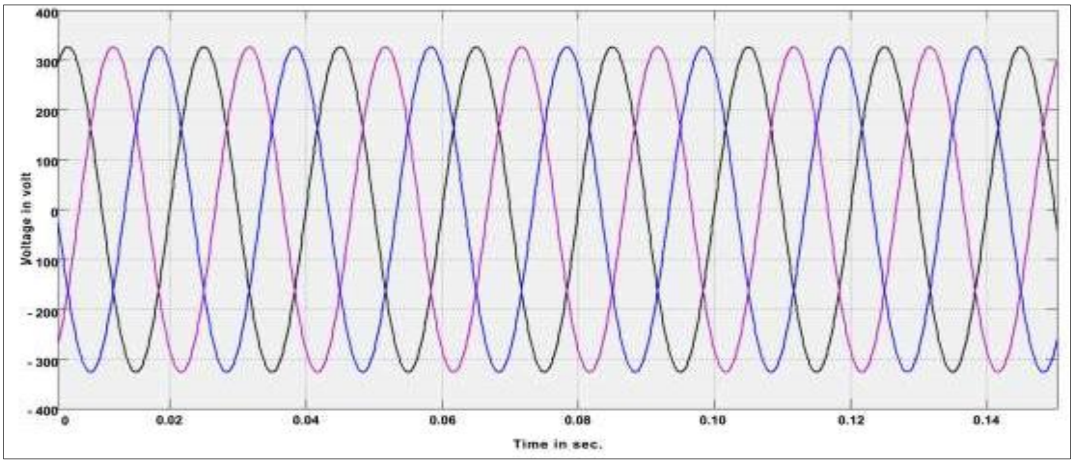

Fig 6

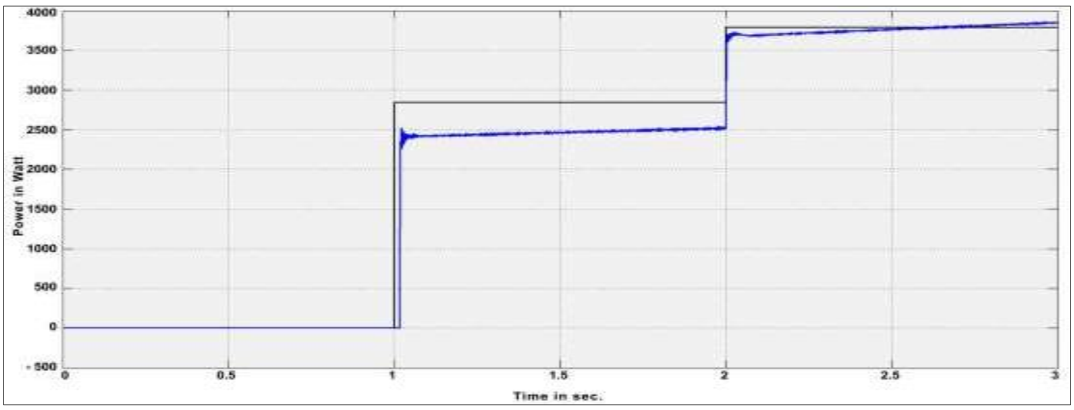

Fig 7

Shows the wave form for powers which are obtained from the solar energy system and on this the line power is depends. Solar energy are obtained by changing solar irradiance by varying its input value, corresponding output is also changed. This change in generated power can be shown by graph.

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