BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI- HYDERABAD

Abstract

Tie-Line Frequency Bias Control of an Interconnected PV-Wind Hybrid Power System

by **VENKATA PAVAN KUMAR ARAPIRALA**

The sustainable methods to balance the load demand is by establishing Hybrid power system. A Hybrid Power system is a mix of distinctive types of power generations from RES which is coordinated together to have a superior eco-friendly solution for power generation. This Hybrid system enables interconnection of more than one RES into conventional power system and transferals the dependency on fossil fuels while sustaining the balance between supply and demand.

The RES as power generation is not constant sources of the supply as the power generated by these RES directly rely on the environmental conditions. Due to this, it is quite a challenging task to incorporate the RES generation into conventional generation. The challenges include maintaining output voltage and frequency constant at the Point of Common Coupling (PCC) irrespective of change in environmental conditions. In order to achieve this task detail modeling of the Hybrid power system is developed out with proper Tie-line control techniques for power interchange while maintaining system voltage and frequency under acceptable limits as per grid code.

In the proposed hybrid power system a two-stage topology is designed to overcome the challenges posed by RES. The First stage includes PV and Wind based generation whose outputs are tied to a common DC Bus-Bar. The second stage is the DC to AC conversion utilizing the Voltage Regulated Inverter (VRI). The proposed hybrid power system is utilized in 1) Stand-alone mode, 2) Grid Connected mode. The Load frequency control technique is implemented in stage two in stand-alone mode while distributing

power to local loads. In grid connected mode or Interconnected state the Tie-line frequency control is implemented to achieve proper power transfer to meet the load demand and by keeping the system in stable condition. Application of control requires hybrid system modeling, consequently, Photovoltaic (PV) and Wind generation are modeled as a part of the hybrid system.

In PV based generation system an equation based two-diode model of PV cell is selected. The output of the PV panels is boosted up to the desired level using boost converter. A Maximum Power Point (MPP) tracking technique i.e. Perturb and Observe (P & O) algorithm is selected for tracking MPP. In a Wind-based generation, a Horizontal Axis Wind Turbine (HAWT) coupled to Permanent Magnet Synchronous Generator (PMSG) is selected for modeling. The AC output voltage from Wind power generation is converted to DC and this DC voltage is boosted up to the desired level using MPPT controlled boost converter. Hill Climb Search (HCS) algorithm is implemented to track MPP in wind generation. The DC outputs from both the RES are combined to form a common DC bus-bar. The DC voltage is converted to three-phase AC voltage utilizing Voltage Regulated Inverter (VRI). This topology makes the output voltage and frequency independent of input conditions, as they directly depend on the DC bus-bar voltage, inverter control logic, and load variations. The performance of the MPPT controlled boost converters is enhanced by Fuzzy Logic Control (FLC) to maintain constant DC voltage irrespective of change in environmental conditions.

The AC output voltage and frequency of the hybrid system fluctuate with the variation of load in the system. It is a challenging task to maintain these variables constant while controlling the power flow to meet the load demand. As such two Load Frequency Control (LFC) techniques are proposed namely Discrete PLL and Droop characteristics based on the hybrid system. Application of two control techniques is investigated under different load conditions and it is observed that the Droop characteristics techniques have enhanced load frequency control over the discrete PLL technique.

In grid-connected mode, the reference voltage and frequency are taken from the grid for inverter operation. The control logic implementation of VRI has to focus on power flow control. This can be achieved by proposed droop characteristics based control for the proposed hybrid power system. The droop characteristics based control is utilized in the implementation of Tie-line frequency bias control of interconnected PV-wind hybrid power system. where the performance of the Tie-line controller is investigated under increase of power demand in one area of the interconnected two-area system.