AN INTEGRATED HYBRID SYSTEM OF RENEWABLE ENERGY SOURCES FOR LOAD REACTIVE POWER COMPENSATION

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ABSTRACT

Here in this paper a classical wind energy conversion system are generally passive generators. The produced power does not depend on the grid requirement but totally on the various disturbance wind condition. A dc integrated wind or hydrogen or super capacitor hybrid power system is investigated in this paper. The aim of the control system is to coordinate these various kinds of sources mainly their power exchange in order to make controllable the produced power. As a result an active wind generator can be built to provide some ancillary services to the grid side. Here in this paper various load fluctuations which occurred at the load side will be compensated irrespective of the disturbances in supply. The control technique should be improved to couple the power management strategies are explained and compared. We initiate that the source following scheme has better operating performance on the grid power regulation than the grid following control technique.

Keywords: Circulated Power, Energy Organization System, Hybrid Power System (HPS), Power Control Strategy, Wind Generator (WG).

I. INTRODUCTION

Non-conventional energy sources and distributed power generation (DGs) have attracted special attention all over the world in order to fulfill the following goals.

1) The protection of energy supply by minimizing the dependency on imported fossil fuels.

2) The minimization of the emission of greenhouse gases from the burning of fossil fuels.

Other than their moderately low operating efficiency and high economical cost and the stability of the electrical creation is the main disadvantage of non-conventional energy generators such as wind based turbines and photovoltaic plates because of the unregulated meteorological situations. In significance their integration into the utility network can lead to grid unsteadiness or even damage if they are not appropriately maintained. Furthermore the standards for inter relating these systems to the service become more and more serious and necessitate the Distributed Generation systems to deliver certain services those are frequency and voltage regulations of the local utility grid. The power produced from Wind is measured. The wind based energy is the world's quickest rising energy source and increasing globally at a rate of 0.25% to 0.35% annually over the last period of decade.

Though classical wind energy conversion systems operate like passive generators. Because of the asymmetrical and different wind speed blowing they cannot produce any additional facilities to the electrical system in a micro grid application where steady active- and reactive power necessities should be recognized to the generators. An another alternate hybrid power systems (HPS) are suggested to overcome these difficulties with the following two advanced enhancements.

1) Energy storage arrangements are utilized to balance or absorb the modification between the produced wind generated power and the essential available grid power.

2) Power organization control techniques are employed to maintain the power conversation among dissimilar sources and to deliver some services to the grid.

Hydrogen technologies, merging fuel cells (FCs) and electrolyzes (ELs) with hydrogen tanks are exciting for extensive term energy storing because of the essential high mass energy density. In case of wind energy surplus the Electro Lyzers changes the extra energy into H2 by electrochemical response. The generated H2 can be stored in the hydrogen tank for future usage purpose. In case of wind energy shortfall the available stored electrolytic H2 can be recycled to produce electricity by an Fuel Cell to meet the energy requirement of the grid. Therefore hydrogen as an energy carrier donates directly to the reduction of dependence on introduced fossil fuel. As per the investigators wind electrolysis is a very effective candidate for an economically sustainable non-conventional hydrogen generation system. Even though Fuel Cells and another power source ELs have low dynamic operating performances and quick dynamic energy storage should be related in order to avoid the fast variations of wind power.

In recent development in technology makes super capacitors the best candidates as quick dynamic energy storage system especially foe mitigating fluctuant energy generation such as wind energy generators. Compared to batteries super capacitors are capable of very quick charges and discharges and can obtain a very extensive number of cycles without memory consequence. Worldwide the super capacitors have good round trip operating efficiency than batteries. The power management with high dynamic and good operating efficiency and flywheel systems are also appropriate for fast dynamic energy storage. Even though the mechanical system is currently hampered by the hazard of explosive shattering of the massive controls due to huge load tensile strength because of high weight and huge speed. The Super Capacitor's are less sensitive in operating temperature than batteries and have no mechanical protection problems.

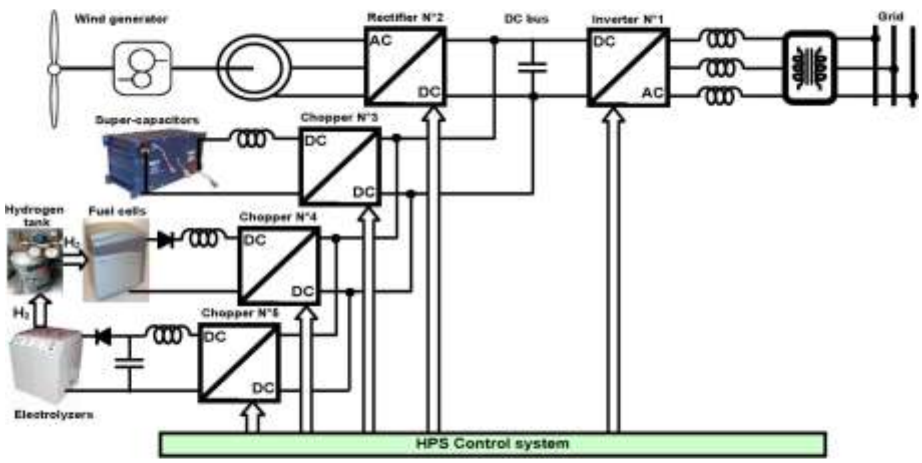

Fig.1.Structure of the Studied Wind/Hydrogen/SC HPS

II. HPS AND CONTROL SYSTEM

2.1 Structure of HPS

In this paper we utilized a dc integrated construction in order to decouple the grid voltages and frequencies from other different types of sources. Those different kinds of sources are integrated to a main dc bus before being coupled to the grid through a main inverter. Every source is electrically coupled with a power electronic change in order to get possibilities for power managing actions. Furthermore this HPS construction and its global control system can also be utilized for other combinations of sources.

2.2 Structure of Control System

The basic power converters introduce some control inputs for power conversion. In this case the construction of the control system can be classified into various different levels. The Switching control unit is developed for each power converter. In an switch control unit the drivers with optocouplers produce the transistors ON/OFF signals from the ideal switching states of the switching functions {0,1} and the modulation technique analyzes the switching functions from the modulation functions.

The automatic control unit (ACU) is constructed for every energy storage source and its power translation arrangement. In an ACU the controller algorithms examine the modulation functions for each power converter through the controlling of some physical quantities according to their reference values.

The Power Control Unit (PCU) is developed to perform the instantaneous power regulating of the total HPS in order to satisfy the grid supplies. These necessities are real and reactive power references which are achieved from the secondary control center and from references of droop controllers. In PCU some power complementary algorithms are executed to organize the power flows of different kinds of energy sources. The dissimilar power harmonizing algorithms correspond to a number of possible operating conditions of the HPS and can be collected.

The main aim of this paper is to present the power regulating control approaches in the PCU. In order to focus on the power regulating control techniques of the HPS the control techniques of the power translation systems through dissimilar power converters will not be comprehensive in this paper. Nevertheless some descriptions of the Automatic Control Units are present in the subsequent paragraphs in order to make the manageable variables of the power conversion systems seem.

III. PCU

3.1 Layout of PCU

The power modeling of the HPS can be provided into two stages the power calculation stage and the power flow stage. Hence the PCU is also classified into two stages, the **power control stage** and **power sharing stage**. The PCU enables one to calculate references for the ACU from power references. The power allocation stage coordinates the power flow exchanges among the altered energy sources with various power balancing control techniques. Those techniques are investigated here in clear with the help of the Multilevel Representation.

3.2 *Power* Control Level

The power exchanges with various sources are maintained only via the related five references as represented as follows(uel_ref ,ifc_ref ,isc_ref ,$Tgear\_ref$,$and\ il\_ref$. Hence the representation of the power should be deduced in order to achieve these power references. Only the source powers and the interchanged power with the dc bus capacitor are taken into account here.For the wind energy generation an effective control strategy implemented a maximum power point tracking (MPPT) in order to extract the maximum power of the presented wind energy according to a nonlinear characteristic in function of the speed. It receives the calculated rotational speed and sets a required power reference.

3.3 Power Sharing Level

The Power allocating level is utilized to develop the power balancing techniques in order to coordinate the various kinds of sources in the HPS. This plays a vital role in the control system because the power conversations lead directly to the stability of the HPS and influence the dc bus voltage.

$$dEdc\ dt\ =\ Cdcudc\ dudc\ dt\ =\ pd = pwg\ +\ psc\ +\ pfc\ -\ pel - pg$$

In this paper wind, hydrogen, Super Capacitor and HPS are the different five power electronic converters are utilized to control the power transfer with each source. According to a selected power flow the two power controlling techniques can be developed.

1) The grid following control technique utilizes the line current loop to control the dc bus voltage.
2) The source following control technique utilizes the current loop to maintain the grid active power and the dc bus voltage is controlled with the wind generation and storage systems.

IV. EXPERIMENTAL TESTS

4.1 Experimental Platform Assessment

An experimental environment of the HPS developed to test the various power balancing control methods. The Hardware in the loop emulations of a part of a power system allows a quick experimental arrangement test before development with the real progression. Few parts of emulator procedure are analyzed in real time in a controller based and are then integrated in hardware with the real equipment's. Such HIL analyzing intensively utilized to enable one to check the availability and continuity of the hybrid active wind generation.

The Fuel Cell and EL emulators are utilized to the same electrical characteristics as the real Fuel Cell stack and the EL stack. The constructional Design models of the FCs and the EL already analyzed through comparison with achieved experimental results and analyzed results from models. Those are designed in a digital control based and measured voltages and currents are produced by utilizing power electronic converters. All energy sources are integrated to the dc bus through different power converters. The dc bus is coupled to the grid through a three phase inverter and three line filters and the transformer which is available at the grid side.
A wind power emulator is utilized to generate the predefined minimized wind power shape. The capacity of the fuel cell and El chimney is adapted by utilizing the modelling parameters of the HIL analysis to be interfaced in the experimental validations.

The power balancing control techniques are examined and compared. With the analysis of the test it is possible to apply our recommended control system for active generator and to test it with the power balancing approaches.

4.2 Power Profile of Different Sources

Various tests are conducted with the help of experiments for both control approaches. The same variable wind power profile is utilized during certain time. The active power requirement from the type of micro grid is assumed. A similar power profiles are achieved for the energy storage system. When the produced wind power is minimum with the rated power the Fuel Cell is enabled in order to balance the power differences. Since the power variations of the Fuel Cell and the EL are limited by the LPF with the constant time period. They are not capable to filter the fast variations in the wind generation. Hence the super conductor delivers or collects the power difference

4.3 Source-Following Strategy

Here in this project the grid following control technique the energy storage system are maintained to delivers or collects the required powers for the purpose of control the dc bus voltage against the variant wind power. The produced grid active power is also maintained and is equal to the micro grid necessities. Because of the line current control loop maintains directly the available grid power.

V. CONCLUSION

Here in this paper a dc-integrated HPS has been examined with the three various types of energy sources 1) a Wind Generation as renewable energy production system 2) Super Conductors as a quick dynamic energy storage system and 3) Fuel Cells with ELs and hydrogen tank as a extended term energy storage system. The construction of the control system is allocated into three levels 1) SCU 2) Automatic Control Unit and 3) PCU. Two power compensating approaches also obtainable and compared for the Power Control Unit the grid following scheme and the source following scheme. For both of them the dc-bus voltage and the grid power can be well matched. The investigational tests also presented that the source following approach has improved presentation on the grid power instruction than the grid following strategy.

REFERENCES

[1] W. Li, G. Joos, and J. Belanger, "Real-time simulation of a wind turbine generator coupled with a battery supercapacitor energy storage system," IEEE Trans. Ind. Electron., vol. 57, no. 4, pp. 1137–1145, Apr. 2010.

[2] [Online]. Available: http://www.eurobserv-er.org/

[3] G. Delille and B. Francois, "A review of some technical and economic features of energy storage technologies for distribution systems integration," Ecol. Eng. Environ. Prot., vol. 1, pp. 40–49, 2009.

[4] C. Abbey and G. Joos, "Supercapacitor energy storage for wind energy applications," IEEE Trans. Ind. Electron., vol. 43, no. 3, pp. 769–776, May 2007.

[5] G. Taljan, M. Fowler, C. Cañizares, and G. Verbi ̌c, "Hydrogen storage for mixed wind-nuclear power plants in the context of a Hydrogen Economy," Hydrogen Energy, vol. 33, no. 17, pp. 4463–4475, Sep. 2008.

[6] M. Little, M. Thomson, and D. Infield, "Electrical integration of renewable energy into stand-alone power supplies incorporating hydrogen storage," Hydrogen Energy, vol. 32, no. 10, pp. 1582–1588, Jul. 2007.

[7] T. Zhou, D. Lu, H. Fakham, and B. Francois, “Power flow control indifferent time scales for a wind/hydrogen/super-capacitors based active hybrid power system,” in Proc. EPE-PEMC, Poznan, Poland, Sep. 2008, pp. 2205–2210.

[8] F. Baalbergen, P. Bauer, and J. A. Ferreira, “Energy storage and power management for typical 4Q-load,” IEEE Trans. Ind. Electron., vol. 56, no. 5, pp. 1485–1498, May 2009.

[9] D. Ipsakis, S. Voutetakis, P. Seferlis, F. Stergiopoulos, and C. Elmasides, “Power management strategies for a stand-alone power system using renewable energy sources and hydrogen storage,” Hydro. Energy, vol. 4, no. 16, pp. 7081–7095, Aug. 2009.

[10] U.S. Department of Energy, Energy Efficiency and Renewable Energy, Wind & Hydropower Technologies Program, Wind Energy Research Area. [Online]. Available: http://www.eere.energy.gov

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