

Modelling and Control of Distributed Energy Resources for Power Management in a Micro Grid

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Abstract - The recent global need is to have a sustainable and low carbon living when there are issues pertaining to environmental degradation which have adversely affected the quality of living. This is possible only by adopting to green generation using renewable energy sources in place of conventional power generation. A well designed power management system will make the renewable energy generation and distribution more efficient hence the power generated can be effectively utilized. The main objective of this research is to develop a dynamic model of photovoltaic and wind energy as sources in a distributed generation (DG) system.

The above mentioned distributed generation is a part of a micro grid. The mathematical models as well as the simulation models of the photovoltaic and wind energy system will be done considering the geographical information system and realistic data. Mathematical modeling of PV, wind energy system, converters and controllers will be carried out using MatlabR2018a / Simulink software. The simulation models will be subjected to conventional modeling as well as to the improved modeling using additional parameters like geographical information system constants and realistic data used in modeling of the solar PV system that resulted in improved output power and efficiency.

Key Words: Renewable Energy, wind energy, solar panel, battery Bank, Inverter, Diode, Rectifier transformer, converter.

1. INTRODUCTION

The ever increasing energy consumption, high cost, limited resource of fossil fuel and the worsening global environment has created increased interest in green power generation systems. Wind and solar power generation are two of the most promising renewable power generation technologies. The growth of wind and photovoltaic (PV) power generation systems has exceeded the most optimistic levels of expectations. However, each of the above mentioned technologies have their own drawbacks. For instance, wind and solar power are highly dependent on climate. Since different alternative energy sources can complement each other to some extent, multisource hybrid energy systems with proper control have great potential to

provide high quality, more reliable power to customers than a system based on a single resource. Hence, a hybrid energy system has caught the attention of the researchers worldwide.

Many alternative energy sources can be used to build a hybrid energy system, but the major renewable energy sources used are wind and PV power. Due to the intermittent nature of wind and solar energy, hybrid energy systems normally require alternate energy sources as a backup. In this work, a hybrid alternative energy system consisting of integrated wind, PV will propose. Wind and PV are the primary power sources of the system that take full advantage of renewable energy.

The different energy sources in the proposed hybrid system will integrate through a dc link bus. The load is connected between the hybrid system and the grid. With the varying load conditions the hybrid output power and the grid power are properly adjusted as well as coordinated so as to match the load with full utilization of PV, wind power, to maintain a constant DC bus voltage even during varying load conditions.

1.1 Integrated hybrid system

The grid integrated hybrid system mainly works in the two mode (DGCM) and grid control mode (GCM). The power controller in the hybrid system is responsible for the automatic change over between these two modes in coordination with the load controller and inverter controller. The system operates in DGCM when load is less than a certain threshold value. In this mode the total output power of the Distributed Generation is maintain a certain reference level with variation of +2% subject to maximum generation of individual of DG. Any surplus Generation available after supplying the load is exported to the grid and deficit power for the load if any is supplied by the grid if the load exceeds its maximum value then load shedding takes place due to the controller action. Mathematical modeling of various components of PV and wind energy system including inverter.

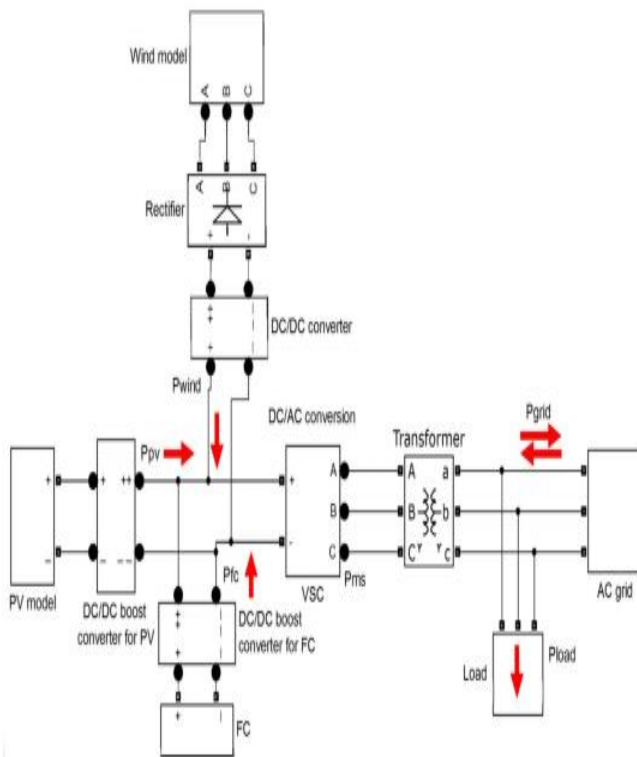


Fig 1: Overall configuration of integrated grid system

1.2 Photovoltaic system (PV System): -

A photovoltaic system converts the sun's radiation into usable electricity. It comprises the solar array and the balance of system components

Solar power systems provide a continuous, reliable power solution that's easily deployed, cost-effective and requires little maintenance

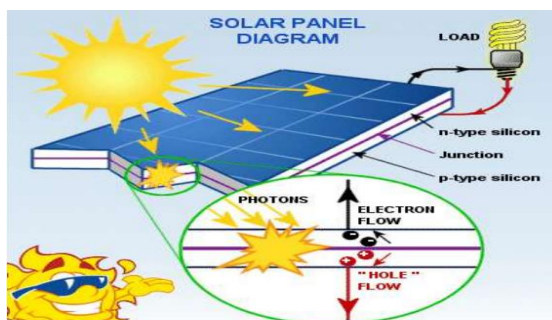


Fig 2: Solar panel structure.

1 Wind Turbine

The wind turbine is coupled directly to an open-end-winding three phase PMSG, without a gearbox due to the high number of poles.

2 Diode rectifier

The Diode rectifier provides unidirectional power flow from the generator to the grid-tied inverter, with a simple and cost effective design.

3 DC-DC boost converters

A second converter stage, based on dc-dc boost converters elevates the voltage while it can be used to control the power drawn from the generator

4 NPC inverter

The third converter stage is based on a medium-voltage NPC inverter connected to the grid. The NPC generates three output voltage levels ($V_{dc1}+V_{dc2}$, 0, $-V_{dc1}-V_{dc2}$) per phase, by connecting each output to the positive, neutral and negative potentials of the dc-link through the appropriate switching state. The NPC shown features IGCT switching devices, although high voltage IGBT based versions are also available.

5 Filters

passive ac filters are often used to mitigate this effect, and torque fluctuations do not affect the system operation due to the very large inertia of the turbine

2. CONCLUSION

Micro grid of a system based on a renewable power generation. The investigation is performed is based on simulation result indicate that dump load and suitable storage system along with proper control scheme are additionally required for the operation of the study system in the micro grid.

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