Integration of Renewable Energy Sources And Distributed Generator To Improve Stability By Facts Devices

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Abstract - Power generation in the world is new trend at the some we have to maintain the stability is other resource to increase the efficiency. Worldwide fast depletion of conventional energy resources necessitates the implement"ation of renewable energy sources for generation to satisfy the growing demand. Since last decade, technological innovations and a changing economic and regulatory environment have resulted considerable revival of interest in connecting wind generation to the grid. Utilities are seeking to understand possible impacts on system operations when a large amount of wind power is introduced into the electric power system. Producers of renewable energy must condition the power produced in order to interconnect with the power grid and not interface with the grid's overall performance. In these aspects Flexible AC Transmission Systems (FACTS) Technology plays a vital role in enhancing the power system performance and improving the power quality of the system. This paper concentrates on power quality issues when wind power integrates with grid and the solution with the usage of any of FACTS devices. An attempt is made with IEEE 16 Bus, 3 feeder test system and modeled for simulation study using MATLAB/SIMULINK simulation. Scopes obtained from the simulation results are proven for the improvement of voltage profile which in turn improves the overall power quality issues like study state and transient stability

Index Terms— FACTS, Wind Energy, Power Quality, Grid Integration.

I. INTRODUCTION

Electrical power generation in the world most important factor now we have the so many power systems to generating the power in the world but main factor to we have to achieve best efficiency with chief cost that is preferable only through renewable energy sources. The current electric power industry is undergoing major changes from being centralized generation into decentralized generation. The advances in technology have created rapid growth in the utilization of distributed generations which leads to energy market becoming more attractive and competitive. Moreover, due to electricity deregulation, environmental issues as well as government incentives, this technology has created interest in development further amongst industrial countries throughout the globe. In addition, these issues also results in the Smart Grid platform to end the traditional electric power industry which traditionally was vertically integrated and congested resulting in a higher energy costs. Nowadays, most of aging and large remote power sys- tem stations with central dispatch suffers from disturbances due to lack of intelligent interoperability units. The sys- tem also becomes vulnerable when utility abnormalities are present, for example on protection or failures to control coordination and human operation errors. Therefore,

there is a need to transform this model into Smart Grid that can enhance power quality and fully integrate with advanced grid elements such as intelligent sensing and digital metering. Smart Grid is recognized as a new platform for future power industry. The rapid rise on this issue is also leading to the fast growth of distributed generation technology markets such as in fuel cells (FC), photovoltaic (PV), wind turbine (WT) and energy storage (ES). This trend will have profound impact on future electricity technology which allows Information and Communication Technologies (ICT) and advanced power electronic devices to be installed and embedded throughout the network. This is the challenge where current bulk generation and distributed generation will co-exist with higher power reliability and quality in the form of Smart Grid. To emphasize these, this paper will provide a fundamental under- standing of distributed generation issues and framework of Smart Grid. Lastly, it finishes off by providing an analysis impact of DG on Smart Grid transient stability

II. OVERVIEW OF DISTRIBUTED GENERATION, RENEWABLE ENERGY SOURCES

2.1. Distributed Generation

Distributed Generation (DG) technology incorporates wind turbines, micro turbines, photovoltaic systems, fuel cells, energy storage and synchronous generator applications to supply active power to distributed systems connected close to the consumers load. This concept is becoming a major player for Green House Gases (GHG) mitigation and power system reliability. Therefore, many developed countries such as Australia, are encouraging DG utilization for local power source and to avoid concentration of new power system transmission or distribution construction. The increasing number of DG connection to the grid for the last decade proves that DG intrinsically offers various technical, economical and environmental advantages for customers, utilities and power operators. How- ever, the presence of DG in the current existing power system has an impact on its operation and configuration. Moreover, since most of current aging power system is considered as passive system and with the insertion of DG, the network becoming active system where both of them can act as power sources. Various studies in the past examined the impact of DG in power system and identified some vital aspects concerning their operation and connection. In reference the analysis on change of power flow direction in corporation of DG integration is verified. In reference the influence of DG on system reliability and stability during peak load is investigated whilst reference [3] focuses on system protection as the short-circuit fault level on the network tends to increase due to DG connection. Reference investigates the voltage variation and protection by comparing the real system behavior with software simulation. The authors conclude that the level of trans- former tap changer is increased with an increase on the penetration level of DG. Reference has also reviews the impact of DG on distribution system (DS). At present DG provides much benefit in order to improve voltage quality, loss reduction and reliability. DG unit can be operated under island mode. It highlights the interconnected DG performance and shows this is greater during islanding condition, especially from security and quality of supply point of view. In addition, the study in demonstrates the positive impact of DG on DS where during faults period, the rotor angle deviation and voltage drop are found to decrease. It means that the transient stability of the system improves with an increase in the penetration level of the DG. However, overall these research scenario investigates

the technical impact of DG on DS where almost all of them are coupled to the medium and low voltage levels. Moreover, none of the research scenario deals with the issues from Smart Grid perspectives. With the presence of Smart Grid concepts and rapid growth of DG and Smart Grid technologies, it is critical to evaluate the sys- tem performance precisely. Thus, the framework and concepts of Smart Grid can be applied appropriately and this avoid degradation of power quality and reliability.

2.2 Renewable energy sources:

Renewable energy source (RES) integrated at distribution level is termed as distributed generation (DG). The utility is concerned due to the high penetration level of intermittent RES in distribution systems as it may pose a threat to network in terms of stability, voltage regulation and power-quality (PQ) issues. Therefore, the DG systems are required to comply with strict technical and regulatory frameworks to ensure safe, reliable and efficient operation of overall network. With the advancement in power electronics and digital control technology, the DG systems can now be actively controlled to enhance the system operation with improved PQ at PCC.

However, the extensive use of power electronics based equipment and non-linear loads at PCC generate harmonic cur rents, which may deteriorate the quality of power. Generally, current controlled voltage source inverters are used to interface the intermittent RES in distributed system. Recently, a few control strategies for grid connected inverters incorporating PQ solution have been proposed. In an inverter operates as active inductor at a certain frequency to absorb the harmonic current. But the exact calculation of network inductance in real-time is difficult and may deteriorate the control performance. A similar approach in which a shunt active filter acts as active conductance to damp out the harmonics in distribution network is proposed . In a control strategy for renewable interfacing inverter based on – theory is proposed.

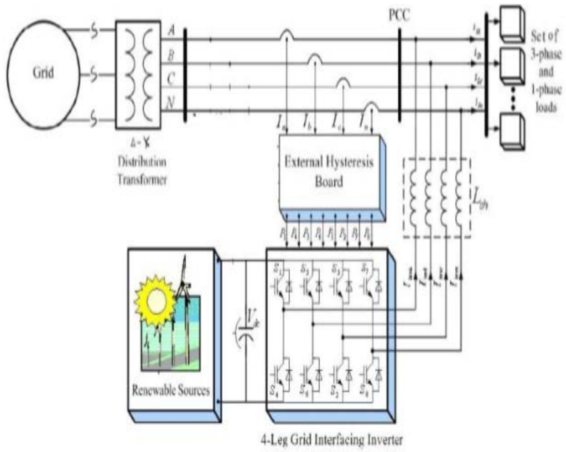

Fig.1: 4 Leg grid interface unit

In this strategy both load and inverter current sensing is required to compensate the load current harmonics. The non-linear load current harmonics may result in voltage harmonics and can create a serious PQ problem in the power system network. Active power filters (APF) are extensively used to compensate the load current harmonics and load unbalance at distribution level. This results in an additional hardware cost. However, in this paper authors have incorporated the features of APF in the, conventional inverter interfacing renewable with the grid, without any additional hardware cost. Here, the main idea is the maximum utilization of inverter rating which is most of the time underutilized due to intermittent nature of RES.

It is shown in this paper that the grid-interfacing inverter can effectively be utilized to perform following important functions: 1) transfer of active power harvested from the renewable resources (wind, solar, etc.); 2) load reactive power demand support; 3) current harmonics compensation at PCC; and 4) current unbalance and neutral current compensation in case of 3-phase 4-wire system**.** Moreover, with adequate control of grid-interfacing inverter, all the four objectives can be accomplished either individually or simultaneously. The PQ constraints at the PCC can therefore be strictly maintained within the utility standards without additional hardware cost.

III. POWER QUALITY ISSUES IN A GRID INTEGRATION OF RENEWABLE ENERGY SYSTEM

A. Solar Photovoltaic System:

In this system the output of the PV panel depends on the solar intensity and the cloud cover. Therefore the PQ problems not only depend on irradiation but also are based on the overall performance of solar photovoltaic system including PV modules, inverters, filters controlling mechanism etc. Survey studies shows that the short fluctuation of irradiance and cloud cover play an important role for low voltage distribution grids with high penetration of PV. Therefore special attention should be paid to the voltage profile and the power flow on the line. It also suggests that voltage and power mitigation can be achieved using super-capacitors which result in an increase of about 20% in the cost of the PV system.

The general block diagram of grid connected PV system is shown in fig (2) below and the system can be a single phase or three phases depending on the grid connection requirements.

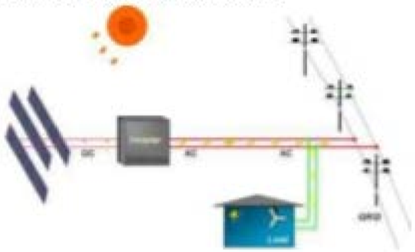

Fig.2:solar plant model

In general, a grid connected PV inverter is not able to control the reactive and harmonic currents drawn from non liner loads. A multifunctional PV inverter for a grid connected system shown in fig (2) has been developed recently presented in [8].This system demonstrates the reliability improvement through UPS functionality, harmonic compensation, reactive power compensation capability together with the connection capability during the voltage sag condition.

The American Wind Energy Association (AWEA) led to the effort in the United States for adoption of the grid code [9] for the interconnection of the wind plants to the utility systems. The rules for realization of grid operation of wind generating systems at the distribution network are defined as -per IEC-61400- 21.

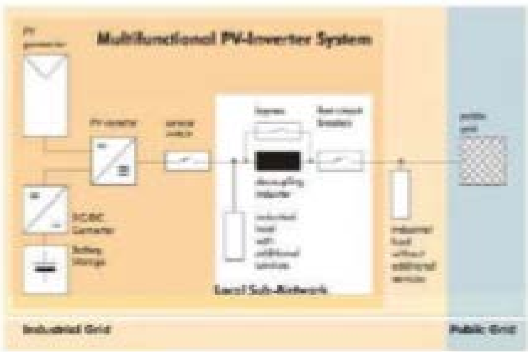

Fig. 3:concept of Multifunctional PV-Inverter Systems B. Wind Energy System

It suggest that new wind farms must be able to provide voltage and reactive power control, frequency control and fault ride through capability in order to maintain the electric system stability. For the existing wind farms with variable speed, double fed induction generator(DFIG) and synchronous generators(SG),a frequency response in the turbine control system can be incorporated by a software upgrade. A recently purposed Z source inverter (ZSI) can be a good approach to mitigate the PQ problem for DG systems connected to the grid [10] fig3 below

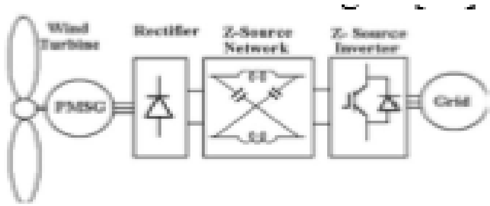

Fig.4: PMSG-based WECS with dc boost chopper and ZSI

IV. ROLE OF FACTS DEVICES

Facts devices are a family of power electronic devices, or a tool box, which is applicable to distribution systems to provide power quality solutions. STATCOM – STATIC SYNCHRONOUS COMPENSATOR The STATCOM (or SSC) is a shunt-connected reactive-power compensation device shown in fig(4) that is capable of generating and/ or absorbing reactive power[12] and in which the output can be varied to control the specific parameters of an electric power system. It is in general solid-state switching converter capable of generating or absorbing independently controllable real and reactive power at its output terminals when it is fed from an energy source or energy-storage device at its input terminals. Specifically, the STATCOM considered in this chapter is a voltage-source converter that, from a given input of dc voltage, produces a set of3-phase ac-output voltages, each in phase with and coupled to the corresponding ac system voltage through a relatively small reactance (which is provided by either an interface reactor or the leakage inductance of a coupling transformer). The dc voltage is provided by an energy-storage capacitor. A FACTS can improve power-system performance in such areas as the following: 1. The dynamic voltage control in transmission and distribution systems; 2. The power-oscillation damping in power transmission systems; 3. The transient stability; 4. The voltage flicker control; and 5. The control of not only reactive power but also if needed) active power in the connected line, requiring a dc energy source

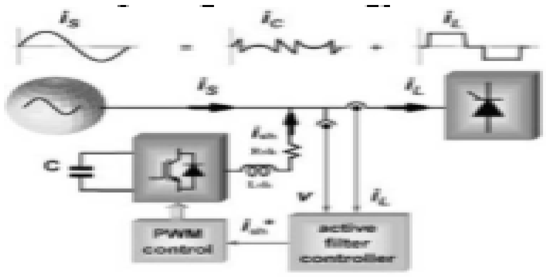

Fig.5: System configuration of FACTS

V. MODEL SIMULATION CIRCUIT

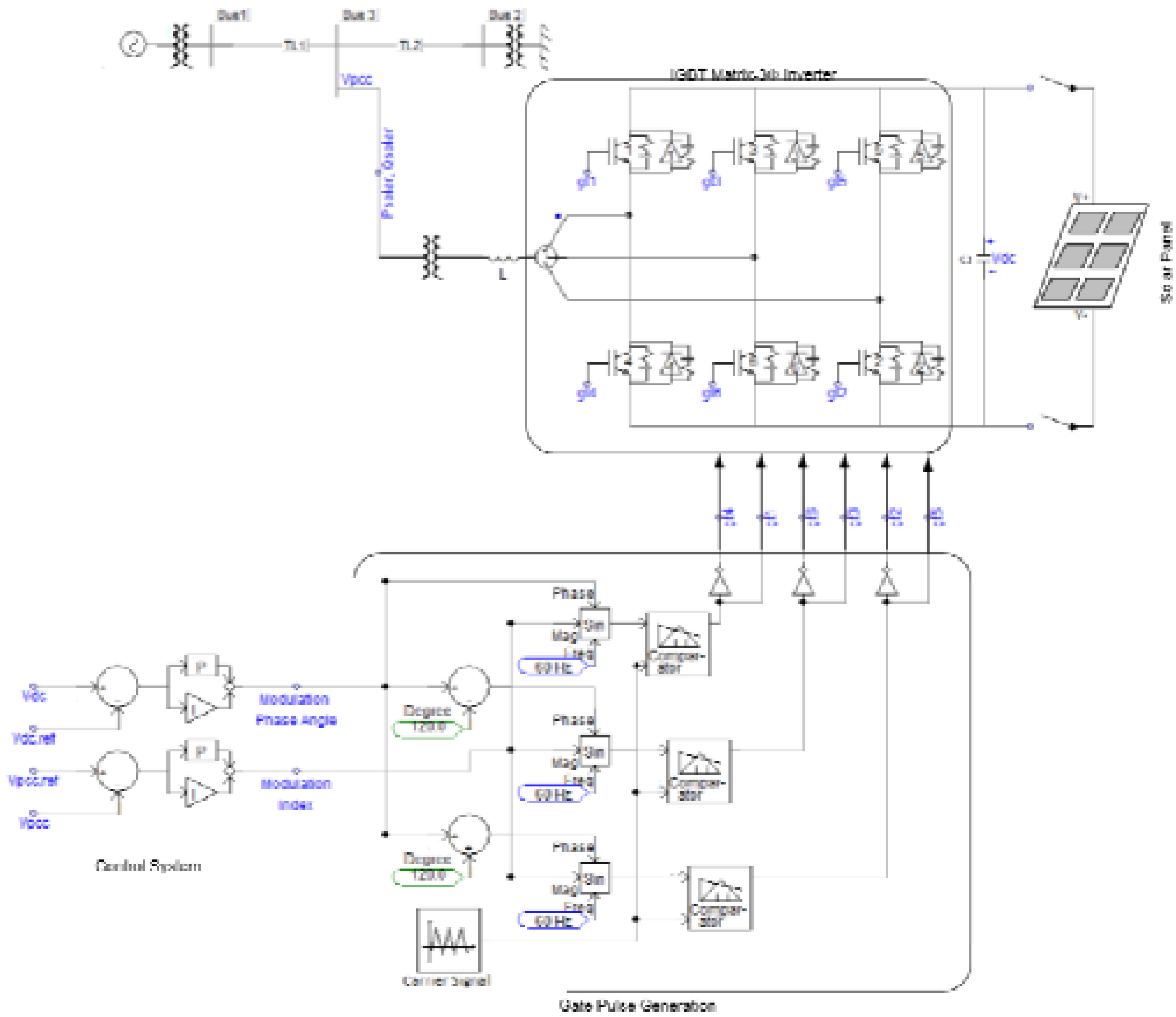

Fig.6: Expected Solar frame model

VI. CASE STUDY OF SIMULATION RESULTS

For this position simulation is carried out with STATCOM and without STATCOM. This is carried out by changing the position of switches in the simulation model. The obtained results from the scopes are shown in fig 4 and fig 5. It is very well seen from the scope that a considerable improvement in voltage profile and considerable improvement in power output when STATCOM is connected at the point of common coupling than when there was no STATCOM connected at the point of common coupling .if we CREATE a fault IS LLG then observe with facts and without facts shown in bellow.

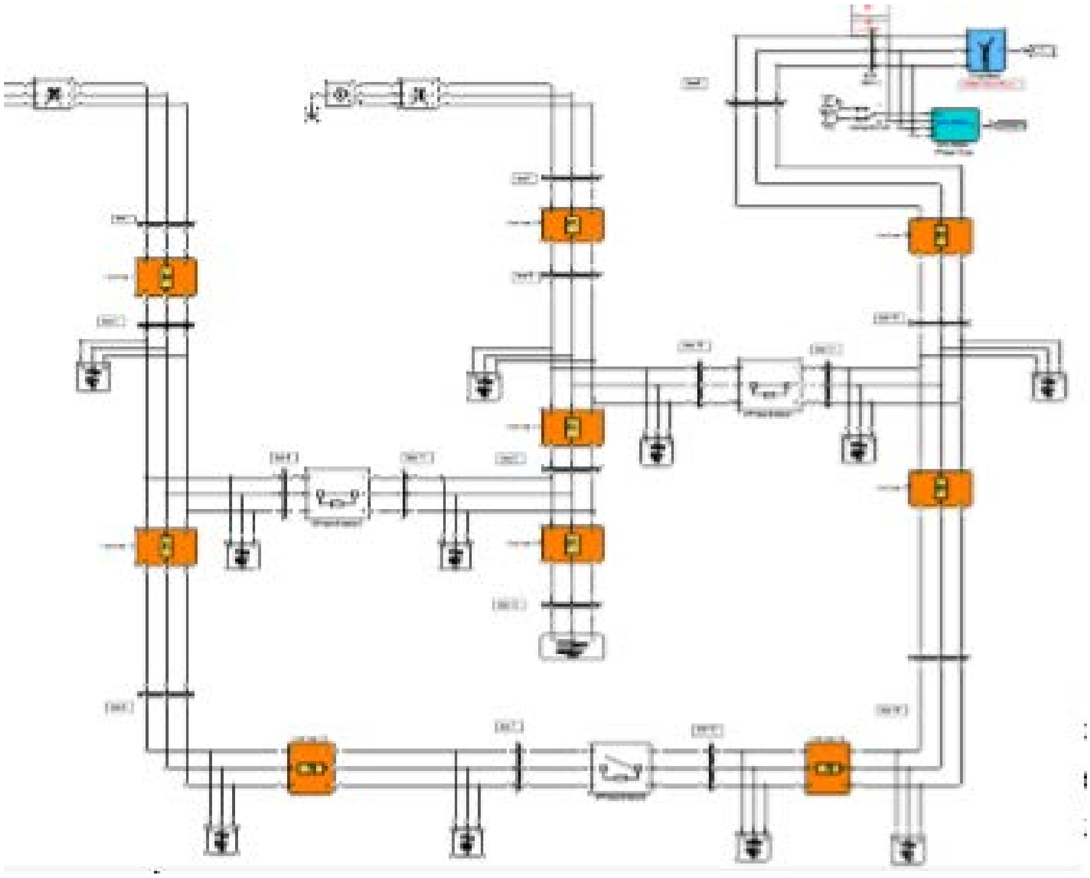

Fig.7: Expected Simulink model of Wind Farm integrated with grid and analyzed the system with wind integration

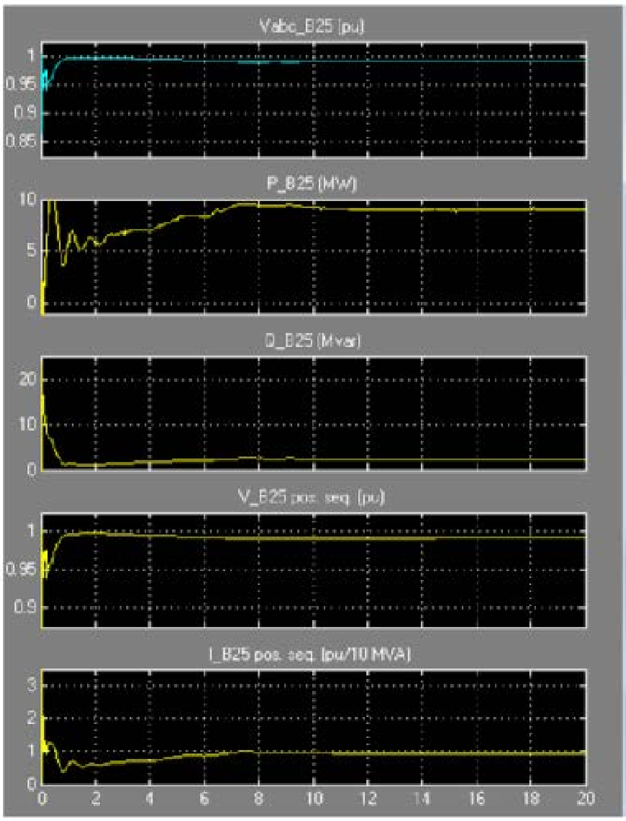

Fig.8:Study state stability by STATEOM

FACTS devices play very important role in improvement of power quality in this paper also by using one of the facts device that is STATECOM we have to improve the transient stability and study steady state stability

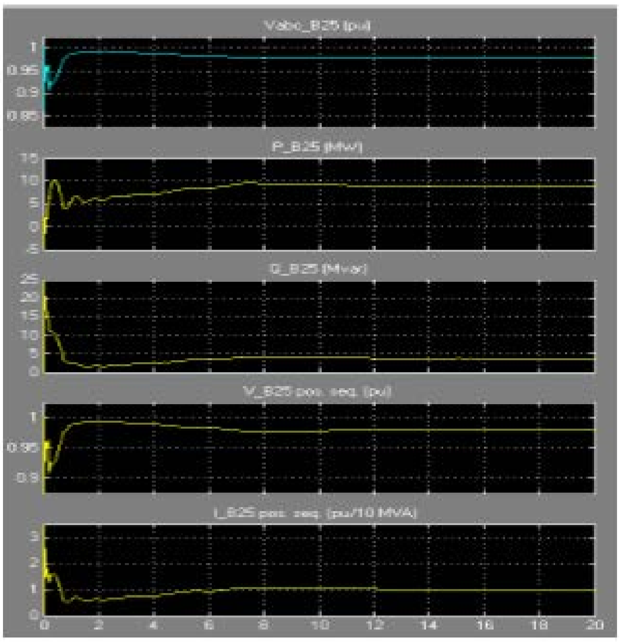

Fig.9: study state analysis with out facts

The response of real power P, reactive power Q, and voltage behavior in scope is observed for 20 seconds and fault is created at 15 seconds of the study considered. From the scope it is very clear that after the fault active power goes to zero indicating that Wind Energy DG has been isolated from the system and voltage improvement with STATCOM is observed.

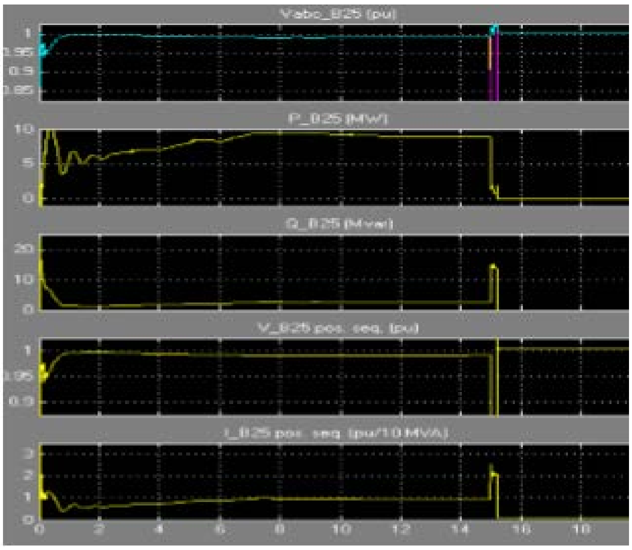

Fig.10: Transient stability with FACTS

We can observe above wave form all the parameter of load flow solutions that is active power voltage and current. The pitch of the blade is varied in the given range in order to maintain the power constant for the varying wind with its cut-in and cut out ranges to handle different loads, here the maximum pitch angle and maximum power can be generated at wind speed of 9m/s is observed.

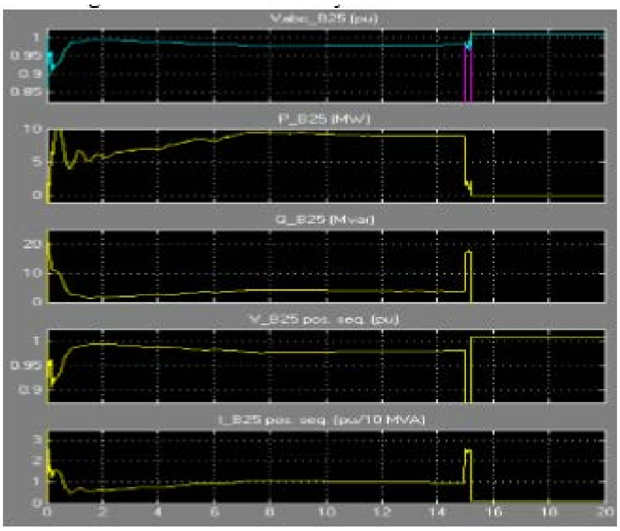

Fig.11: Transient stability without FACTS

7. CONCLUSION

The attempt made to verify the performance of power system with FACTS and without FACTS found satisfactory as it is very clearly seen from the scopes the improvement in the performance curves at the point of common coupling. Very interesting is that voltage is stabilized even during fault condition. FACTS controller implementation plays a vital role in the improvement of overall performance of the power system. As the wind integration draws reactive power from mains, causes the system voltage deterioration, specially at the point of coupling. A suitable controller helps the system to uplift to maintain grid codes. In this case study STATCOM is used to maintain voltage within limits or as required by the system. With this test study further work is planned to apply the same on real system case study. This work made the confident report to apply on real system. thus integration of renewable energy source by using of FACTS it will be the overall stability.

VII. AUTHOR'S PROFILE

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PhD Research scholar, MJRPU at Jaipur in the dept of Electrical engineering .he completed MTCH from JNTUA. his interesting areas are power system and control systems.

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