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Review on Autonomous PV-Array Excited Wind-Driven Induction Generator for off grid Application in India

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Abstract *– Wind electrical generation systems are the most cost-competitive of all the environmentally clean and safe renewable energy sources in the world. They are also competitive with fossil fuel generated power and much cheaper than nuclear power. The recent evolution of power semiconductors and variable frequency drives technology has aided the acceptance of variable speed generation systems. Such systems can yield 20-30% more power than constant-speed generation systems.*

Keywords*: off gird, PV, wind, wind driven induction generator,*

I. Introduction

During the past few decades the advanced technological nation of the world have been engaged in an energy and resources race that has brought us to the position of energy crisis. Many developing countries have also been engaged in this race during last two decades or so. It is now widely recognized that the fossil fuels and other conventional resources, presently used in generation of electrical energy, may not be either sufficient or suitable to keep pace with ever increasing world demand for electrical energy. The prospects for meeting this demand and avoiding crises in supply would be improved if new and alternative energy source could be developed.

Solar energy is the most abundant and constant stream of energy. It is available directly (solar insolation). Especially in countries like India where the government is facing oil crunch, the tapping of PV energy which is available (in abundance) throughout the year will be very important. On the other hand, wind energy is also playing a significant role in power generation programmes of many countries including India.

The conventional energy sources are limited and pollute the environment. So more attention and interest have been paid to the utilization of renewable energy source such as Wind Energy, Fuel Cell, Solar Energy etc., Wind Energy is the fastest growing and most promising renewable energy source among them as it is economically viable.

In 2008, India was the country that brought online the third largest amount of wind energy, after the US and China, and it now ranks fifth in total installed capacity with 9,645 MW of wind power installed at the end of 2008. A strong domestic manufacturing base has underpinned the growth of the Indian wind energy market. The Indian wind turbine manufacturer Suzlon is now a recognised player on the global market and many international companies are established in India. India has a great untapped potential for wind energy. A strong domestic manufacturing base has underpinned the growth of the Indian wind energy market. India has a great untapped potential for wind energy. According to official estimates, the Country's total wind energy resource amounts to 48 GW of installed capacity, but some experts think that this figure is on the conservative side, and that technological improvements could significantly increase this potential. The positive development of wind energy in India has mainly been driven by progressive state level legislation, including policy measures such as renewable portfolio standards and feed-in- 10 tariffs. At the moment, there is no coherent national renewable energy policy to drive the development of wind energy. This is urgently needed to realize the country‟s full potential and reap the benefits for both the environment and the economy. The Government of India is currently considering the introduction of a national renewable energy policy, so this report comes as a timely reminder of how important a role wind energy could play in securing India‟s energy security, curbing its CO2 emissions, providing new employment and boosting economic development. This also realizes how important a role wind energy could play in securing India's energy security, curbing its CO2 emissions, providing new employment and boosting economic development. As can be seen by the Indian Wind Energy Outlook, the wind industry, both domestic and international, stands

ready to do its part in achieving an energy revolution in India.

II. Literature Survey

S.Lenin Prakash et al.[1] "Autonomous PV-Array Excited Wind-Driven Induction Generator for off grid Application in India", A cascaded PI-SMC control has been successfully implemented for a dc-dc boost converter interfaced between PV array and a three phase voltage source inverter of a PVEWIG system for regulating the inverter DC link voltage. The modeling and simulation results of the battery less operation of PVEWIG scheme have been presented. The battery less mode operation of PVEWIG system has been successfully implemented and tested in hardware using a 2.4 kW PV panel and 2.25 kW IG driven by WTE. An exhaustive hardware results have been presented which validates the proposed control scheme and its simulation results. Also the PVEWIG system was put into operation in typical operating conditions for a complete day from morning to evening and all the weather and electrical parameters were monitored and recorded. The complete field test results of the PVEWIG without battery is presented, which demonstrates the ruggedness and the reliability of the system. The hardware results substantiates that the proposed control scheme is capable of providing a regulated output voltage to the load under all kinds of disturbances including variation in irradiation, temperature, wind speed, load as well as unbalance in load, for a battery less mode of PVEWIG system. The results further signify that the PVEWIG system with the proposed control scheme is an attractive solution for isolated off-grid applications where utility grid is not available.

M. J. Hossain et al.[2] "Robust Control for Power Sharing in Microgrids With Low-Inertia Wind and PV Generators", In this paper, a systematic procedure for designing integrated a robust microgrid controller and PV and DFIG droop controllers was presented in order to enhance the stability of islanded microgrids. The controller scheme is designed based on PMU measurement signals and the appropriate inclusion of uncertainty in the design process enhances the robustness of the controller. A properly designed robust controller damps small-signal oscillations and maintains a stable operation in post-fault conditions even with severe contingencies. The scheme provides feasible and smooth transition of the microgrid from the grid-connected to islanded mode operation. The simulation studies validate the performance of the controllers for a microgrid subjected to a severe three-phase fault and intentional islanding.

Rupesh G. Wandhare et al.[3] "Novel Integration of PV-Wind Energy System with Enhanced Efficiency", Nature has provided ample opportunities to mankind to make best use of its resources and still maintain its beauty. In this context, the proposed hybrid PV-wind system provides an elegant integration of the wind turbine and solar PV to extract optimum energy from the two sources. It yields a compact converter system, while incurring reduced cost. The PV generated power can be routed to the grid using both the rotor and grid side converters of the wind-DFIG system, during its sub-synchronous operation. It has been verified that unlike the conventional wind-DFIG system, the circulating power is significantly reduced with PV-DFIG integration at the DC link. Enhanced efficiency is observed compared to existing PV/wind hybrid systems. It is demonstrated that the proposed hybrid system provides an opportunity to integrate a higher capacity PV source than can be done through a dedicated converter as in a conventional solar PV system. Simulations and experimental results have shown that the proposed system optimally uses the daily available energy from solar and wind sources making the best possible utilization of its converters.

Adeola Balogun et al.[4] "Decoupled Direct Control of Natural and Power Variables of Doubly Fed Induction Generator for Extended Wind Speed Range Using Feedback Linearization", Decoupled control schemes of the natural and power outputs of DFIG have been presented. The control schemes were obtained using feedback linearization theory, field, and voltage orientations. It was revealed in the small signal analysis that, unlike the vector control, the controllers were robust against mismatch in actual and estimated parameters of the machine. Simulations were done based on some variations in the parameters of the controllers and the plant. The results from the simulations demonstrate that in response to a ramp change in rotor speed, the controlled variables tracked their respective commands effectively. Transitioning from subsynchronous DFIG into shorted-stator mode generated some transients, in which the controllers were able to dampen to some permissible limits. The experimental results given show that the torque variables were effectively controlled to tend toward their respective commands.

Yongchang Zhang et al.[5] "Three-Vectors-Based Predictive Direct Power Control of the Doubly Fed Induction Generator for Wind Energy Applications", This paper proposes an improved three-vectors-based PDPC to achieve both active power and reactive power ripple reduction with simple calculation. Compared to prior art using two switching tables, this paper employs only one switching table to select three appropriate voltage vectors. The duration of each vector is obtained in a much simpler way, which brings the benefits of simplicity and robustness against machine parameters variations and control delay. By dynamically selecting the most appropriate candidate vector sequence, the switching frequency can be reduced up to 48.6%, which is useful for high-power wind energy applications. The effectiveness of the proposed PDPC is validated by a

series of simulation results from a 2-MW-DFIG system. The experimental results from a scaled-down laboratory setup are also presented to confirm the theoretical analysis of the proposed PDPC.

III. PV ARRAY FED INVERTER EXCITED WIND DRIVEN IG

The PVEWIG system consists of PV array, dc-dc converter, battery, 3 leg inverter, wind driven three phase squirrel cage induction generator and a non-linear load. The PV array feeds a dc-dc boost converter. The voltage across the dcdc boost converter is connected to a battery, which is inverted by a three phase inverter and the IG is integrated to the inverter output and is locked to inverter voltage and frequency. The IG would require reactive power which it would normally draw from a utility grid in a grid connected scheme. In the present scheme, the reactive power required by the induction machine is supplied by the PV array fed inverter.

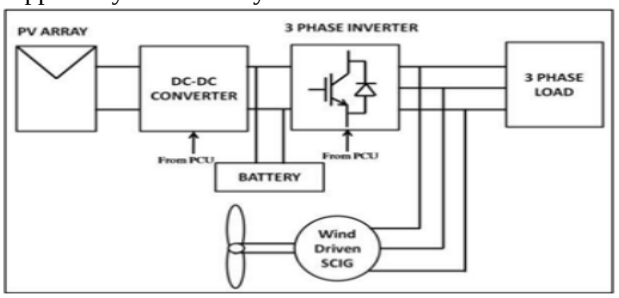

Fig.1 Block diagram of the Power Circuit for PVEWIG System with Battery

The output of the inverter acts as a virtual grid providing a constant voltage and frequency. The three-phase load is connected to inverter output and is supplied by PV-IG and battery or PV-IG, the load-sharing being dependent on irradiation and wind speed. The inverter output, IG output and load forms the point of common coupling (PCC). The block schematic of the entire PVEWIG scheme is shown in Fig. 1. One of the unique features of this hybrid scheme is that, this system employs an induction generator without a need of either utility grid or excitation capacitors, thereby avoiding all the disadvantages associated with it. In the absence of battery, the real power balance is such that the sum of PV array power and real power output of IG equals the inverter power output which is delivered to the load. The power balancing is explained in more detail in the subsequent sections.

IV. Bidirectional DC: DC Converter

The Bidirectional DC: A DC converter plays a vital role in dual directional power flow applications such us like hybrid electrical vehicle, standalone power conversion systems with battery storage. Fig.2 represents the circuit diagram of bidirectional converter. At normal condition DC: DC bidirectional converter supplies the power from source (WECS/SECS) to grid/ load; it acts like a boost converter. The output of bidirectional converter feeds to inverter and convert from DC supply to AC supply then it connected to grid or load. The outputs of WECS and SECS were regulating by the boost converters, some minor fluctuation on input also adjusted by boost converter with parallel-connected battery, even though sometimes due to natural calamity the sources can't produce minimum required of power. Now, Bi directional DC: DC converter converts its power flow direction from the grid to battery (i.e. battery charging) now it acts like a buck converter (Vin>Vout) or battery charging unit.

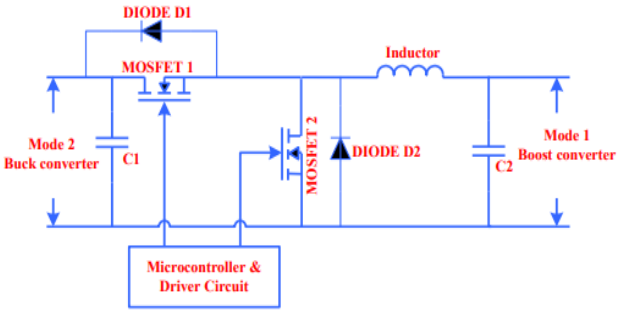

Fig.2 DC: DC Bidirectional Converter

V. Conclusion

An Isolated renewable energy system (RES) is fully based on RES, but at the same time reliable is necessary for meeting the power demands of remote places where utility grid is not available and for which hybrid wind-solar systems plays a crucial role. A grid connected hybrid scheme for residential power supply based on an integrated photo-voltaic (PV) array and a wind-driven induction generator has been reviewed. The designed system contains a DC: DC Boost conversion modules to regulate the energy outputs from solar and wind generator modules.

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