HYBRID SOLAR AND WIND POWER GENERATION WITH MPPT CONTROL

PRAPANJANI.C[1], Mr.ARAVINDH.R[2], Mr.THANGARAJ.D[3]

ME Student (POWER ELECTRONICS AND DRIVES)[1], Assistant Professor[2,3]

Department of Electrical & Electronics Engineering)

A.V.S Engineering College, Salem, India.

ABSTRACT

Electricity is most needed for our day to day life. There are two ways of electricity generation either by conventional energy resources or by nonconventional energy resources. Electrical energy demand increases in word so to fulfill demand we have to generate electrical energy. Now a day"s electrical energy is generated by the conventional energy resources like coal, diesel, and nuclear etc. The main drawback of these sources is that it produces waste like ash in coal power plant, nuclear waste in nuclear power plant and taking care of this wastage is very costly. And it also damages he nature. The nuclear waste is very harmful to human being also. The conventional energy resources are depleting day by day. Soon it will be completely vanishes from the earth so we have to find another way to generate electricity. The new source should be reliable, pollution free and economical. The non-conventional energy resources should be good alternative energy resources for the conventional energy resources. There are many nonconventional energy resources like geothermal, tidal, wind, solar etc. the tidal energy has drawbacks like it can only implemented on sea shores. While geothermal energy needs very lager step to extract heat from earth. Solar and wind are easily available in all condition.

1. INTRODUCTION

Electricity is most needed for our day to day life. There are two ways of electricity generation either by conventional energy resources or by nonconventional energy resources. Electrical energy demand increases in word so to fulfill demand we have to generate electrical energy. Now a day"s electrical energy is generated by the conventional energy resources like coal, diesel, and nuclear etc. The main drawback of these sources is that it produces waste like ash in coal power plant, nuclear waste in nuclear power plant and taking care of this wastage is very costly. And it also damages he nature. The nuclear waste is very harmful to human being also. The conventional energy resources are depleting day by day. Soon it will be completely vanishes from the earth so we have to find another way to generate electricity. The new source should be reliable, pollution free and economical. The non-conventional energy resources should be good alternative energy resources for the conventional energy resources. There are many nonconventional energy resources like geothermal, tidal, wind, solar etc. the tidal energy has drawbacks like it can only implemented on sea shores. While geothermal energy needs very lager step to extract heat from earth. Solar and wind are easily available in all condition.

2. EXISTING

The existing system is implemented with integrated control schemes, which are INC based control scheme for estimating the maximum energy from the PV generator and adaptive control scheme to generate the switching pulses of utility connected VSC. After estimating the peak energy from the PV array, VSC converts this DC power in to the AC power by providing control in unbalanced. For estimation of switching sequences of the grid tied VSC, unit vectors are used. For slow response, an control scheme is utilized at a only fixed step size.

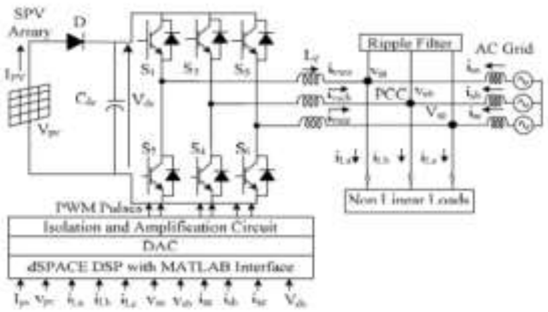

Fig-1: Existing block diagram

3. PROPOSED SYSTEM

In this proposed system solar and wind power is used for generating power. Solar and wind has good advantages than other than any other non-conventional energy sources. Both the energy sources have greater availability in all areas. It needs lower cost. There is no need to find special location to install this system. Solar energy is that energy which is gets by the radiation of the sun. Solar energy is present on the earth continuously and in abundant manner. Solar energy is freely available. It doesn‟t produce any gases that mean it is pollution free. It is affordable in cost. It has low maintenance cost. Only problem with solar system it cannot produce energy in bad weather condition. But it has greater efficiency than other energy sources. It only need initial investment. It has long life span and has lower emission. Wind Energy Wind energy is the energy which is extracted from wind. For extraction we use wind mill. Ii is renewable energy sources. The wind energy needs less cost for generation of electricity. Maintenance cost is also less for wind energy system.

3.1 PROPOSED BLOCK DIAGRAM

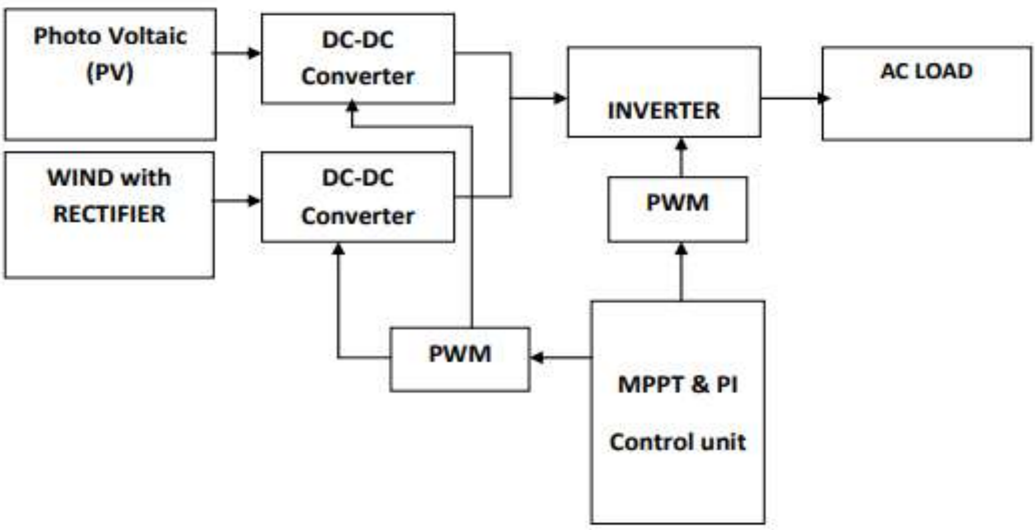

Fig-2: Proposed Block Diagram

4. HARDWARE REQUIREMENTS

4.1 MAXIMUM POWER POINT TRACKING

Maximum power point tracking (MPPT) is a technique that grid connected inverters, solar battery chargers and similar devices use to get the maximum possible power from one or more photovoltaic devices, typically solar panels, though optical power transmission systems can benefit from similar technology.[2] Solar cells have a complex relationship between solar irradiation, temperature and total resistance that produces a non-linear output efficiency which can be analyzed based on the I-V curve. It is the purpose of the MPPT system to sample the output of the cells and apply the proper resistance (load) to obtain maximum power for any given environmental conditions. MPPT devices are typically integrated into an electric system that provides voltage or current conversion, filtering, and regulation for driving various loads, including power grids, batteries, or motors.

4.2 PIC 16F877

PI controller will eliminate forced oscillations and steady state error resulting in operation of on-off controller and P controller respectively. However, introducing integral mode has a negative effect on speed of the response and overall stability of the system. Thus, PI controller will not increase the speed of response. It can be expected since PI controller does not have means to predict what will happen with the error in near future. This problem can be solved by 15 introducing derivative mode which has ability to predict what will happen with the error in near future and thus to decrease a reaction time of the controller. PI controllers are very often used in industry, especially when speed of the response is not an issue. A control without D mode is used when: a) Fast response of the system is not required b) Large disturbances and noise are present during operation of the process c) There is only one energy storage in process (capacitive or inductive) d) There are large transport delays in the system

The following steps are considered for the design of PI controller.

1. Read the open loop transfer function of the given higher order system.
2. Form the closed loop transfer function.
3. Obtain the step response of closed loop system.
4. Check the response for the required specifications.

5. If the specifications are not met, get a reduced order model and design a controller for the reduced order model.
6. Obtain the initial values of the parameter Kp and Ki by pole zero Cancellation method.
7. Cascade the controller with reduced order model and get the closed loop response with the initial values of the controller parameters.
8. Find the optimum values for the controller parameters which satisfy the required specifications.
9. By applying the optimum values, cascade this controller with the original system.
10. Obtain the closed loop step response of the system with the controller.
11. If the specifications are met give exit command else tune the parameters of the controller till they meet the required specifications. 19 For designing the PI controller, the values of controller parameters Kp and Ki are obtained through existing tuning method. The GA is employed to obtain the optimized values of Kp and Ki to meet out the designs specifications.

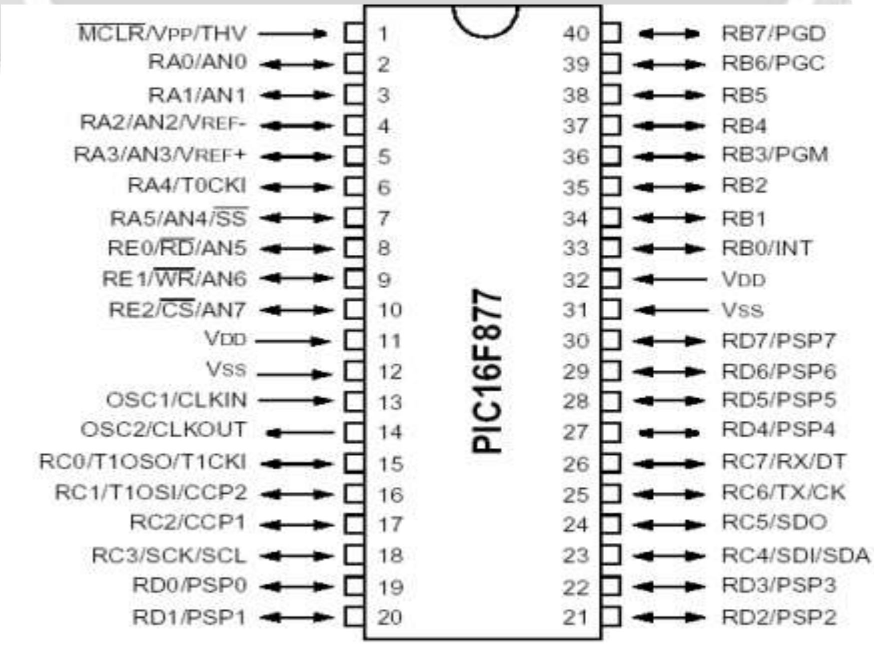

Fig-3: PIN DIAGRAM OF PIC 16F877

4.3 PERMANENT MAGNET SYNCHRONOUS GENERATOR: (PMSG)

The amount of energy captured from a WECS depends not only on the wind at the site, but depends on the control strategy used for the WECS and also depends on the conversion efficiency. Permanent magnet synchronous generators (PMSG) wind energy converters system (WECS) with variable speed operation is being used more frequently in low power wind turbine applications. Variable speed systems have several advantages such as the reduction of mechanical stress and an increase in energy capture. In order to achieve optimum wind energy extraction at low power fixed pitch WECS, the wind turbine generator (WTG) is operating in variable-speed variable-frequency mode. The rotor speed is allowed to vary with the wind speed, by maintaining the tip speed ratio to the value that maximizes aerodynamic efficiency. The PMSG load line should be matched very closely to the maximum power line of the WTG. MPPT control is very important for the practical WECS systems to maintain efficient power generating conditions irrespective of the deviation in the wind speed conditions. To achieve optimal power output, a sensor-less scheme developed by Tan et al in [1] will be used in this work for extracting desired output power from the WTG over a wide range of wind speeds. In spite of, all this complex control theory to get MPPT on PMSG WECS the standard way to implement a grid connected PMSG WECS at variable speed is using two power conversion stages: the first one an AC-DC stage and the second one a DC-AC stage. To realize the first one a classical three phase full bridge rectifier associated to a bulky capacitor is used and the second stage could 20 be implemented by two types of converters schemes Voltage source current controlled inverter (VS-CCI) and Line commutated inverter (LCI).

4.4 WIND MILL

A windmill is a machine which converts the energy of wind into rotational motion by means of adjustable vanes called sails. The main use is for a grinding mill powered by the wind, reducing a solid or coarse substance into pulp or minute grains, by crushing, grinding, or pressing. Windmills have also provided energy to sawmills, paper mills, hammermills, and windpumps for obtaining fresh water from underground or for drainage (especially of land below sea level).

4.5 SOLAR PANEL

A solar panel (photovoltaic module or photovoltaic panel) is a packaged interconnected assembly of solar cells, also known as photovoltaic cells. The solar panel is used as a component in a larger photovoltaic system to offer electricity for commercial and residential applications. Because a single solar panel can only produce a limited amount of power, many installations contain several panels. This is known as a photovoltaic array. A photovoltaic installation typically includes an array of solar panels, an inverter, batteries and interconnection wiring. Solar panels use light energy (photons) from the sun to generate electricity through the photovoltaic effect. The structural (load carrying) member of a module can either be the top layer (superstrate) or the back layer (substrate). The majority of modules use wafer-based crystalline silicon cells or a thin-film cell based on cadmium telluride or silicon. Crystalline silicon, which is commonly used in the 23 wafer form in photovoltaic (PV) modules, is derived from silicon, a commonly used semi-conductor. In order to use the cells in practical applications, they must be: ¬ Connected electrically to one another and to the rest of the system ¬ Protected from mechanical damage during manufacture, transport, installation and use (in particular against hail impact, wind and snow loads). This is especially important for wafer-based silicon cells which are brittle. ¬ Protected from moisture, which corrodes metal contacts and interconnects, (and for thin-film cells the transparent conductive oxide layer) thus decreasing performance and lifetime. Most modules are usually rigid, but there are some flexible modules available, based on thin-film cells.

4.6 DC TO DC CONVERTER: (BOOST CONVERTER)

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

4.7 OPERATING PRINCIPLE

The key principle that drives the boost converter is the tendency of an inductor to resist changes in current. When being charged it acts as a load and absorbs energy (somewhat like a resistor), when being discharged, it acts as an energy source (somewhat like a battery). The voltage it produces during the discharge phase is related to the rate of change of current, and not to the original charging voltage, thus allowing different input and output voltages.

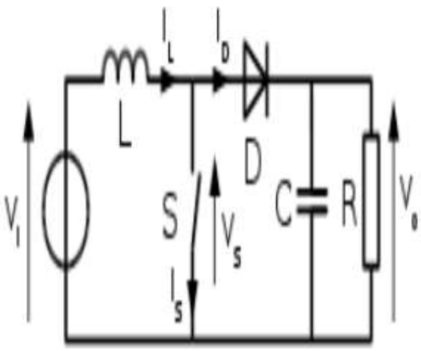

Fig-4: Boost converter schematic

The basic principle of a Boost converter consists of 2 distinct states :

- In the On-state, the switch S is closed, resulting in an increase in the inductor current;
- In the Off-state, the switch is open and the only path offered to inductor current is through the flyback diode D, the capacitor C and the load R. This results in transferring the energy accumulated during the On-state into the capacitor.
- The input current is the same as the inductor current as can be seen in figure 2. So it is not discontinuous as in the buck converter and the requirements on the input filter are relaxed compared to a buck converter.

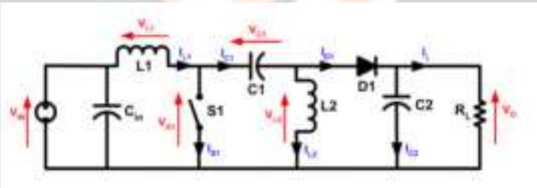

Fig-5: Circuit Diagram of Boost Converter

4.8 PWM

Pulse-width modulation (PWM), is a commonly used technique for controlling power to inertial electrical devices, made practical by modern electronic power switches.The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast pace. The longer the switch is on compared to the off periods, the higher the power supplied to the load is. 27 The PWM switching frequency has to be much faster than what would affect the load, which is to say the device that uses the power. Typically switching have to be done several times a minute in an electric stove, 120 Hz in a lamp dimmer, from few kilohertz (kHz) to tens of kHz for a motor drive and well into the tens or hundreds of kHz in audio amplifiers and computer power supplies.

4.9 INVERTER

An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits. Static inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility highvoltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries. The electrical inverter is a high-power electronic oscillator. It is so named because early mechanical AC to DC converters were made to work in reverse, and thus were "inverted", to convert DC to AC.

An inverter converts the DC electricity from sources such as batteries, solar panels, or fuel cells to AC electricity. The electricity can be at any required voltage; in particular it can operate AC equipment designed for mains operation, or rectified to produce DC at any desired voltage.

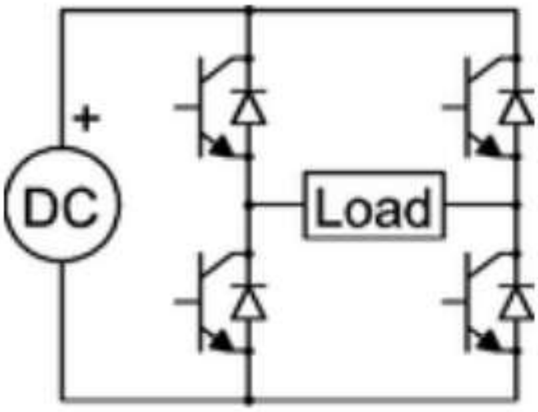

Fig-6: Inverter Circuit

5 SOFTWARE REQUIREMENT

5.1 MPLAB

MPLAB IDE is an integrated development environment that provides development engineers with the flexibility to develop and debug firmware for various Microchip devices MPLAB IDE is a Windows-based Integrated Development Environment for the Microchip Technology Incorporated PICmicrocontroller (MCU) and dsPIC digital signal controller (DSC) families. In the MPLAB IDE, you can:

- Create source code using the built-in editor.
- Assemble, compile and link source code using various language tools. An assembler, linker and librarian come with MPLAB IDE. C compilers are available from Microchip and other third party vendors.
- Debug the executable logic by watching program flow with a simulator, such as MPLAB SIM, or in real time with an emulator, such as MPLAB ICE. Third party emulators that work with MPLAB IDE are also available.
- Make timing measurements.
- View variables in Watch windows.
- Program firmware into devices with programmers such as PICSTART Plus or PRO MATE II.
- Find quick answers to questions from the MPLAB IDE on-line Help.

5.1.1 MPLAB SIMULATOR

MPLAB SIM is a discrete-event simulator for the PIC microcontroller (MCU) families. It is integrated into MPLAB IDE integrated development environment. The MPLAB SIM debugging tool is designed to model operation of Microchip Technology's PIC microcontrollers to assist users in debugging software for these devices.

5.1.2 IC PROG

The PRO MATE II is a Microchip microcontroller device programmer. Through interchangeable programming socket modules, PRO MATE II enables you to quickly and easily program the entire line of Microchip PIC micro microcontroller devices and many of the Microchip memory parts. PRO MATE II may be used with MPLAB IDE running under supported Windows OS's (see Read me for PRO MATE II.txt for support list), with the command-line controller PROCMD or as a stand-alone programmer.

5.1.3 COMPILER-HIGH TECH C

A program written in the high level language called C; which will be converted into PIC micro MCU machine code by a compiler. Machine code is suitable for use by a PIC micro MCU or Microchip development system product like MPLAB IDE.

5.1.4 PIC START PLUS PROGRAMMER:

The PIC start plus development system from microchip technology provides the product development engineer with a highly flexible low cost microcontroller design tool set for all microchip PIC micro devices. The pic start plus development system includes PIC start plus development programmer.

5.1.5 MPLAB IDE

The PIC start plus programmer gives the product developer ability to program user software in to any of the supported microcontrollers. The PIC start plus software running under MPLAB provides for full interactive control over the programmer.

5.2 EMBEDDED C

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. In 2008, the C Standards Committee extended the C language to address these issues by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as, fixed-point arithmetic, named address spaces, and basic I/O hardware addressing. Embedded C use most of the syntax and semantics of standard C, e.g., main() function, variable definition, datatype declaration, conditional statements (if, switch. case), loops (while, for), functions, arrays and strings, structures and union, bit operations, macros, unions, etc.

6 HARDWARE IMPLEMENTATION

6.1 OVERALL SETUP

The following figure represents the overall hardware implementation of hybrid solar and wind mill power generation with MPPT control.

Fig-10: Overall setup

6.2 OUTPUT RESULT

The digital output result is shown below

Fig-11: Output result

7 ADVANTAGES AND APPLICATIONS

ADVANTAGES:

1) Draws continuous dc current from the Renewable energy.
2) Features a lower capacitor voltage rating, and
3) Reduces the switching for Renewable energy and inverter.

APPLICATIONS:

- AC network interconnections
- Renewable electricity superhighways.
- Renewable energy sources.
- Electric motor.
- Windmill generation systems.
- Battery storage systems.
- Flexible alternative current transmission systems.
- High-voltage transmission systems

8 CONCULSION

Accelerated installation of variable renewable generation coupled with the introduction of the smart grid, have created an increased interest in micro grids. This project has developed a framework for voltage regulation in autonomous micro grids that is capable to operate under wide range of operation modes and conditions. Solar PV and wind turbine size and locations in the micro grid were preselected, however, the size and location of the energy storage was determined using optimization approach.

The hybrid solar PV/wind generation provided more effective voltage regulation to the micro grid system as compared with each of the solar PV/wind turbine acting alone. Furthermore, when the voltage variation fell beyond the capabilities of the hybrid system, the coordination of the hybrid PV/wind energy system with energy storage, a feature of the smart micro grid, were apt to bring the voltage back within statutory limits. This improves the voltage profile quality and offers active power adjustment capacity to the distribution system. The efficacy of real-time pricing demand response tool in shaping load demand is suggested for further studies which will not only greatly minimize the peak load, but also the load demand variation.

9 REFERENCE

[1] Recep Yumurtaci , “Wind, solar and hydrogen energy technologies for stand alone applications,” Turkish Journal of Electrical Engineering & Computer Sciences, pp. 1077-1091 Jun, 2013.

[2] M. D. Ilic´, Y. Makarov, and D. Hawkins, “Operations of electric power systems with high penetration of wind power: Risks and possible solutions, in Proc. IEEE Power Eng. Soc. General Meeting, Jun. 2007.

[3] Chaitanya Marisarla and K. Ravi Kumar, “A Hybrid Wind and Solar Energy System with Battery Energy Storage for an Isolated System,”International Journal of Engineering and Innovative Technology, Volume 3, Issue 3, September 2013.

[4] J. M. Guerrero, F. Blaabjerg, T. Zhelev, K. Hemmes, E. Monmasson, S.Jemei, M. P. Comech, R. Granadino, and J. I. Frau, “Distributed generation toward a new energy paradigm,” IEEE Ind. Electron. Mag., vol. 4, no. 1, pp. 52–64, Mar. 2010.

[5] G. R. Mohapatra and A. Kalam, “Dynamic stability analysis of renewable energy sources interconnected to the distribution networks,” in Proc. Australas. Univ. Power Eng. Conf., Dec. 14–17, 2008, pp. 1–4.

[6] P. Thounthong and S. Rael, “The benefits of hybridization,” IEEE Ind. Electron. Mag., vol. 3, no. 3, pp. 25–37, Sep. 2009.

[7] P. F. Ribeiro, B. K. Johnson, M. L. Crow, A. Arsoy, and Y. Liu, “Energy storage systems for advanced power applications,” in Proc. IEEE, Dec.,2001, vol. 89, no. 12, pp. 1744–1756. 37

[8] W. Li and G. Joos, “A power electronic interface for a battery Super capacitor hybrid energy storage system for wind applications,” in Proc. IEEE Power Electron. Spec. Conf., Jun . 15–19, 2008, pp. 1762– 1768.

[9] S. M. Muyeen, R. Takahashi, T. Murata, and J. Tamura, “Integration of an energy capacitor system with a variable-speed wind generator,” IEEE Trans. Energy Convers., vol. 24, no. 3, pp. 740–749, Sep. 2009.

[10] L. Wang and D. J. Lee and W. J. Lee and Z. Chen, “‘“Analysis of a novel autonomous marine hybrid power generation/energy storage system with a highvoltage direct current link”, journal of power source, Volume 185, Issue 2, Pages 1284–1292, 1 December 2008.