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Hybrid Model Controller-A Review

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***Abstract*— In electric distribution system Power control of a hybrid generation system that is wind and solar system for interconnection operation is presented in this paper. Renewable resources such as the solar wind etc offers clean, abundant energy .As the power demand increases power failure also increases so the renewable energy can be used to provide constant loads. To converting the basic circuit equation of solar cell into simplified form a model developed including the effects of changing solar irradiation and temperature.**

This paper introduces the performance of hybrid power system which has a combination of solar power and wind power. PV array is extracting maximum energy from sunlight irradiation by using Maximum Power Point Tracker; it collects the power from the system and sends power to the dummy utility grid .On the other hand, depending on the velocity of the wind available, wind turbine rotates and energizes an asynchronous generator for power supply to the grid.

These two separate sources are connected together for hybrid operation and synchronized appropriately for segmented power supply to the grid. For this 'Sim Power System' tool of MATLAB has been used for simulating the same.

Keywords*— *Solar Energy, Wind Energy, hybrid power system, Matlab/ Simpower system.

I. INTRODUCTION

Combined win-PV hybrid generation system utilizes the solar and wind resources for electric power generation. Individual wind and solar renewable sources have unpredictable random behavior. As throughout the day solar energy is present but due to the sun intensity andun predictable shadows by the clouds, birds, trees etc the solar irradiation levels varies. Due to this cause solar energy is unreliable and less used.

Wind is a form of solar energy. Due to the uneven heating of the atmosphere by the sun wind flow. Due to the earth terrains, bodies of water and vegetation the wind flow patterns are modified. Wind turbine converts the kinetic energy in the wind in to mechanical then to electrical by rotating the generator which are connected internally. Wind is highly unpredictable in nature as it can be here one moment and gone in another moment but it is capable of supplying large amount of power. Due to this concept of wind energy it is an unreliable one and less used. So it is better to use hybrid generation system which is better than individual wind or individual PV generation system. So it is overcome the demerits of individual system. Grid interface of hybrid generation system improves the system reliability.

In this system there is a wind turbine, the output of the wind turbine goes to permanent magnet synchronous generator. The output of the wind system is in ac so we need ac to dc converter to convert the ac output in to dc .Similarly in the PV side the output of the PV array is connected with a dc-dc boost converter to rise the output voltage up to a desire level. And the output of PV and wind are connected with a common DC link voltage. The common DC link voltage will be connected with the DC to AC converter and the output of the inverter is synchronizing with grid. This inverter changes DC power from PV array and the wind turbine into AC power and it maintain the voltage and frequency is equal to the grid voltage and frequency.

II. LITERATURE SURVEY

1 Md. SifatFerdous Chowdhury and Mohammad Abdul Mannan at " Simulating Solar and Wind Based Hybrid Systems Synchronized and Segmented for Grid Connectivity" , INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY SCIENCES AND ENGINEERING, VOL. 5, NO. 8, AUGUST 2014

In this paper two separate sources are connected together for hybrid operation and synchronized appropriately for segmented power supply to the grid. For this, devices of this hybrid systems are-PV array, boost converter, Maximum Power Point Tracker (MPPT), harmonic reducing filter, IGBT switch, three level bridge inverter, Voltage source converter (VSC), Asynchronous generator, wind turbine, P.F. correction capacitor and transformer for step up the voltage level. For that the signal goes to PI controller which minimizing the error signal and compared with the waveform for get a pulse. At the beginning the power will sends to consumer then transformer step –up the Voltage to the grid level voltage. Thus, these papers are to develop and simulate a hybrid system that combines the wind model and the Photovoltaic model.

2 FarzamNejabatkhahat"Overview of Power Management Strategies of HybridAC/DC Microgrid"IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 30, NO. 12, DECEMBER 2014.

This paper introduces the hybrid ac/dc systems withdc and ac sources/loads are considered. This paper presents an over view of power management strategies for a hybrid ac/dc microgrid system, which includes different system structures (ac-coupled,dc-coupled, and ac–dc-coupled hybrid microgrids), different operation modes, a thorough study of various power management and control schemes in both steady state and transient conditions. In this paper,the power management strategies determine output active and reactive powers of DGs and SEs, and control the voltages and frequency at the same time Droop method is studied.

3. Xiangjun Li,Dong Hui, and Xiaokang Lai at "Battery Energy Storage Station (BESS)-Based Smoothing Control of Photovoltaic (PV) andWind Power Generation Fluctuations" IEEE TRANSACTIONS ON SUSTAINABLE ENERGY, VOL. 4, NO. 2, APRIL 2013

In this paper ,the battery energy storage station (BESS) is explained of smoothing wind- or solar-power generation fluctuations. This hybrid power systems require a suitable control strategy that can effectively regulate power output levels and battery state of charge (SOC). In this paper,a smoothing control methodf or reducing wind/PV hybrid output power fluctuations and regulating battery SOC under the typical conditions is explained.

4. Sharad W. Mohod and Mohan V. Aware"STATCOM-Control Scheme for Grid ConnectedWind Energy System for Power Quality Improvement"IEEE SYSTEMS JOURNAL, VOL. 4, NO. 3, SEPTEMBER 2010

This paper gives the information that how power quality affects after injecting wind power into an electric grid.The influence of the wind turbine in the gridsystem concerning the power quality measurements are-the active power, reactive power, variation of voltage, flicker, harmonics,and electrical behavior of switching operation and these are measured .This paper demonstrates the power quality problem due to installation of wind turbine with the grid. In this mitigate the power quality issues.The STATCOM control scheme for the grid connected wind energy generation system for power quality improvement is simulated using MATLAB/SIMULINK in power system blockset. The effectiveness of the proposed scheme relives the main supply source from the reactive power demand of the load and the induction generator.

5. J. George Hwang, Peter W. Lehn, andManfred Winkelnkemper, at"A Generalized Class of Stationary Frame-CurrentControllers for Grid-Connected AC–DC Converters"IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 25, NO. 4, OCTOBER 2010.

This paper introduces how within power systems, high-power pulse width-modulated ac–dc converters are used in flexible ac transmission systems controllers and for interfacing renewable energy sources to the grid. These converters traditionally employed PI controllers designed in the synchronous -frame with decoupling significantly from that of decoupled -frame controllers. This paper derives a stationary frame controller that is the exact equivalent of the commonly used synchronous frame controller with decoupling. It is studied that after ignoring this decoupling component greatly increases the controller's sensitivity to frequency variation. Numerous stationary frame controllers, including the common PR controller, may be derived from the general PRX2 controller.

6. Jean Patric da Costa, Humberto Pinheiro,ThomasDegner, and Gunter Arnold at"Robust Controller for DFIGs of Grid-ConnectedWind Turbines."IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 58, NO. 9, SEPTEMBER 2011 4023

This paper proposes a new robust controller in astationary reference frame for doubly fed induction generators(DFIGs) of grid-connected wind turbines.A controller design procedure that guaranteesthe DFIG stability under uncertainties and disturbances at thegrid side is presented in detail. It is demonstrated that a very fast dynamic behavior can be obtained with the proposed controller, which improves the transient response of the grid-connectedDFIG, particularly under conditions of unbalanced voltage dipsresulting from asymmetrical network faults. In order to conformwith the fault ride-through capability requirements, this paperproposes a new reference strategy, which is divided into normaland fault operation modes.

7. ChenleiBao, XinboRuan, Xuehua Wang, Weiwei Li, IEEE Donghua Pan, and KaileiWeng"Step-by-Step Controller Design for LCL-TypeGrid-Connected Inverter withCapacitor–Current-Feedback Active-Damping"IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 29, NO. 3, MARCH 2014 1239

This paper gives information about LCL filter is essential injected to the control of LCL-type gridconnectedinverters. Generally, the current regulatorguarantees the quality of the injected grid current, and the activedamping suppresses the resonance peak caused by the LCLfilter and makes it easier to stabilize the whole system. Basedon the proportional-integral (PI) and proportional-resonant (PR)compensator together with capacitor–current-feedback activedampingwhich are widely used for.In this paper,it is explained that ifcarefully dealing with the interaction between the current regulatorand active damping, the complete satisfactory regions of thecontroller parameters formeeting the system specifications are obtained,and from which the controller parameters can be easilypicked out. Based on these satisfactory regions, it is more convenientand explicit to optimize the system performance. Besides,the insight of tuning the controller parameters from these satisfactoryregions is also discussed. Simulation and experimental resultsverify the proposed step-by-step design method.

8. Yi Wang, JianhuiMeng, Xiangyu Zhang, and Lie Xu, at "Control of PMSG-Based Wind Turbines for SystemInertial Response and Power Oscillation Damping" IEEE TRANSACTIONS ON SUSTAINABLE ENERGY, VOL. 6, NO. 2, APRIL 2015 565

This paper investigates an improved active powercontrol method for variable speed wind turbine to enhance theinertial response and damping capability during transient events.The optimized power point tracking (OPPT) controller, whichshifts the turbine operating point from the maximum power pointtracking (MPPT) curve to the virtual inertia control (VIC) curvesaccording to the frequency deviation. Compared to the conventionalsupplementary derivative regulator-based inertia control,the proposed control scheme can not only provide fast inertialresponse, but also increase the system damping capability duringtransient events. Thus, inertial response and power oscillationdamping function can be obtained in a single controller by theproposed OPPT control.

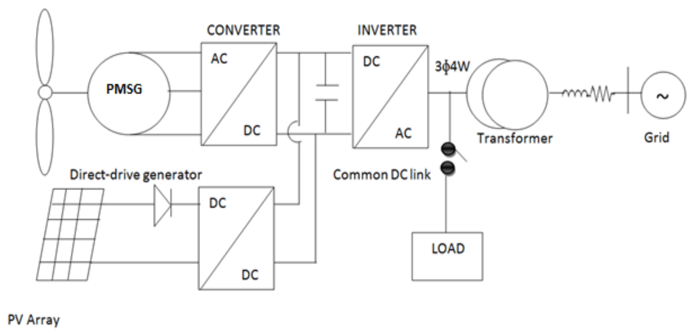
9. Haider Ali, Syed WajidALi Shah, Usman Khalid, M. Baseer and Najam us Saqib"Synchronized Wind-Solar Hybrid System for Future Smart Grids"Institute of I.T, Abbottabad, Pakistan.

In this paper a hybrid wind solar system and its synchronization with utility grid is presented.Proposed system is based upon phase loop locked (PLL) technique. This System is designed to have twobasic types of alternative energy sources i.e. solar panel and wind turbine. Developed solar panel modelemploys a maximum power point tracking (MPPT) and Boost converters with reference inputs from the gridfor synchronization. Wind turbine contains a pulse width modulation (PWM) based controller and voltageside converter (VSC) for synchronization. This piece of work talks about the detailed design of every moduleto achieve the synchronized voltages with fairly less power loss and minimum harmonics.. Simulation resultsshows that excess energy can be successfully are transferred to the local grid within the range. Simulationmodels have been designed in SimPower for analysis purposes.

10. Rakesh sahu, Balaram Das, Rati RanjanSabat, Manoj Kumar SwainHYBRID POWER MODEL OFRENEWABLE ENERGY SOURCES FORON GRID POWER SUPPLY, International journal of advanced research in Electrical,Electronics and Instrumentation Engineering

In this paper a simulation approach has been suggested for designing On-grid system. Hourly average of windspeed/solar radiation and biomass data is taken for the generating unit and the anticipated load data are used to predictthe general performance of the generating system connected to grid. Finally, the results obtained and methods are suggested to enhance the performance of the proposed model.

III. BLOCK DIAGRAM-HYBRID MODEL CONNECTED TO GRID



A. Solar Cell

In PV panels solar cells are made of silicon. . A PV system convert's sunlight in to electricity. No of PV Panels can be grouped to form large photovoltaic arrays. The solar arrays are the combination of number of cells connected in series or in parallel or the combination of a group of panels.

There are many stages are used in grid connected PV system like PV array, DC to DC converter, DC to AC converter. In this paper a model is developed through converting common circuit equation of solar cell in to simplified form including the effects of changing solar irradiation and changing temperature.

The power injected into the grid from the PV panel through two stages. In first stage in order to enhance the DC voltage level of PV panel the PV array is connected to the DC-DC converter. And MPPT is used to track the maximum power point in order to achieve the maximum power point. In second stage through grid connected inverter control dc power is converted into ac power. Also this control control the current and power injected from the grid.

B. Wind Turbine

Wind is a form of solar energy ,wind always blows from a higher atmospheric pressure region to the lower atmospheric pressure region due to the non uniform heat by the sun and due to the rotation of the earth. Wind energy can change into many form of energy, such as wind turbine is used to generate electricity, mechanical power windmills for water lifting wind pumps, also in propelling ships. Wind power is an alternative of fossil fuels, is plenteous, widely expanded, clean, and renewable and during operation no greenhouse gas produced.There is also development of turbines with two or three blades. .By using the power of the wind wind turbines produce electricity to drive an electrical generator. A force is exerted and generates lift when wind is passing over the blades. The rotating blades rotate the shaft which is connected with the gearbox. The gearbox adjusts the rotational speed which is convenient for the generator to get a desired output. The output of the wind generator is fed to the transformer.So the power contained in the wind is given by the kinetic energy of the flowing air mass per unit time.

IV. THE PROPOSED METHODOGY

A. Modeling of a Solar Cell

PV array are formed by combine no of solar cell in series and in parallel. A simple solar cell equivalent circuit model is shown in figure. To enhance the performance or rating no of cell are combine. Solar cell are connected in series to provide greater output voltage and combined in parallel to increase the current. Hence a particular PV array is the combination of several PV module connected in series and parallel. A module is the combination of no of solar cells connected in series and parallel.

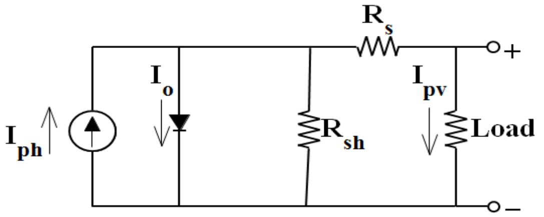


Photo –current of the module

1. $$I_{ph} = [I_{scr} + k_i(T - 298)] * \lambda/1000$$

Reverse saturation current of the module

$$I_{rs} = I_{scr}/[\exp\,(qV_{oc}/N_s kAT) \;-1$$

Saturation current of the moduleI_0

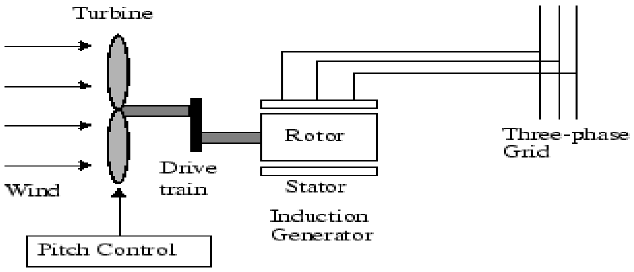
$$I_o = I_{rs}[\frac{T}{T_r}]^3 \exp\,[\frac{qE_{go}}{BK}\{\frac{1}{T_r} - \frac{1}{T}\}]$$

Current output of PV module

$$I_{pv} = N_p \times I_{ph} - N_p * I_o[\exp\left\{\frac{q * V_{pv} + I_{pv}R_s}{N_s AKT}\right\} - 1]$$

B. Wind Turbine & Induction Generator Model

The wind turbine and the induction generator (WTIG) are shown below in Fig below.The stator winding is connected directly to the grid and the rotor is driven by the wind turbine. The power captured by the wind turbine is converted into electrical power by the induction generator and is transmitted to the grid by the stator winding. The pitch angle is controlled in order to limit the generator output power to its nominal value for high wind speeds. In order to generate power the induction generator speed must be slightly above the synchronous speed. But the speed variation is typically so small that the WTIG is considered to be a fixed-speed wind generator. The reactive power absorbed by the induction generator is provided by the grid or by some devices like capacitor banks, SVC,STATCOM or synchronous condenser.



V. CONCLUSION

A PV module can be modeled with varying irradiation and temperature. Aboost converter is designed and simulated. To control the gate pulse of the high frequency switchof the boost converter MPPT algorithm are used. and simulated in Matlab/Simulink. From the simulation result it is observed that both the method give nearly same result. A dynamic model of wind turbine is model and simulated. PMSG is used in this paper as a wind generator due to its self excitation capabilities and requires less maintain. A grid side VSI is used to synchronize the wind-PV hybrid system. Thus,two different system will be simulated together and then connected with controller ,due to this voltage stability will be maintained and then given to the grid.

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