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HYBRID CONTROL OF GRID CONNECTED RENEWABLE ENERGY GENERATION SYSTEM

Mr.K.Rama Chandra * Dr.T.Deva Raju

M.Tech Scholar., M.E, Ph.D, Professor.,
* DEPT.OF EEE, SREE VIDYANIKETHAN ENGINEERING COLLEGE,TIRUPATI ,INDIA

ABSTRACT

This project presents power control systems of a lattice joined hybrid generation system with adaptable power exchange. The system is the combination of photovoltaic (PV) array, wind turbine, and battery storage by means of a typical dc system. A supervisory control manages power generation of the individual segments to empower the hybrid system to work in the proposed methods of operation. A basic method utilizing a low-pass filter was presented for power averaging. A modified hysteresis-control procedure was connected in the battery converter. The reproduction and exploratory results were introduced to assess the dynamic execution of the hybrid system under the proposed methods of generation.

KEYWORDS: Dynamic modelling and control, Grid connected hybrid system, A modified hysteresis control, Power veraging,Power Dispatching,Supervisory control.

INTRODUCTION

The coordination of renewable energy sources and energy storing systems has been one of the new patterns in power electronic innovation. The expanding number of renewable energy sources and conveyed generators requires new systems for their operations to keep up or enhance the power supply strength and quality. The project was taking into account Dommel's calculation, particularly produced for the recreation of high-voltage direct current systems and proficient for the transient stability of power system under power electronic control. A 30-kW hybrid inverter and its control system were created. An investigation of unit measuring or long term based reliability is past the extent of this project.
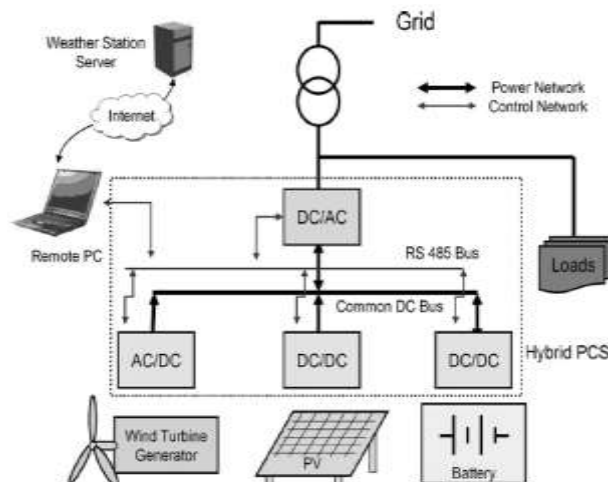

Fig. 1.Configuration of hybrid power and control system.

SYSTEM CONFIGURATION

Fig. 1 shows the setup of the hybrid power and its control system. The hybrid system comprises of a wind turbine, a PV array, battery storage and typical dc transport, power electronic converters for conditioning the power associated

with the combination of energy sources, and a grid interface inverter. The PV system comprises of a PV cluster and a step up dc–dc converter for boosting the array voltage to a larger amount of basic dc voltage The BESS is isolated into battery storing and a buck–booster that is a bidirectional dc–dc converter for charging or releasing the battery storing. The battery converter connects the battery-terminal transport and the basic dc transport, whose voltage levels are commonly distinctive, and controls the present stream between the two transports. The grid interface inverter moves into grid dc-power generation from the wind turbine, PV array, and BESS as air conditioning power. The supervisory-control system is the combination of a PC for remote control, its system operation programming, and correspondence system with the nearby controllers. The supervisory system screens the whole hybrid system and directions power generation of the individual energy sources.

CONTROL STRATEGIES
A. Supervisory-Control Strategies:
Fig. 2 demonstrates the supervisory-control techniques of the grid connected hybrid system. It recommends three conceivable methods of operation, which are ordinary operation, dispatch operation, and averaging operation. Supervisory-control methods in three conceivable methods of operation are as per the following.
Mode I—Typical operation:
The hybrid system exchanges as much power into the grid as the PV array and the wind-turbine can produce. Sun powered irradiance and wind rate have integral profile, and even without utilization of battery, better soundness in power supply may be normal when contrasted and a solitary source system.
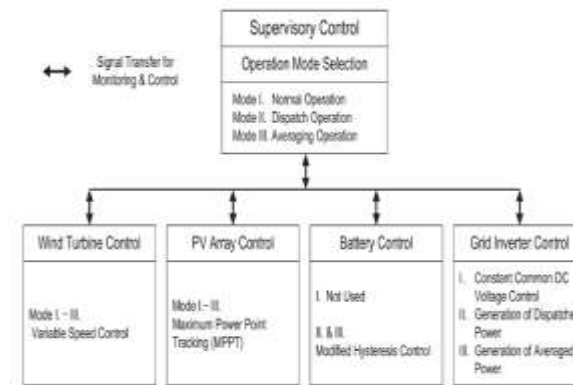

Fig 2 .Supervisory-control strategies of a grid-connected hybrid system.

Mode II—Dispatch operation:
The supervisory control injects the desired power infusion to the system. The dispatched power can be instructed for the purpose of power contract with utility or demand management, for example, top burden sharing, dynamic burden control, and so on. Battery is utilized to compensate power mismatch between generation of PV array and wind turbine and the dispatched sum. In this project, an altered hysteresis-control method is actualized in the battery charger/discharger to reduce charging frequency and current.
Mode III—Averaging operation:
The reason for this mode is to smooth the power fluctuations of the renewable energy sources and exchange more steady power into the system. This enhances the nature of power conveyed to the grid. This method of operation mitigates the voltage and consonant variety at the point of common coupling (PCC) with the system. The supervisory system should include an additional control block for power averaging, and instruct the resulting averaged value for power command of the grid inverter. Utilization of battery is vital for adjusting the power creation and infusion, and its control is the same as that in mode II. The wind and PV systems are still under the greatest power control.
B. Nearby Control of the Hybrid PCS
Fig. 3 demonstrates the step up of the hybrid PCS and its nearby controllers. The wind controller comprises of a wind-turbine speed controller and a d−q-edge based current controller. In buck mode, the series switch (S1) turns initiated and the parallel switch (S2) deactivated, and in support mode, S1 turns enacted and S2 deactivated. A control structure of the system side inverter is essentially indistinguishable to that of the wind converter with the exception of an upper level controller. The network operation controller controls power infusion into the grid as per operation methods of the hybrid systems.
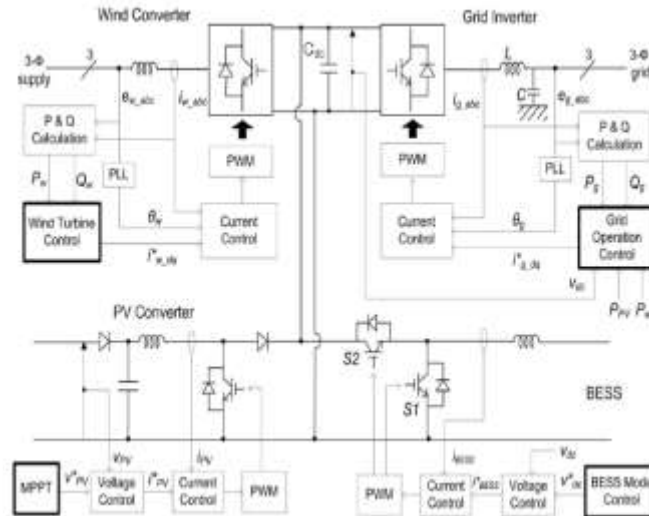
Fig. 3.Configuration of the hybrid PCS and its local control schematic.

C. Wind-Turbine Control

Basic concept of wind-turbine control is to obtain the maximum power from varying wind speed and minimize the rating of the wind converter by regulating reactive power generation at zero . Below rated wind speeds, real power from the wind generator is
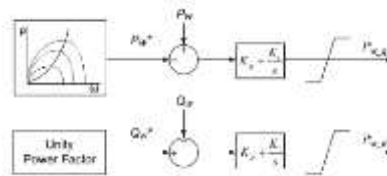

Fig. 4. Power controller of the wind system.

regulated to capture the maximum energy from varying wind speed. The following equation specifies the available maximum power

$$P_M^{MAX} = \frac{1}{2}\pi\rho R^5 \frac{C_P^{MAX}}{\lambda_{OPT}^3}\omega_M^3 \qquad (1)$$

where ρ is the air density, R is the blade radius, ωM is the angular speed of the wind turbine, $CMAX\,P$ is the maximum power coefficient, and λOPT is the optimal tip speed ratio. Above rated wind speeds, the maximum power control is overridden by stall regulation for constant power. Fig. 4 shows the power controller of the wind-side converter;

D. PV-Array Control

Power output of a PV array depends on the voltage level where it operates under a given condition of irradiance and cell-surface temperature. For efficient operation, a PV array should operate near at the peak point of the V −P curve. Various MPPT techniques have been proposed.The incremental conductance (Inc Cond) method was implemented in this project .The MPPT block in Fig. 5 senses the PV array current iPV and array voltage VPV and returns the array voltage command.
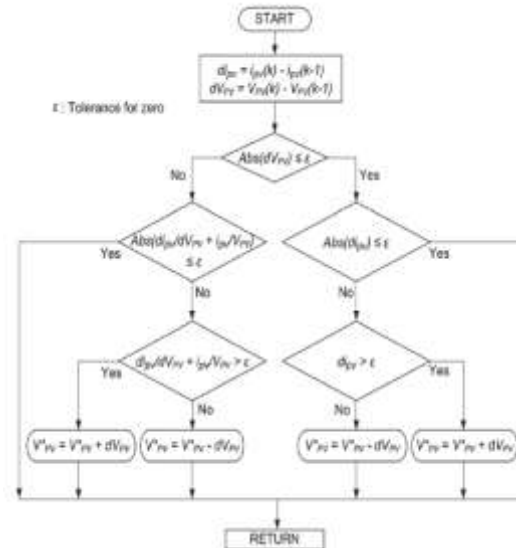
Fig. 5. MPPT control block (Inc Cond method).

E. Battery Control

The primary goal of the battery converter is to regulate the common dc-bus voltage. The battery load current rapidly changes according to changes in weather conditions and power command for grid inverter in dispatching or averaging mode of operation. Common dc-bus voltage must be regulated to stay within a stable region regardless of the battery-current variation. To do this, a modified hysteresis-control strategy is applied. The concept of this strategy is to regulate the common dc voltage within a specific band, for example, a hysteresis band. Therefore, the battery charger/discharger is controlled in such a way that the dc-bus voltage should not violate the specified upper and lower limits, Vdc_up and Vdc_lw, as shown in Fig. 6.
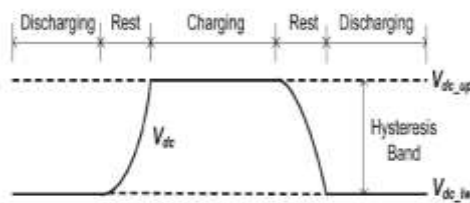
Fig. 6. Modified hysteresis-control strategy.

A decision criterion for charging/discharging becomes the level of the common dc-bus voltage, and the battery buck–booster operates according to the scheme as below:

$$\text{If } V_{dc} > V_{dc\_up}, \quad \text{then charging} \rightarrow V_{dc}^* = V_{dc\_up}$$

$$\text{If } V_{dc} < V_{dc\_lw}, \quad \text{then discharging} \rightarrow V_{dc}^* = V_{dc\_lw}$$

$$\text{If } V_{dc\_lw} \leq V_{dc} \leq V_{dc\_up}, \quad \text{then no control (rest).} \quad (2)$$

When the common dc voltage Vdc becomes larger than the upper limit, charging mode begins with the voltage command V ∗ dc equal to the upper limit and continues until the dc voltage reaches the limit. Accordingly, the battery-mode control block in Fig. 3 can be built as shown in Fig. 7.
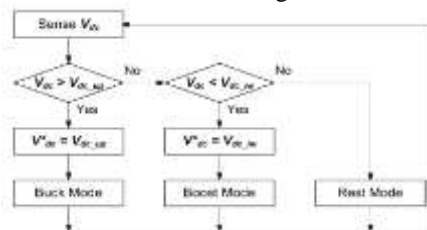

Fig.7. Battery-mode control block (modified hysteresis).

There is another reason for such hysteresis control other than voltage regulation of the dc bus. the battery can take a rest during the rest interval in Fig. 6. Energy that can be extracted or stored across the hysteresis band in a dc-bus capacitor ΔEC is described as follows:

$$\Delta E_C = \frac{1}{2} C_{dc} \left(V_{dc\_up}^2 - V_{dc\_lw}^2 \right). \qquad (3)$$

This energy gap is utilized for balancing PV, wind, and grid injection without use of the battery. *Cdc* is the capacitance of the common dc bus.

F. Grid-Inverter Control
A power controller of the grid inverter in Fig. 3 may be constructed in three different types according to the operation modes of the hybrid system.

Mode I—Typical operation: The common dc-bus voltage is regulated at a constant value so that real power generation from the wind turbine and PV array can pass into the grid. Fig. 8 shows the voltage controller in the normal mode for power regulation.
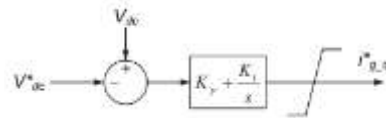
Fig.8 Power controller for normal operation.

Mode II—dispatch operation: The power controller regulates the real power injection into the network *Pg* at the dispatched target *P∗ g* by a user or an operation, which can be presented in Fig. 9.
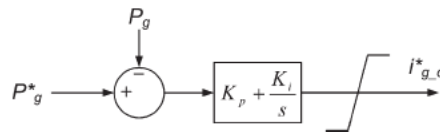
Fig. 9. Power controller for dispatch operation.

Mode III—averaging operation:
A sum of the power measured from the wind and solar sources is averaged by a low-pass filter, and then, the filtered value is specified as the real power command. Averaging effect can be adjusted by setting different time constants for a low pass filter. Fig. 10 presents the power controller for averaging mode.
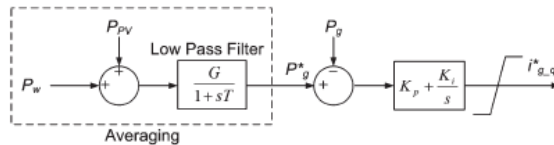

Fig. 10. Power controller for averaging operation.

RESULTS AND DISCUSSION
Computer-simulation study was carried out to analyze the dynamic performance of the proposed control strategies. The results in various modes of operation should be as follows as shown in figures 12, 13,14,15,16
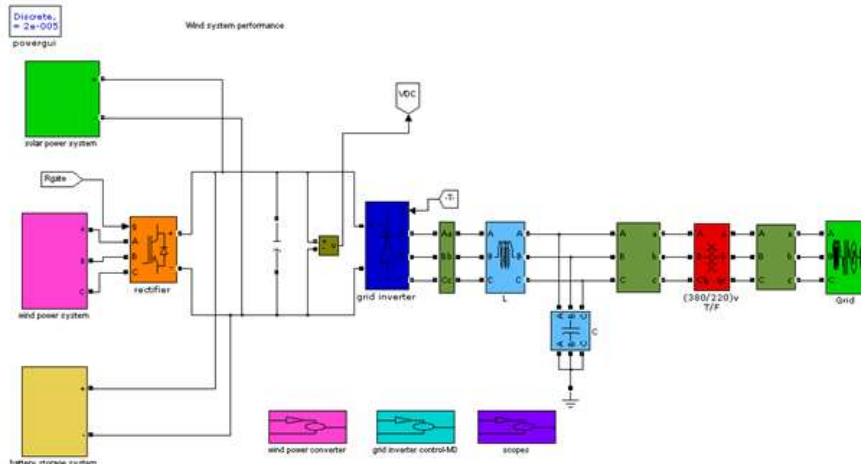
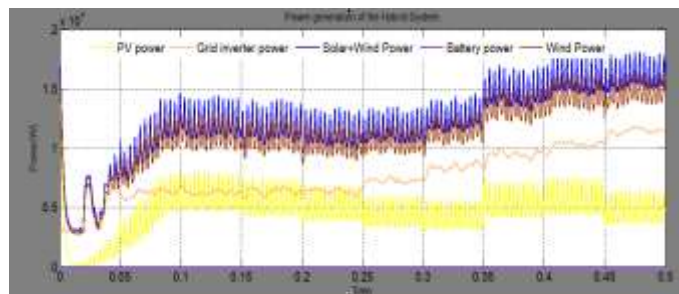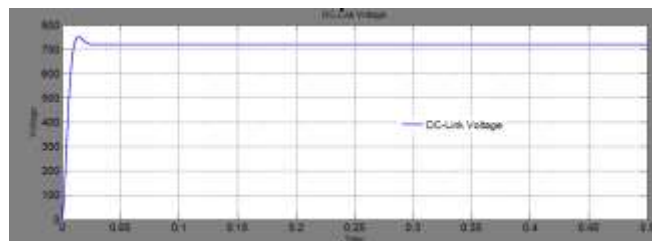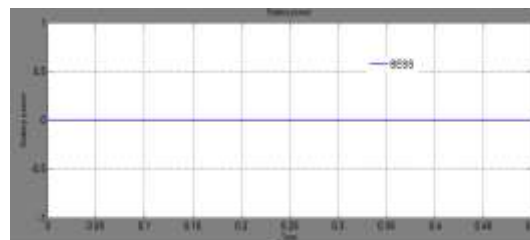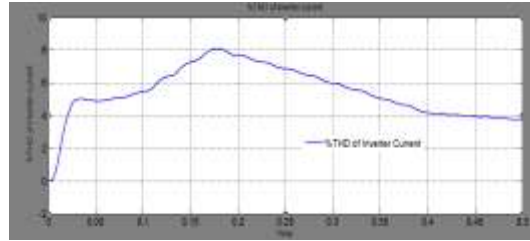*Fig.11 Simulink model of Hybrid power and its control system*
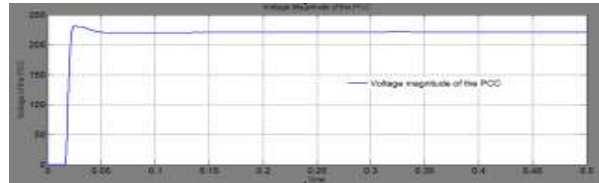

Fig.12 Power generation of the hybrid system in normal operation

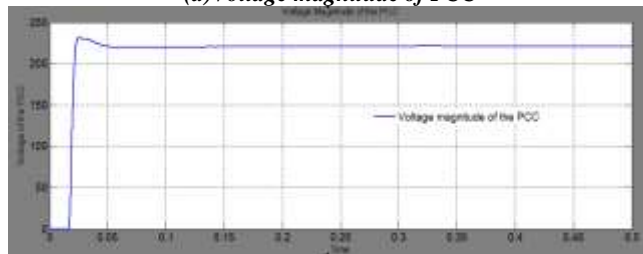*(a)Common DC-Link voltage*

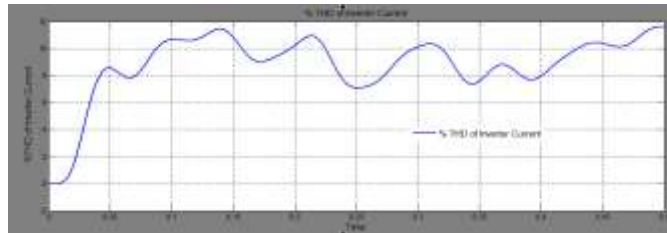*(b) BESS Performance*

(c)%THD of Inverter current

(d)Voltage magnitude of PCC

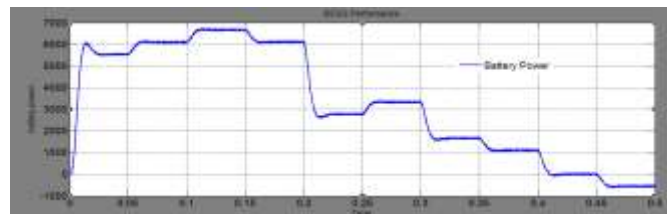***Fig.13 Simulation results in Typical mode (a)Common DC-Link Voltage (b)BESS Performance (c)%THD of Inverter current
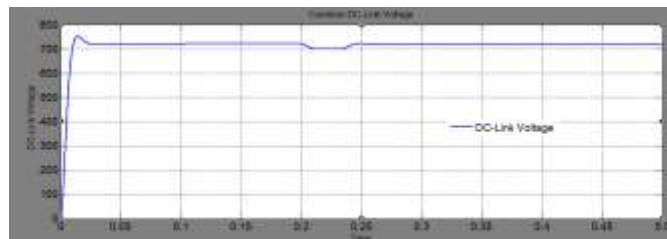(d)Voltage magnitude of PCC***

(a)Voltage magnitude of PCC

(b)%THD of Inverter current

(c)Battery power

(d)DC-Link voltage

Fig.14 Simulation results in Dispatch mode (a)Voltage magnitude of PCC(b)%THD of Inverter current(c)Battery power(d)DC-Link voltage
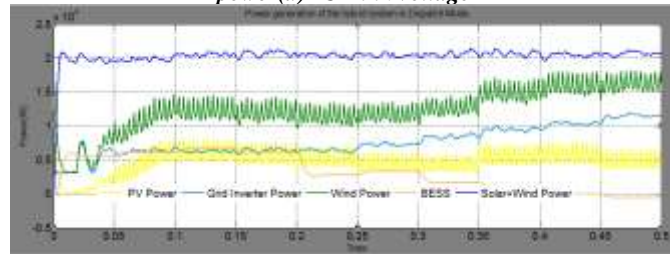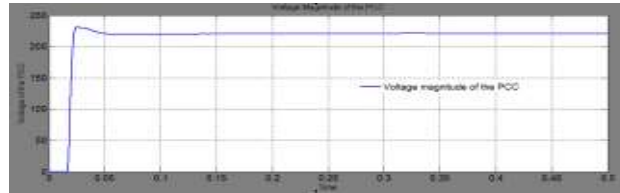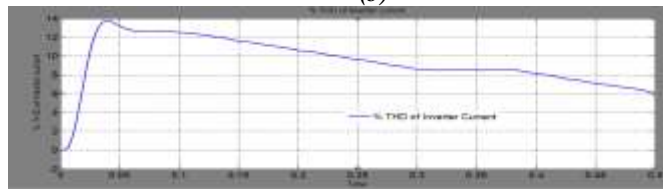

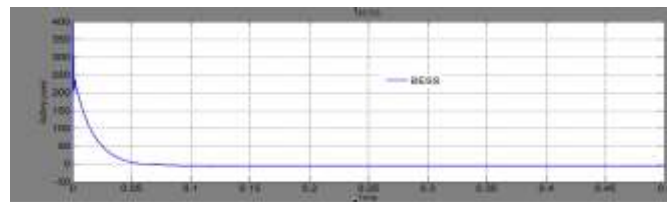*Fig.15 Power generation of the hybrid system in Dispatch –operation mode*

(a)   Voltage magnitude of PCC
(b)

(b)%THD of Inverter current

(c)DC-Link voltage

(c)BESS Performance

Fig.16 Simulation results in Averaging mode (a)Voltage magnitude of PCC(b)%THD of Inverter current(c)Battery power(d)DC-Link voltage
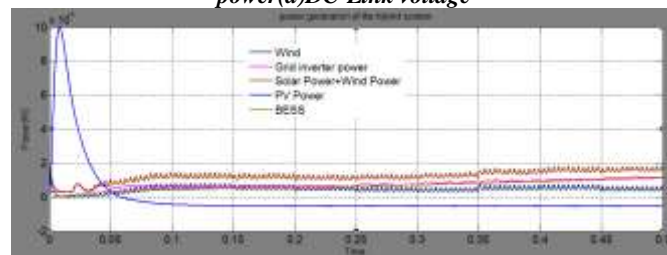

Fig.17 Power generation of the hybrid system in Averaging –operation mode

CONCLUSION
In this project, supervisory-control strategies for versatile power transfer of a grid-connected wind/PV/BESS hybrid system have been proposed. Dispatch and averaging modes of operation were added for flexible operation and improvement in quality of power delivered to the grid. A modified hysteresis control strategy was applied for relieving the excessive use of battery storage. The proposed control offers grid- or user-friendly options in operating modes. Dynamic modeling and simulations of the hybrid system under the proposed control strategies were carried out using MAT LAB/SIMULINK

ACKNOWLEDGEMENTS

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