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Enhance Power Quality of RES with Employing Smart Loads

Shivaji.Bhukya, S.Prakash

Abstract: ***In this paper investigates the improve power quality of RES with adopting smart loads in detail. In wind energy conversion system permanent magnet synchronous generator (PMSG) is employed is employed to get better simulation results over induction generators. Obtained validate MATLAB simulation results considering variable speed variations periodically. Variable wind power production needed in distribution stochastic and periodic power variations to reach load demand. This load management maintenance is highly requires to maintain power quality. This load management is allocated employing smart loads (SLs), capacitor banks and critical loads (Electrical spring).From various case studies, it is found that SLs are effective in improving the voltage profiles of the test feeder.***

Index Terms: PMSG, smart loads, power quality, Electrical Spring (ES)

I. INTRODUCTION

Since past two decades a rapid increment is growing in power generations to reach the power demand. Power generation is mainly available in two sources conventional energy sources like fossil fuels (Hydal and Thermal) and Non conventional energy sources (Solar, Wind and Geo thermal etc). Power generation in fossil fuel, releases many chemical gases and injecting in the air, which causes to environmental pollution. Cost of fossil fuel also more so people thinking about alternating methods to generate the power. Now a day's all electrical engineer are huge look about renewable energy sources (RES) to produce power. In RES resources solar and wind are prominent one to develop the power. In this section explained detail power generation in solar systems and wind energy systems. Solar power generation need high initial cost and it generate power in during day time only. Solar power production highly depends on light energy (sun). Wind energy has capacity to develop high amounts of electrical power, but its availability can't be predicted. So in this paper discuss enhance power quality wind energy system employing smart loads.

Wind power generation is a very simple and easy maintenance. Wind turbine (WT) converts the movement wind speed (kinetic energy) into mechanical energy, WT coupled with generator it converts mechanical energy into electrical energy.

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*****Correspondence Author(s)
Shivaji.Bhukya, PhD Scholar, Department of EEE, BIHER
S.Prakash, Professor, Department of EEE, BIHER CHENNAI

Produced electrical energy from generators is transmitted to a power station (grid). Wind power is copious in certain states, with the biggest wind forms situated in Texas. Wind is novel since it carries incentives for former's to give bundles of land for structure wind turbines, and has the most potential to the extent boundless appropriation because of the enormous regions of land with predictable wind accessible to bridle.

Recently, a novel control strategy is proposed to control the power developed by PMSG, those are direct torque control (DTC) and direct power control (DPC). DTC scheme was first proposed by Takahashi and T. Nogouchi [1-2].

DTC mechanism does not require current controller and current control loops, no need of specific variations of currents. In this approach controls the rotor flux and generator toque with help of suitable operating of inverter switching states [3]. In [4] compare the simulation results between DTC control scheme and FOC control scheme. In [5] described DTC control scheme with space vector pulse width modulation. In [6-9], the authors modeled DTC control scheme to a PMSG. DTC control not require PI control scheme to control the speed of PMSG, need the knowledge about grid voltages, speed of rotor positions. In [6-8] proposed advanced control scheme developed DTC control scheme with control of power factor of rotor winding.

DPC control scheme has merits of being simple;need fewer sensors, having little computational complexity compare to DTC control scheme. The dynamic response of DPC control scheme is faster than DTC control scheme [11].

In present years, few advanced control schemes were presented to control the speed of PMSG based WT generator system. Those are predictive control scheme [6-8]. Sensor less control schemes to estimate the positions of the rotor, not require encoder to measure the position of rotor [10-12]. In [13], included comparative study of various predictive control schemes to and switching states of inverter based on PWM technique.

II. SYSTEM CONFIGURATION

The block-diagram of enhance power quality of WECS with smart loads, critical loads (Electrical spring - ES) and capacitor bank is shown in below figure.1.

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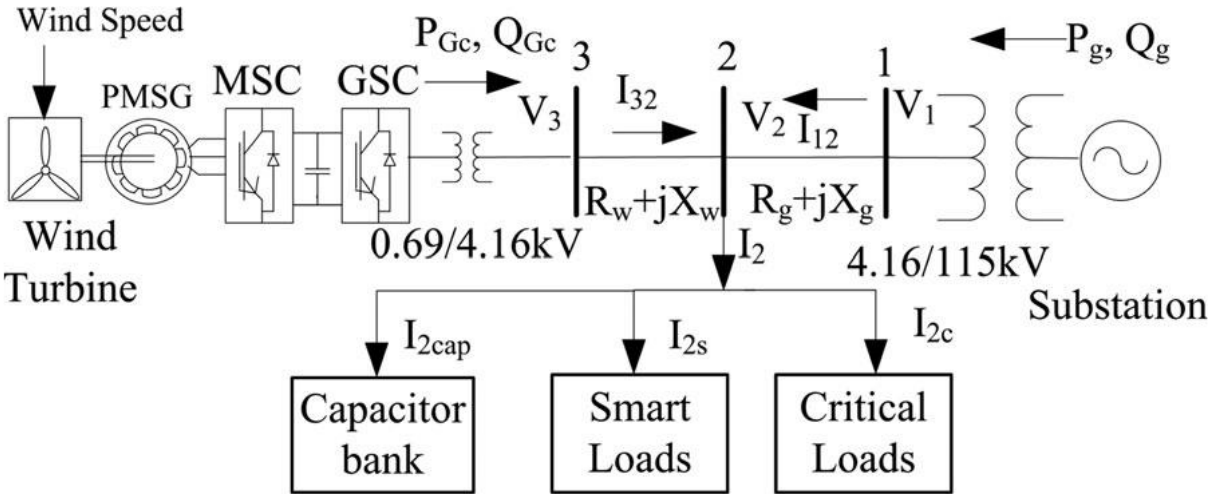

Fig. 1 Schematic diagram of proposed distribution network with PMSG based wind energy conversion system and SLs.

To operate PMSG for different wind speed more output mechanical output employed main side control (MSC) scheme in rotor side of PMSG and grid side control (GSC) scheme in distribution system.

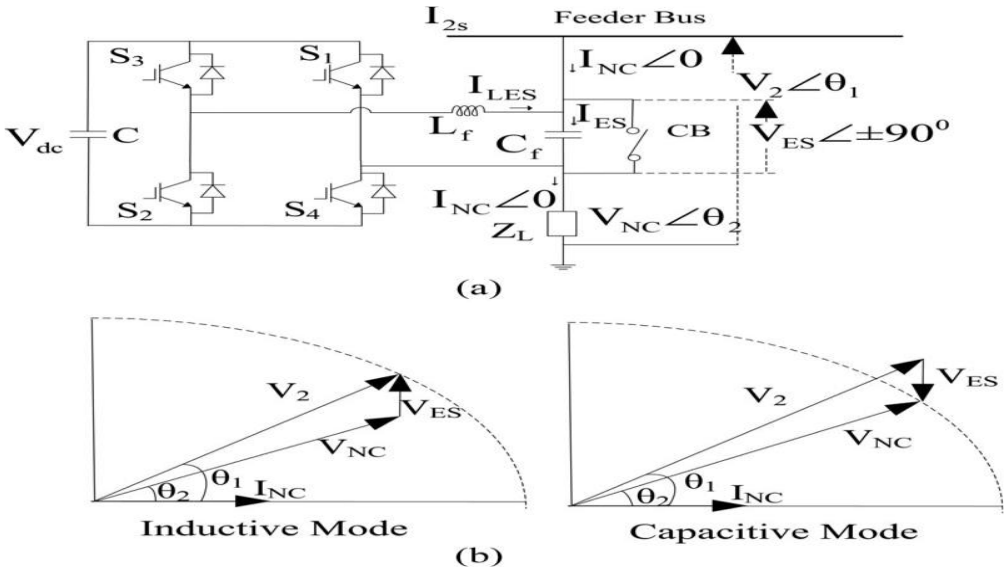

Fig. 2 (a) Circuit diagram of smart load allocation in each phase. (b) Phasor of capacitive and inductive mode of smart load

III. PROPOSED CONTROL SCHEME

To operate voltage source inverters (switch pattern) design controllers like sliding mode controller, cascade controllers, μ- synthesis process, linear quadratic Gaussian with loop transfer recovery (LQR/LTR) technique, Inferential model predictive control, adaptive control. To implement these controller methods requires a lot of process knowledge. Despite of all these advanced control strategies, PI/PID controllers are being used in most of the power system network design, to operate voltage source converter. In this by varying the gains of PID parameters desired output response can be achieved. This is the reason PID controllers treat as the foundation of each power framework structure. Still dynamic research is going on around there in light of the fact that much of the time structure of PID controllers are inadequately tuned, so therefore a few controllers are too aggressive and a few controllers are giving too sluggish yield reaction.

Now advances in control theory, PID control algorithms are utilizing in complex control v, for example, model predictive control, are worked as a supervisory control algorithm, which gives set focuses to PID controller.

A. Grid side VSC control Scheme

The block diagram of Grid side VSC control Scheme is shown in below figure 3. It includes PI controllers and park transformation (abc to dqo conversation or dqo to abc conversation). In GSC control scheme voltages and currents are consider as reference values.

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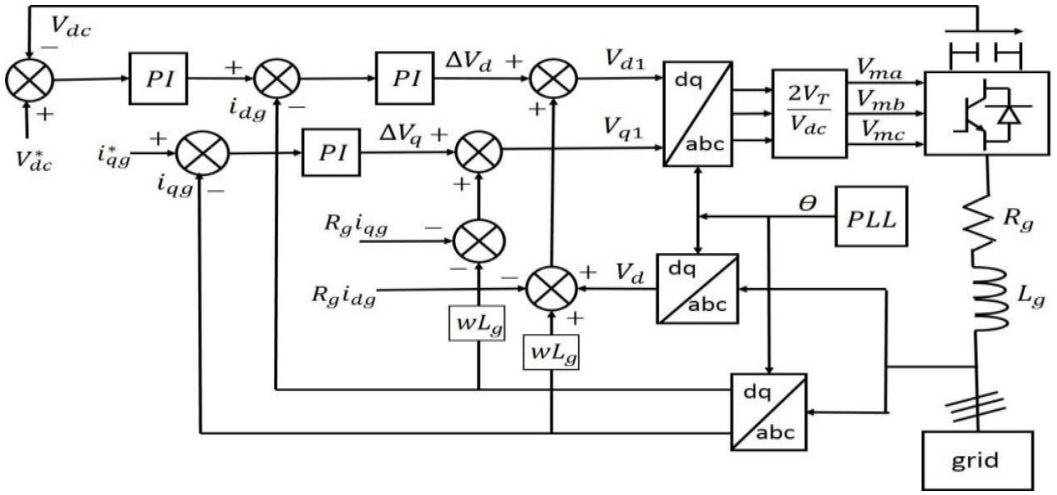


Fig. 3 Grid side VSC control scheme

B. Rotor side VSC control Scheme

The block diagram of rotor side control scheme of PMSG is shown in below figure 4. It includes PI controllers and park transformation (abc to dqo conversation or dqo to abc conversation). In RSC control scheme rotation speed of machine and reactive power consider as reference values.

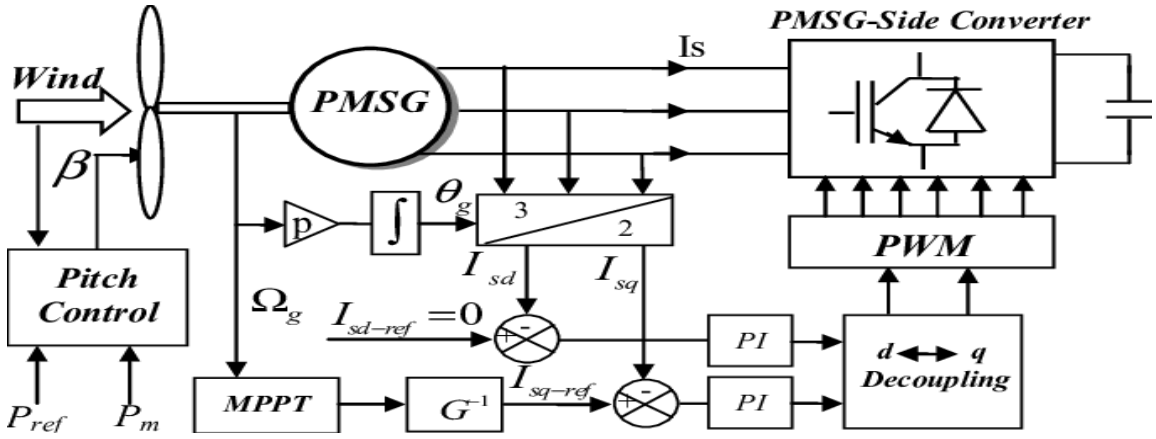


Fig. 4 Rotor side VSC control scheme

C. Load side control scheme

The block diagram of load side control scheme is shown in below figure 5. It includes PI controllers and park transformation (abc to dqo conversation or dqo to abc conversation) and low pass filters removes harmonics from output voltage and currents.

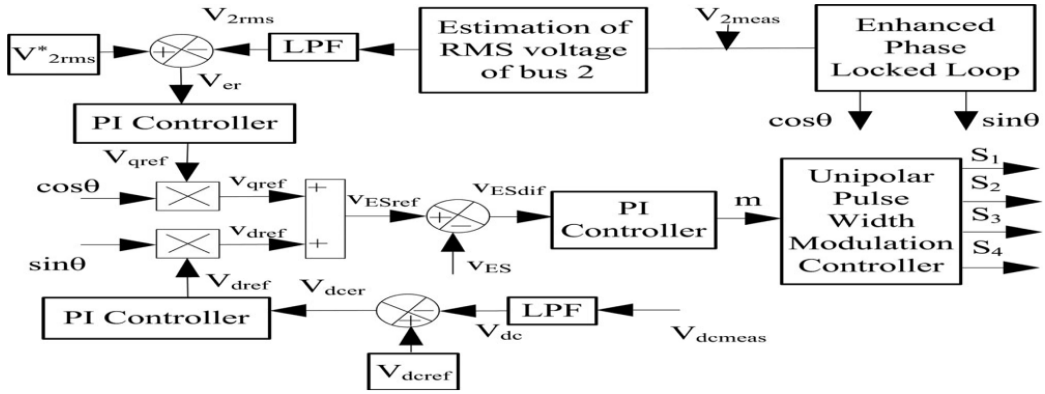


Fig. 5 Proposed Load side Control scheme

IV. RESULTS AND DISCUSSION

In this article we expose the how the intermittent wind power in the test feeder without utilizing ES and with utilizing the ES is presented. The simulated wind speed displaying practical impacts is included to WT to study effect of stochastic and deterministic varieties in wind speed on test feeder. The mean wind speed is 9 m/s while the base wind speed is viewed as 12 m/s. The simulation results are gotten for 650 s with the goal that voltage flicker severity files can be evaluated. The proposed MATLAB simlink diagram of PMSG feed WECS is appeared in underneath figure.6.

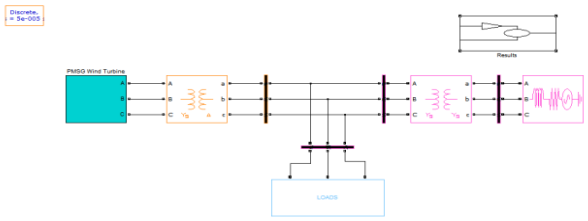


Fig. 6 Block diagram of WECS

The WECS simulation results without using ES are shown in figure.7.

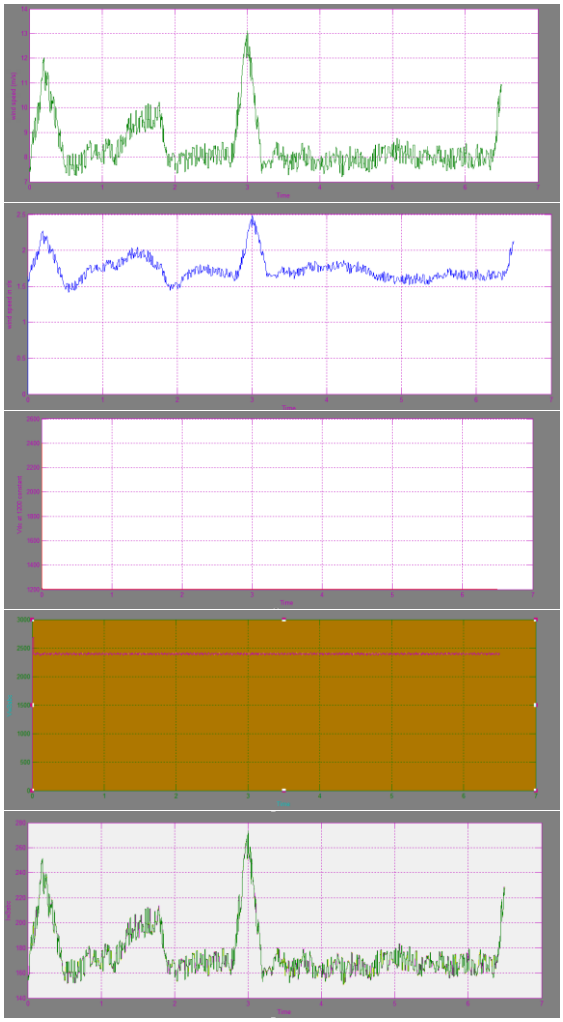
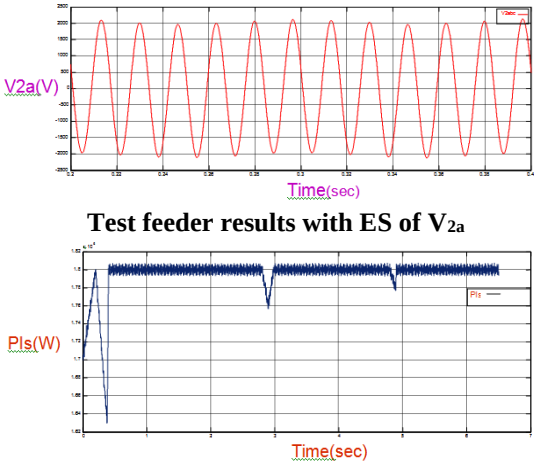


Fig. 7 a) & b) Performance of WECS with ES

The WECS simulation results with employing ES are shown in figure.8.



Test feeder results with ES of V_{2a}

Fig. 8 a) & b) Performance of WECS with ES

From figure 7 and 8 results it is clear that with using reduced voltage flickers, improved voltage regulation and enhances power quality.

V. CONCLUSION

In this article discussed the enhance power quality of RES with employing smart loads and electrical spring in detail. In wind energy conversion system permanent magnet synchronous generator (PMSG) is employed is employed to get better simulation results over induction generators. Obtained validate MATLAB simulation results are proven that proposed control scheme works very well for variable speed variations periodically. Variable wind power production needed in distribution stochastic and periodic power variations to reach load demand. This load management maintenance is highly requires to maintain power quality.

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