Design and Implementation of Grid Connected Hybrid PV and Wind Energy Generation System

Swati U Gajbhiye
PG student
Department Of Integrated Power System
TGPCET, Nagpur, India

Abstract

In this paper, power control of a wind and solar hybrid generation system for interconnection operation with electric distribution system. The proposed system consists of a variable-speed direct-drive wind generator, wind-side converter, solar array, dc-dc converter and grid interface inverter. Power control strategy is to extract the maximum energy available from varying condition of wind speed and solar irradiance while maintaining power quality at a satisfactory level. In order to capture the maximum power, variable speed control is employed for wind turbine and maximum power point tracking is applied for photovoltaic system. The grid interface inverter transfers the energy drawn from the wind turbine and PV array into the grid by keeping common dc voltage constant. The simulation results show the control performance and dynamic behavior of the wind/PV system.

Keywords: Wind energy, Grid-connected, Stand-alone, Hybrid renewable energy, Photovoltaic

I. INTRODUCTION

Now days in the electric utility industry are encouraging the entry of power generation and energy storage at the distribution level. Together, they are identified as distributed generation (DG) units. Several new technologies are being developed and marketed for distributed generation, with capacity ranges from a few kW to 100 MW. Solar and wind power is naturally intermittent and can create technical challenges to the grid power supply especially when the amount of solar and wind power integration increases or the grid is not strong enough to handle rapid changes in generation levels. In addition, if solar wind are used to supply power to a stand-alone system, energy storage system becomes essential to guarantee continuous supply of power. The size of the energy storage depends on the intermittency level of the solar or wind. The solar and wind pv hybrid generation system then this output synchronis with grid as the voltage and frequency. The combination of hybrid solar and wind power systems into the grid can further help in improving the overall economy and reliability of renewable power generation to supply its load. Similarly, the integration of hybrid solar and wind power in a stand-alone system can minimize the energy storage size needed to supply continuous power.the combined solar and wind system into grid can help to minimum cost and improving reliability of power generation to supply its load. The stand-alone systems can be sub-classified into common DC bus or common AC bus. Distributed generators can help fluctuations in power supply since generations' units will be close to the loads. Combining both PV solar and wind powers can minimize the storage requirements and ultimately the overall cost of the system . Increasing PV panels and capacity of wind turbines could be a better choice compared to the increasing of batteries since batteries are much more expensive with a shorter lifespan compared to the life time of a PV or WT. The increased penetration of grid-connected renewable energy sources has an impact on the grid power quality in particular weak grids. Voltage fluctuation, frequency fluctuation and harmonics are major power quality issues. Furthermore, intermittent energy from solar PV and wind has a huge impact on network reliability. However, accurate forecasting and scheduling systems can minimize the impacts. Various statistical forecasting and regression analysis approaches and algorithms are used to forecast weather pattern, solar radiation and wind speed.

II. BLOCK DIAGRAM

The wind turbine convert mechanical energy into electrical energy and it is capable of supplying large amount of power. The output of wind turbine goes to permanent magnet synchronous generator.The output of the wind system is in ac so we need ac to dc converter to convert the ac output in to dc. In PV side the output of the PV array is connected with a dc-dc boost converter to raise the output voltage up to a desire level. The output of pv and wind are connected with a common DC link voltage. The common DC link voltage will be connected with the DC to AC converter and the output of the inverter is synchronizing with grid. This inverter changes DC power from PV array and the wind turbine into AC power and it maintain the voltage and frequency is equal to grid voltage and frequency.

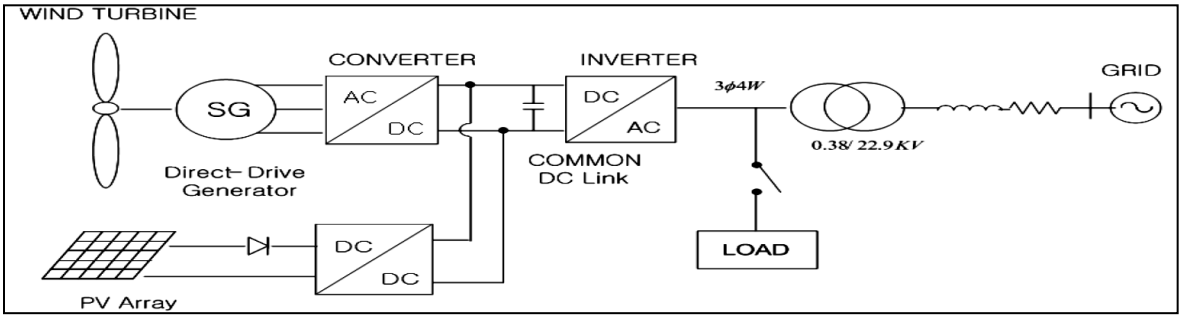

Fig. 1: Diagram of Grid-connected wind/solar hybrid system

A hybrid solar PV and wind system along with battery bank which is connected to an AC Microgrid. The system can work in grid-connected mode or stand-alone mode. The DC outputs' voltages from individual solar PV and wind stream, through individual DC/AC and AC/DC-DC/AC units, are integrated and combined in parallel on the AC side to provide the power to the grid/loads even with only one source available. Hence, in the grid-connected mode of operation, the renewable energy sources act as current sources and inject power directly into the AC bus. The battery system interfaced by a bi-directional converter and can be charged or discharged depending on the situation of the generation, load and its state of charge. However, in the stand-alone mode, the renewable energy sources act as current sources feeding directly the loads and the battery bank acts as a voltage source controlling the AC bus voltage by charging or discharging. The battery converter regulates the magnitude and frequency of the load voltage. The individual RES units can be employed for MPPT systems to have the maximum power from the solar PV and wind systems in the grid-connected mode. The same thing can be applicable in the stand-alone mode provided that the battery bank exists as a voltage source to control the AC bus voltage by charging or discharging.

III. FLOWCHART

The MPPT methods that are P&O are used for maximum PowerPoint tracking. The Porter and Observer algorithm is simple in operation and required less .hardware so the P&O method is chosen for the grid synchronization purpose because of its simplicity and easy implementation.

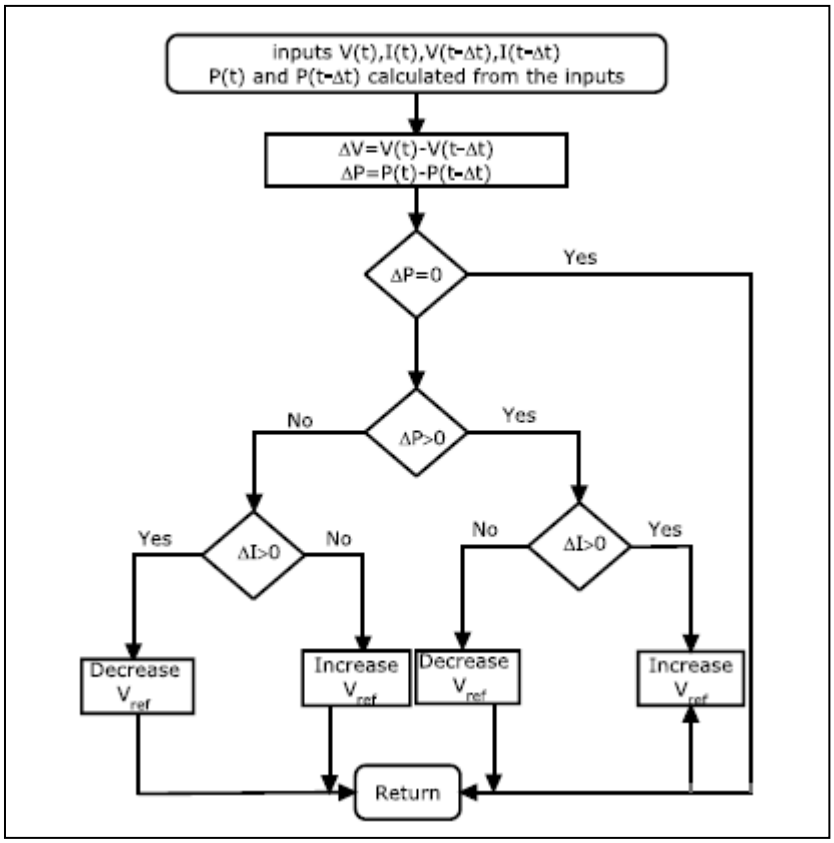

Fig. 2: Flow chart of proposed Method

IV. RESULT ANALYSIS

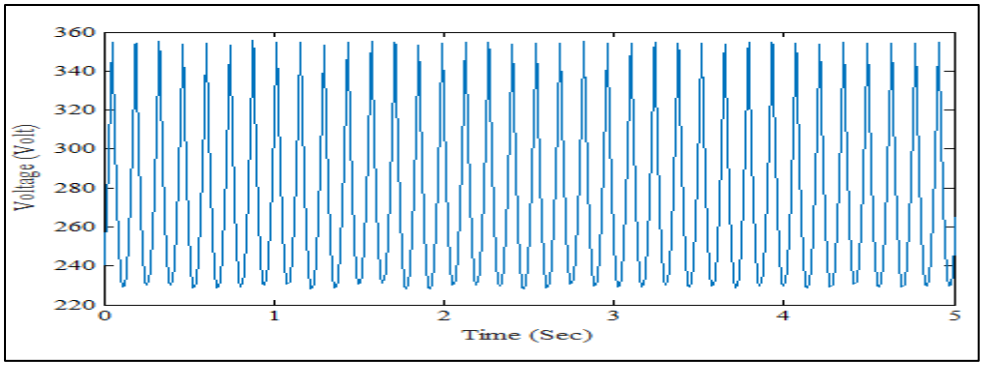

Fig. 3: Wind voltage

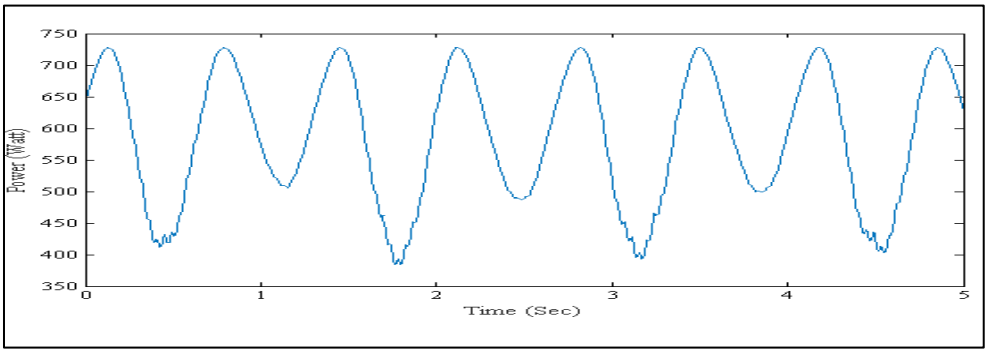

Fig. 4: Wind power

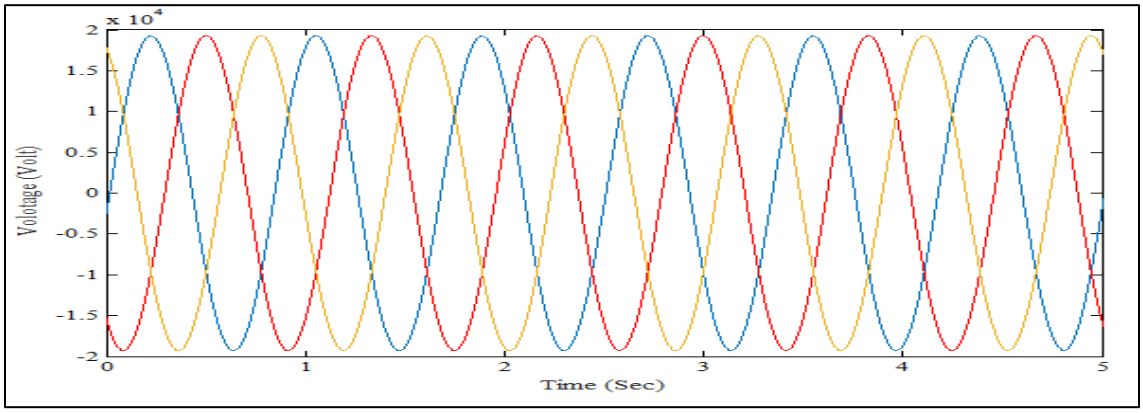

Fig. 5: Source voltage

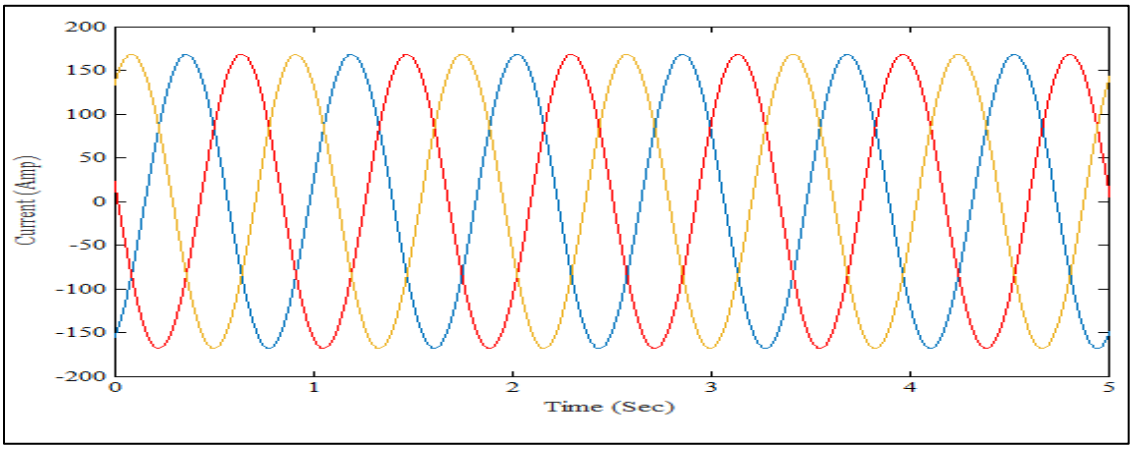

Fig. 6: Source current

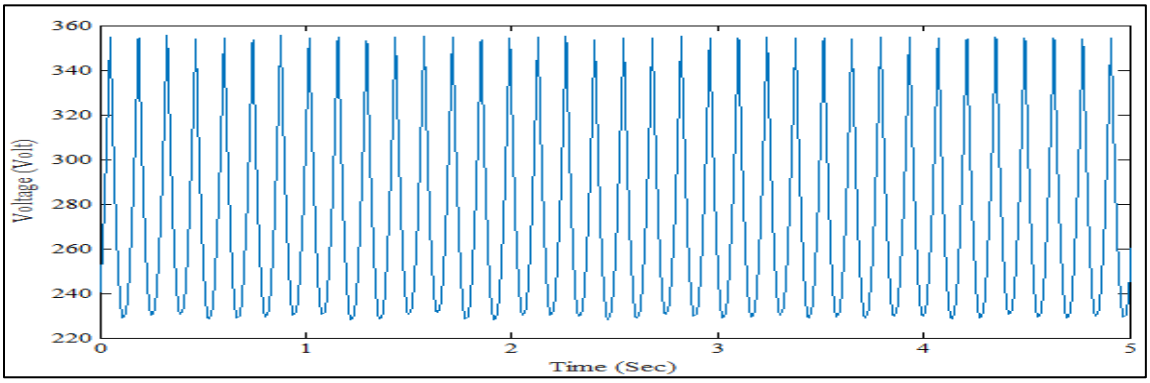

Fig. 7: Solar voltage

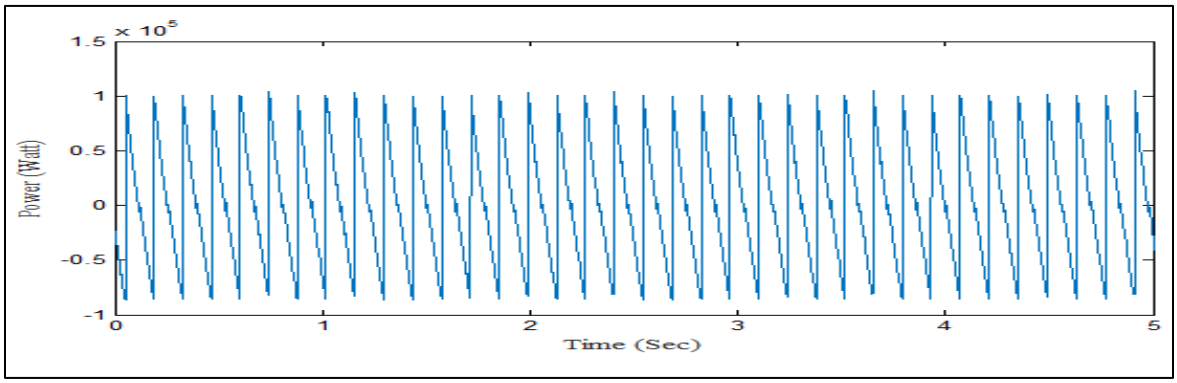

Fig. 8: Solar power

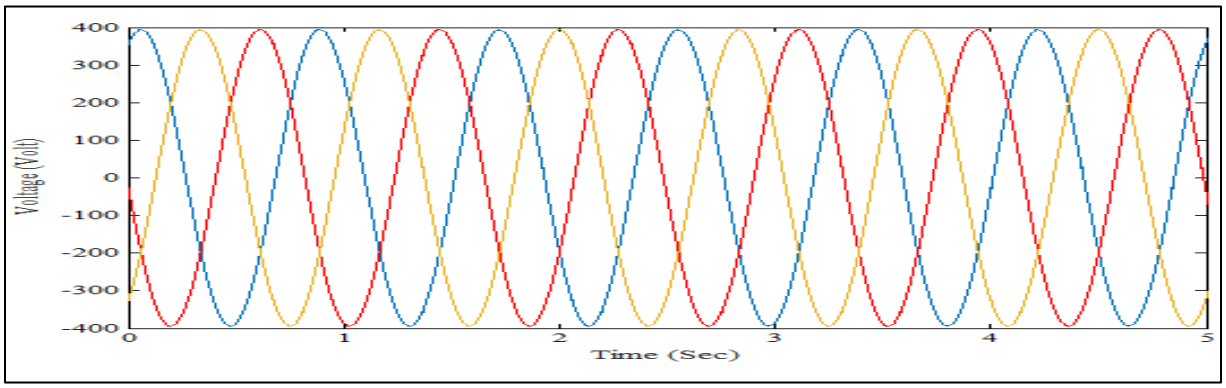

Fig. 9: Pcc voltage

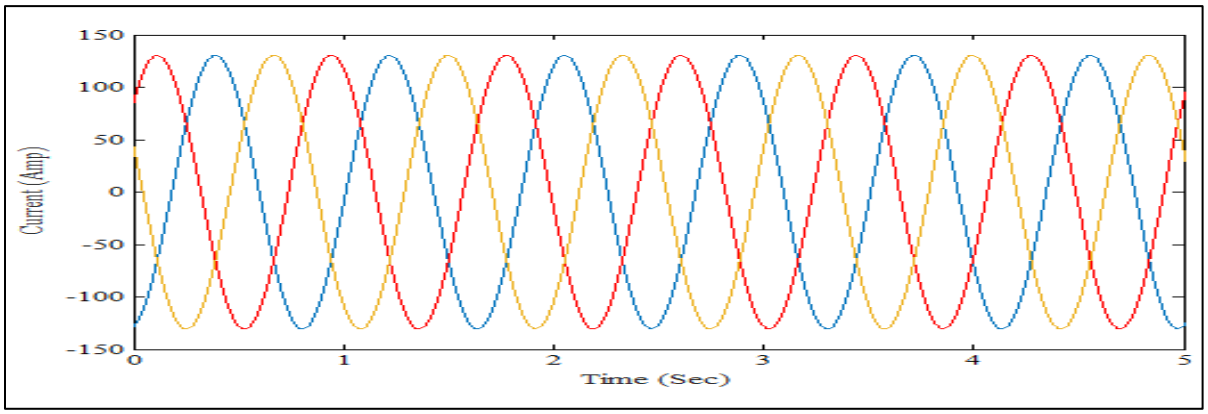

Fig. 10: Pcc current

V. CONCLUSION

This paper give an overview of different research works related to control for grid-connected and stand-alone hybrid solar PV and wind systems. Solar PV and wind hybrid system can be connected in a common DC or common AC bus whether they are working in a grid-connected mode or a stand-alone mode.

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