Control Architecture for Interfacing of Solar/Wind Hybrid System: A Review

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Abstract— Wind generation and PV have considerable potential in meeting the variable load demand but their coordinated control with utility system is a big hurdle in their main stream application like continuous grid connected operation. . This paper presents a brief overview on control architecture for interfacing of solar/wind hybrid system. The topologies available in literature for stand-alone and grid connected hybrid PV/Wind has been presented. The different approaches for hybrid PV/Wind design and control strategies are also briefly addressed.

Keywords: Alternative Energy Sources (AESs) Permanent Magnet Synchronous Generator (PMSG), Point of Common Coupling (PCC), power electronics converters (PECs), Solar Generation, Wind Generation

I. Introduction

Wind and solar energy are popular renewable sources that are being utilized because of their environmental benefits. Furthermore, generous subsidized policies have been implemented by various countries to accelerate and stimulate investment in wind and solar energy development. However, despite the tangible benefits, the main hindrance to the public accepting wind and solar energy systems is the related high capital investment [1]. Nevertheless, wind turbines and PV have considerable potential in meeting the variable load demand but their coordinated control with utility system is a big deal.

With the purpose of utilizing diverse energy sources, a large number of technical studies have been conducted on supplementing energy obtained from conventional combustion sources with solar and wind energy. Various architecture and control topologies have been proposed in literature on integration of wind and solar energy systems and their hybrid combinations for power quality improvement when operated in a stand-alone as well as grid connected mode [6]-[8].

The technological development for their control issues including economical and efficient operation has also been discussed [9]-[11]. In addition to this different types of generation side control for grid integrity to increase the efficiency of system by using Maximum power Point Tacking (MPPT) methods is also presented. The available energy sources (AESs) are typically utilized in two ways one is self-consumption; in which they act as a source for local or remotely located loads and in another type they acts as a supportive energy source to the grid in which they feed the peak demand or acts an alternative sources at the time when grid power is unavailable. In the first case they have both DC and AC bus linked as shown in Fig. 1 [12] and in second case they have typically connected AC link and all the controls are available at AC side to synchronize with the AC connected system, as shown in Fig. 2 [13]. In both above mentioned conditions the required controls are provided by PECs for stable and reliable operation of the hybrid system.

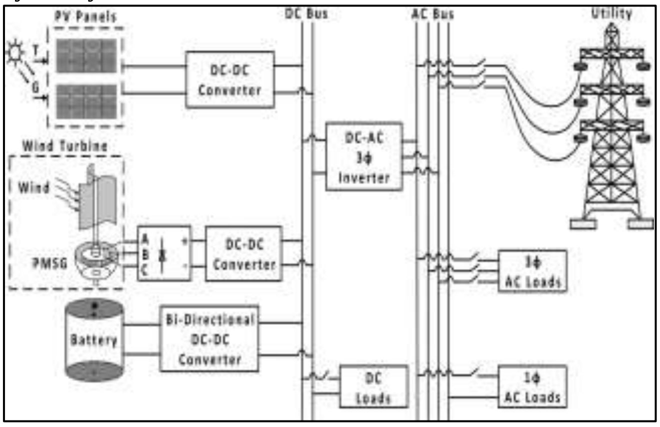

Fig. 1: Typical configuration of the DC and AC bus linked hybrid AESs.

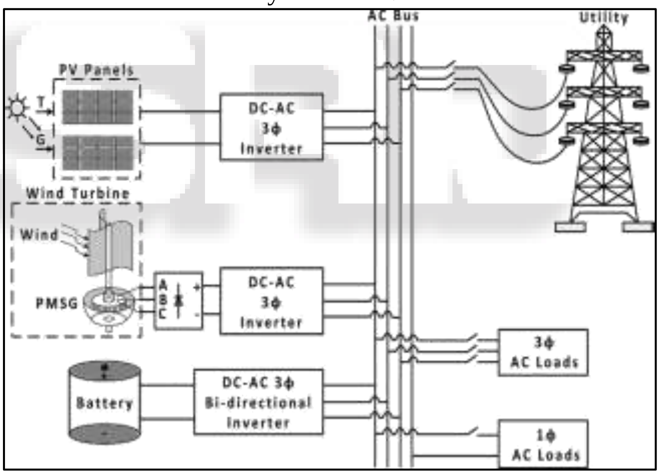

Fig. 2: Typical configuration of the AC bus linked hybrid AESs.

II. Control Architectures for Hybrid AES

For grid integrity of AESs the probable combination could be either the AES must be linked to a common DC-bus. The output generated by the PV/wind when regulated and collected to the dc-bus, further from there a common DC/AC power converter converts the DC into AC and links to the AC bus. This is termed as DC coupled hybrid system. Other way is AC coupled hybrid system in which individual inverter control is required to convert DC generated power from the AES and then they are connected to a common AC bus.

A. DC Coupled Hybrid System

In this system the power generated from AES is connected to the DC bus and supplies the local load as shown in fig.3 [13]-[15]. It can be seen in the figure that individual DC converters are required to regulate the Dc output and all the DC power generated are connected to a common DC-bus. The Dc converter can be controlled either via current controller or voltage controller, where the DC generated voltage or current if feed-back in conjunction with a reference signal to generate the PWM for the power switches of the converters. The local can be supplied by the Dc bus. At Dc bus a DC-AC converter is installed to convert power at DC bus into AC and synchronize with the grid.

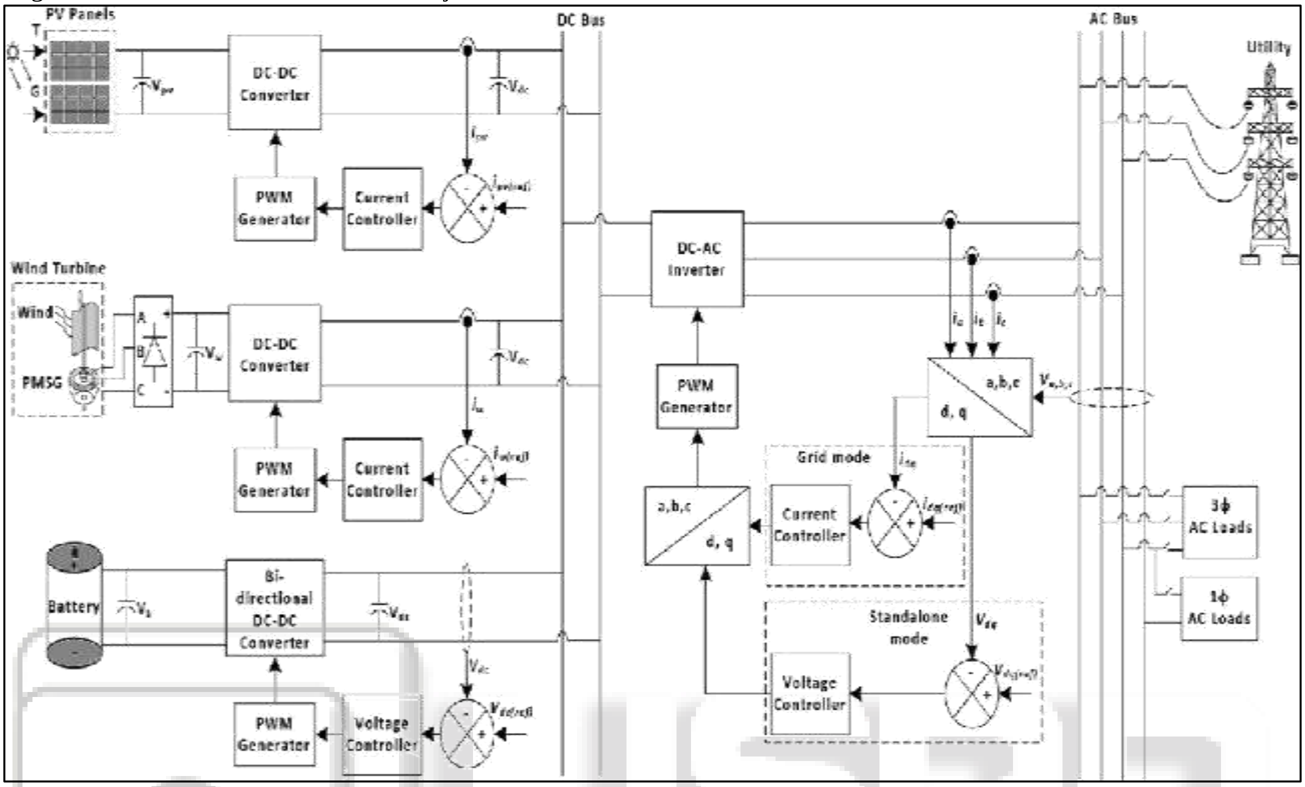

Fig. 3: DC coupled hybrid AES system

B. *AC Coupled Hybrid System*

In this system generally no Dc bus is required as shown in figure 4. The power generated from AESs are converted into AC using individual Ac converter and connected to the AC bus which is known as point of common coupling. To generate control firstly three phase system is converter into two phase using abc-dq transform than a voltage or current control generated the reference signals which s fed to PWM via dq-abc transform.

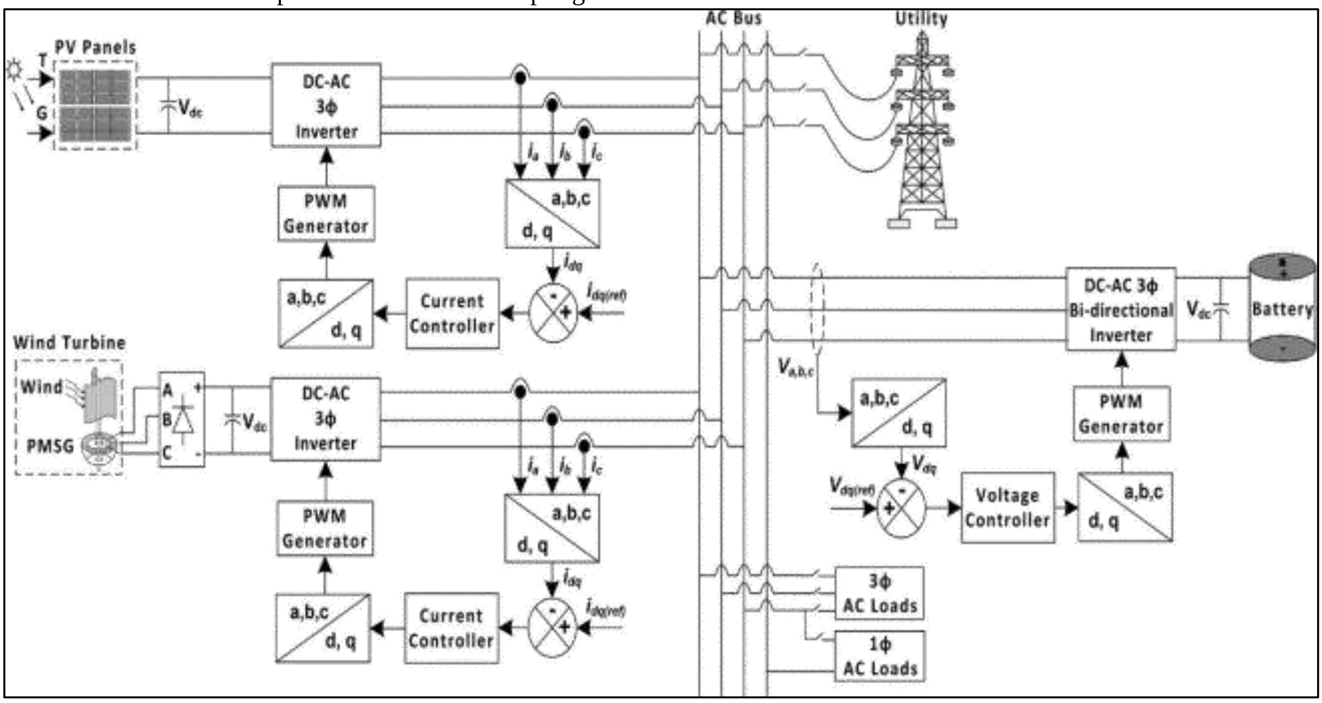

Fig. 4: Hybrid AES configuration of AC coupled System

III. AES SIDE CONTROL TECHNIQUES

Generally all the available AES produces DC power and to enhance the capability and maximize the generated power, control techniques are utilized at AES side which are generally called Maximum Power Point Techniques (MPPT). Since the power generated from AES particularly PV and wind varies with the environmental conditions like solar irradiance and wind speed [23]-[27].MPPT track the point of maximum output at the operating point and feed the gate pulses of boost converter. The boost converter boost the generated output voltage to level which can be fed to the load or can be supplied to the DC-AC converter. General block diagram of MPPT control is shown in Fig.5 with boost converter (any DC-DC converter can be used) for wind/solar and input variables of MPPT block depend on MPPT methods. Broadly MPPT techniques can be classified as Perturb and observe, Incremental and conductance, and modified version of the above mentioned techniques. In this paper these techniques has not been discussed since this is not the scope of the paper.

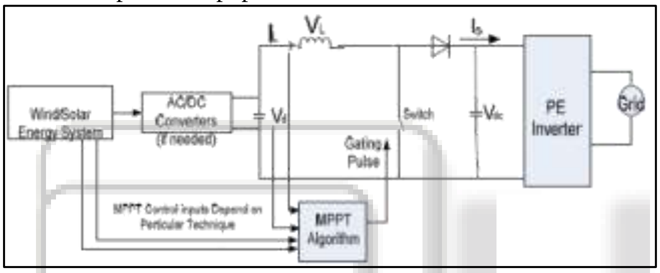

Fig. 5: Basic Diagram of MPPT control

IV. CONCLUSION

Efficiency, stability, quality and reliability are most important aspects while interfacing PV/wind generation with the utility system. These could be achieved by designing a proper control architecture for interfacing elements like DC-DC and DC-AC converters. Also the utility of the hybrid sources much depends upon their control configuration like DC-coupled or AC-coupled. This paper presents a brief overview on control architecture for interfacing of solar/wind hybrid system. The topologies available in literature for stand-alone and grid connected hybrid PV/Wind has been presented. The different approaches for hybrid PV/Wind design and control strategies are also briefly addressed.

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