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Modelling of Grid Connected Solar Wind Hybrid Energy System having Artificial Intelligence Techniques for Power Enhancement and System Stability

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ABSTRACT: Energy demand is growing rapidly and the use of renewable energy sources plays an important role in reducing the gap between supply and demand. The introduction of multiple power electronics and non-linear loads is added to the network and causes power quality problems. The problem of lack of energy and the problem of the quality of energy can be solved at the same time using the inverter connected to the renewable sources grid system However, a grid connected microgrid suffers a crucial stability issues during a fault in utility grid. The integration of the solar system with the network is rather complex and expensive. With this construction proposal, however, it is not only possible to create an economical and simple hybrid system, but also a reliable, efficient and economical system. The system is made economic by implementing a wind energy system along with fuel cell system in the solar system. Efficient controlling methods based on intelligent control can be implemented

KEYWORDS: Renewable Energy system, PV Array, Wind System, Fuel Cell, DC/DC Converter, Controlled Inverter, Grid System

I. INTRODUCTION

Energy incorporates a very important role for the development of a nation and it's to be preserved in a very most effective manner. Energy is that the ultimate issue accountable for each industrial and agricultural development. The new technologies that are developed to provide energy within the most environmental friendly manner and conservation of energy resources in most economical means has equal importance. The utilization of renewable energy technology to satisfy the energy demands has been steady increasing for the past few years. Import of petroleum products constitutes a serious drain on our foreign exchange reserve. Renewable energy sources are considered to be the higher choice to meet these challenges. The necessary drawbacks related to renewable energy systems are their inability to ensure reliability and their intermittent nature. A serious challenge of grid integration an increasing number of renewable-energy-based distributed generators is featured whereas making certain stability, voltage regulation, and power quality [1].

Microgrids are local energy networks that involve renewable energy sources and storage systems. They have the capability to be locally controlled. Therefore, they can disconnect from the grid when there is a blackout, or a fault at the main grid, and continue to supply a portion of their local loads in a so called “islanded mode.” Several states in the USA invested millions to promote high penetration of microgrids as a part of their climate resiliency plans against natural disasters, especially after hurricane Sandy. Since microgrids typically include renewable sources and batteries, DC microgrids [2] will have the capability to increase the overall system efficiency.

The microgrid consists of different DG, ESSs and loads, and the aim is to integrate an ac/dc converter so that the microgrid can operate both in islanded mode or grid connected. As it can be seen on the figure, different types of energy generation systems are included in the microgrid [3,4]. On the one hand, various solar panel arrays and a mini wind-power system are installed on the roof, connected to the microgrid through dc-dc and an ac-dc converter, respectively. On the other hand, two programmable dc sources have been included with the aim of programming different generation profiles and emulating the behavior of other DG units. Regarding the loads connected to the system, in this case different programmable loads are employed. This enables the emulation of different load profiles to test diverse operation conditions in the microgrid. In order to compensate energy generation and demand differences, different ESS units are used on the microgrid.

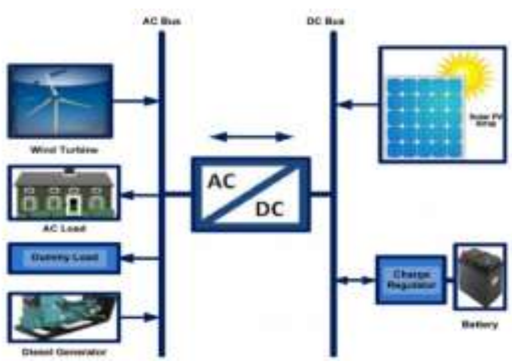

Figure 1: A Block diagram of a typical PV-wind hybrid system

Micro-grids are small scale power systems that use distributed renewable and/or non-renewable generations and energy storage systems to supply power to local loads. Most of renewable sources and energy storage devices, such as Photovoltaics (PV), fuel cells and batteries, generate DC power, and more and more electrical loads in residential houses or commercial buildings use DC power, such as laptops, LED lighting, etc. In a DC micro-grid, these sources and loads are connected directly via a common DC bus [5].

Fig. 1 shows the structure of a typical DC micro-grid. Compared with the AC systems, DC micro-grids have the advantage of higher efficiency by eliminating the wasteful AC to DC and DC to AC conversion stages [1]. DC micro-grids hold extraordinary promise for a wide variety of situations [6], but there are still a few barriers to deploy this technology, such as the initial cost of the system, lack of standards and code of practice, etc.

To improve the system performance, the DC micro-grids must be controlled in an optimal way based on system control law. Many control methods have been proposed, and they are classified into three categories [3]:

Independent control: each power converter in the DC micro-grid operates independently. The system is low cost and reliable, but the system performance cannot be optimized because each power converter does not know the operation of other power converters in the system.

Centralized control [4]: all the power converters in the DC micro-grid are controlled by a central controller through external communication links. Various control methods, such as active load sharing control, can be easily applied to the DC micro-grid, and the system performance can be optimized. However, the reliability of the system is degraded due to the whole system depends on the central controller and external communication links.

Distributed control [3][5][6]: the DC micro-grid control is distributed to each power converter controller. The system can still function under the conditions of single or multiple power converters failure, so it has better reliability than the system under centralized control. For some distributed control methods, low bandwidth external communication link for each power converters are still needed for correct operation [5].

II. LITERATURE SURVEY

[1] F. Ding et al. presented detailed transient models of the grid-connected PV/Battery hybrid generation system, and all these models are simulated by using MATLAB/Simulink. PV array is firstly connected to the common dc bus by a boost converter, where the battery is also connected by a bi-directional DC/DC converter, and then integrated into the ac utility grid by a common DC/AC inverter. Maximum power point tracking helps PV array to generate the maximum power to the grid, and the battery energy storage can be charged and discharge to balance the power between PV generation and utility grid. Finally, different cases are simulated, and the results have verified the validity of models and control schemes.

[2] Lahari N V et al. studied a novel integration of wind energy from grid connected Permanent Magnet Synchronous Generator (PMSG) and solar energy systems. In order to extract maximum power from Wind energy and solar energy systems a novel technique, known as Maximum Power Point Tracking (MPPT) technique, has been adopted, in this paper. Additionally, to maintain and sustain the continuity of supply to the load on demand at all times, the outputs of wind energy and solar energy are integrated suitably. For wind generator, the overall operation is based on the estimation of the speed, that is basically a sensor-less rotor speed estimator, which in fact avoids all mechanical sensors. The rotor speed so estimated, is used to control the turbine speed by maintaining the input dc quantities (Voltage and Current) for boost converter. Simulation studies of the proposed system are carried out using MATLAB / Simulink platform, and results are presented.

[3] Ujjwal Kumar Kalla et al. presented an adaptive back propagation learning scheme for three phase four wire grid integrated solar PV - battery microgrid feeding three phase and single phase nonlinear loads simultaneously. The proposed power quality improved 3 phase 4 wire solar PV - battery micogrid is capable of delivering highly non-sinusoidal currents to nonlinear and unbalance loads of different types such that single and three phase industrial and domestic loads, while the source currents in all three phases remains balanced and sinusoidal. An adaptive back propagation learning scheme is used to control the microgrid voltage control and power quality improvement under various loading conditions through mitigation of harmonic currents, reactive power compensation and active power balancing in the system. It also improve the system power factor in highly nonlinear and unbalanced loading conditions. The proposed scheme significantly improves the steady state and dynamic performances of the 3 phase 4 wire grid integrated solar PV - battery micogrid system.

[4] Ujjwal Kumar Kalla et al. aimed at normalized neural network based control scheme for power quality improved integration of solar PV and utility grid. In the proposed scheme the solar PV and grid are integrated using a three leg voltage source converter consists of six IGBTs, three interfacing inductors and a DC bus capacitor. The neural network based scheme is used for estimating fundamental real and reactive power components of the load current in all three phases independently therefore the three phase grid current remains balanced and sinusoidal under all type of loading conditions including unbalancing in load currents of three phases. The proposed controller mitigates the harmonic current, compensates reactive power need of the system, improves system power factor and regulates the system voltage at the point of common coupling (PCC)

[5] Adikanda Parida et al. proposed an optimum rotor current control strategy considering minimum losses of the induction generator over entire period of operation is proposed. In the proposed scheme, a solar photovoltaic (PV) unit of appropriate capacity has been augmented with the rotor circuit of the DFIG along with a marginal battery backup to supplement the rotor power in order to maintain continuity of power generation. The active power fluctuations at the stator terminals of the DFIG can be minimised as both solar PV and wind energy can complement each other during lean periods of

either of the sources. The proposed scheme has been simulated and experimentally validated with a 2.5 kW DFIG using dSPACE CP1104 module, which produced satisfactory results.

[6] M. A. Rosli et al. proposed a multi-input power converter (MIPC) for hybrid photovoltaic (PV) array, wind turbine (WT), fuel cell (FC) and battery storage (BT) connected AC grid network. The aim is to simplify the power system and reduce the cost. The proposed MIPC consists of a dc-dc converter and a dc-ac inverter. The output power characteristics of the PV array, WT and FC are introduced. The perturbation and observation (P&O) method is mainly used to accomplish the maximum power point tracking (MPPT) algorithm for PV array and WT sources and set FC operation power on optimal range by proton exchange membrane fuel cell (PEMFC). The MIPC is capable to operate in five modes; first to third modes occur when the power only from either renewable energy (RE) sources, fourth mode happens when power is demanded from all RE sources and finally when no power are available from all RE sources. The proposed system has been simulated by Matlab/Simulink software and the results are discussed in details.

III MODELLING OF PV ARRAY

The configurations of an active photovoltaic shunt power filter system are shown in Figure 1.1. Solar energy is converted into electricity by the photovoltaic system.

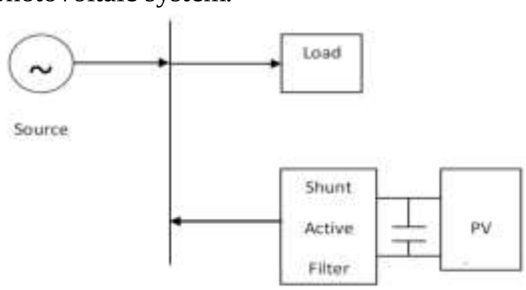

Figure 2: Configurations of a Photovoltaic Interactive Shunt Active Power Filter System

IV. WIND ENERGY

As shown in Figure 1.6, the kinetic energy of the wind causes the wind turbine blades to rotate. This leads to a rotation of the generator shaft, which is connected to the rotor blades. The generator converts the mechanical energy of the rotating shaft into electrical energy. It is optional to connect the slow shaft of the rotor blades with a reducer to the high speed shaft of the generator. In some cases, transmissions are not desirable because they are expensive, cumbersome and heavy. A multipolar generator is an alternative possibility of a gearless system.

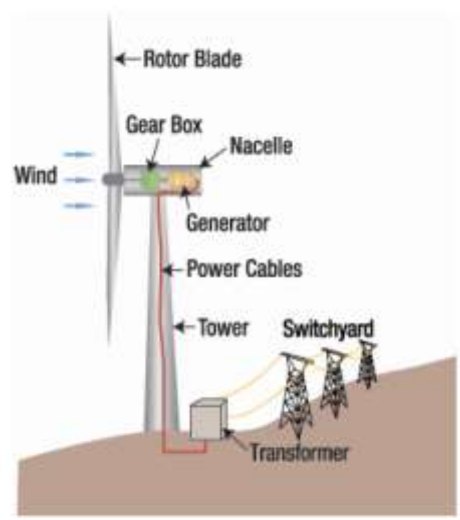

Figure 3: Wind Generator

V. FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)

After a large disturbance in a power system such as a short-circuit fault, it is very crucial to maintain system transient stability for secure operation. Following the restructuring and deregulation of the power supply industry, development of new transmission circuits are restricted because of various constraints such as environment, economy etc. This has led to the trend of utilizing the existing transmission system to its maximum possible operating limits in the competitive market. The trend, in general, leads to the system transient stability margin being reduced, making the system more vulnerable for large disturbances. One way to enhance system stability is by using series compensation which modifies the transmission line reactance to increase the stability limit. In order to improve the transient stability performance, early detection of fault, and fast fault clearance is most important. However, with recent advanced developments in power electronics, the flexible AC transmission systems (FACTS) devices can be used for power system stability enhancement in healthy or post-fault condition

VI. PROPOSED METHODOLOGY

The work on the hybrid system is intended to be further enhanced by using artificial techniques such as fuzzy [7], PSO, neural network [4] etc. on various power control devices.

Also the system efficiency is targeted to be further enhance by making a fuel cell technology which will work as an substitute for the solar system

VII.CONCLUSION

This paper studies the effect of hybrid system on our grid along with its benefits and implementation techniques. The FACTs devices are being discussed which can be further implemented with then to enhance their power transfer capabilities. Also the system is analyzed to depth such that it can be then implemented with the fuel cell energy systems also.

REFERENCES

[1] F. Ding, P. Li, B. Huang, F. Gao, C. Ding, W. Chengshan, "Modeling and Simulation of Grid-connected Hybrid Photovoltaic/Battery Distributed Generation System", *2010 China International Conference on Electricity Distribution*, pp. 1-10, Sept 2010.

[2] Lahari N V and H. Vasantha Kumar Shetty, “Integration of Grid Connected PMG Wind Energy And Solar Energy Systems using Different Control Stratagies”, IEEE, 2015.

[3] Ujjwal Kumar Kalla and Madhuri Mantri, “An Adaptive Control of Voltage Source Converter Based Scheme for Grid Connected Solar PV - Battery System”,IEEE, 2016.

[4] Ujjwal Kumar Kalla, “A Normalized Neural Network Based Controller for Power Quality Improved Grid Connected Solar PV Systems”, IEEE, 2016.

[5] AdikandaParida, Debashis Chatterjee, “Model-based loss minimisation scheme for wind solar hybrid generation system using (grid-connected) doubly fed induction generator”, IET Electric Power Applications, 2016.

[6] M. A. Rosli, N. Z. Yahaya and Z. Baharudin, “A Multi-Input Converter for Hybrid Photovoltaic Array/Wind Turbine/Fuel Cell and Battery Storage System Connected AC Grid Network”, IEEE, 2014.

[7] Jayasankar V N, Vinatha U, “Implementation of Adaptive Fuzzy Controller in a Grid Connected Wind-Solar Hybrid Energy System with Power Quality Improvement Features”, IEEE, 2016.

[8] Ying Liu, Wenping Qin, Xiaoqing Han, Peng Wang, “Modelling of Large-Scale Wind/Solar Hybrid System and Influence Analysis on Power System Transient Voltage Stability”, IEEE, 2017.

[9] S. Kotra and M. K. Mishra, “A supervisory power management system for a hybrid microgrid with hess,” IEEE Transactions on Industrial Electronics, vol. 64, no. 5, pp. 3640–3649, May 2017.

[10] Q. Xu, J. Xiao, X. Hu, P. Wang, and M. Y. Lee, “A decentralized power management strategy for hybrid energy storage system with autonomous bus voltage restoration and state-of-charge recovery,” IEEE Trans. on Ind. Electron., vol. 64, no. 9, pp. 7098–7108, Sept 2017.