Enhancement of Power Quality and Stability in Wind Farm to Weak- Grid Connection Using Upqc

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ABSTRACT:

Most of the wind energy conversion systems around the world employ Squirrel Cage Induction Generator (SCIG) which is directly connected to the grid. In modern power generation, the Wind Farms (WF) are connected through Medium Voltage (MV) distribution headlines. A situation commonly found in such scheme is that the power generated is comparable to the transport capacity of the grid. This case is known as Wind Farm to Weak Grid Connection. The major problems due to weak grids are voltage fluctuations and this causes poor voltage regulation at the Point Of Common Coupling (PCC). Thus the combination of weak grids, wind power fluctuation and system load changes results in disturbances in the PCC voltage, it will have negative impact on Power Quality and WF stability. This situation can be improved using control methods at generator level, or compensation techniques at PCC. In case of wind farms based on SCIG directly connected to the grid, it is necessary to employ the Custom Power System (CUPS). This project proposes the CUPS device i.e., Unified Power Quality Compensator (UPQC) which is designed to mitigate voltage fluctuations at the grid side and to maintain the voltage in the WF terminals. The internal control strategy is based on the management of active and reactive power in the series and shunt converters of the UPQC, and the exchange of power between converters through UPQC DC–Link. This approach increases the compensation capability of the UPQC with respect to other custom strategies i.e., DVR and DSTATCOM that use reactive power only. Simulations results show the effectiveness of the proposed compensation strategy for the enhancement of Power Quality and Wind Farm stability.

1. INTRODUCTION

The site of generation services is found by wind flow availability for wind energy generation, often far from HV power transmission grids and main consumption centers. In case of services with average power ratings, the medium voltage distribution headlines are linking WF. A condition generally found inside such scheme is that the power generated is the same to the transfer power capacity of the power grid to which the WF is connected, also known as feeble grid connection. The major point of this kind of links is the improved voltage regulation consideration to modify in load. So, the system's ability to control voltage at the PCC to the electrical system is a main factor for the successful operation of the WF. Also, be well known that given the strike as well as neglect nature of wind resources, the WF generates irregular electric power. These fluctuations have a negative control on consistency along with power worth in electric power systems. The process of SCIG demands non-active power, usually provided from the mains and/otherwise by restricted generation in capacitor banks. In the event that changes happen in its mechanical speed, i.e., due to wind trouble, so resolve the WF active power injected into the power grid, mainly important to variations of WF terminal voltage because of system impedance. This power instability send out into the power system, and can produce a occurrence known as “flicker”, which consists of fluctuations in the illumination stage caused by voltage variations. Also, the normal operation of WF is impaired due to such instability. In exacting case of “feeble grids”, the force is even greater. In order to decrease the voltage fluctuations that may cause “flicker”, and improve WF terminal voltage regulation, several solutions have been posed. The main familiar one is to improve the power grid, raising the S/C power stage at the PCC, thus dropping the impact of power fluctuations and voltage regulation problems. In modern years, the technical improvement of high PE devices has lead to accomplishment of electronic apparatus coordinated for electric power systems, with fast reply compare to the line frequency. These dynamic compensators allow huge flexibility in: a) scheming the power flow in transmission systems using FACTS devices, and b) improving the power quality in sharing systems employing Custom Power System (CUPS) devices. The utilization of these dynamic compensators to get better integration of wind energy in meager grids is the safe to adopt in this work. In this project we suggest and analyze a compensation plan using an UPQC, for the case of SCIG–based WF, connected to a feeble distribution power grid. This system is in use from a true case. The UPQC is controlled to regiment the WF fatal voltage, and to reasonable voltage fluctuations at the PCC, caused by system load changes and exciting WF generated power, respectively. The UPQC series converters are responsible to inject voltage in phase with PCC for regulating the WF terminal voltage and the UPQC shunt converters are responsible to inject current between U1 and PCC to reduce voltage fluctuations and to attenuates the power fluctuations, requiring true and non- active power handle capacity. Active power is shared between the series and shunt converters through a common DC link. Simulations were passed out to demonstrate the effectiveness of the proposed compensation approach.

2.PROBLEMS OF WEAK GRIDS The term ‘weak grid’ is used in many connections both with and without the inclusion of wind energy. It is used without any rigour definition usually just taken to mean the voltage level is not as constant as in a ‘stiff grid’. The problem with weak grids in connection with wind energy is the opposite. Due to the impedance of the grid the amount of wind energy that can be absorbed by the grid at the point of connection is limited because of the upper voltage level limit. So in connection with wind energy a weak grid is a power supply

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system where the amount of wind energy that can be absorbed is limited by the grid capacity and not e.g. by operating limits of the conventional generation.

2.1 VOLTAGE FLUCTUATIONS Even though blackouts appears to get all the attention, main power problems are caused by voltage fluctuations like high voltage surges, sags, and impulses. Users fail to notice this issue and do not pay much interest in protecting the power system against imperceptible voltage fluctuations. The most populous way in which people believe in, to protect our systems against all power related problems is by installing uninterrupted power supply (UPS) systems.

2.2 VOLTAGE QUALITY The assessment of the impact of the wind farm on the voltage quality shall be based on the following concepts: ¬ Rapid voltage changes or voltage jumps ¬ Voltage variations and flicker ¬ Harmonics For the relevant connection point, requirements for harmonic voltages shall be converted to requirements for harmonic currents according to agreement with the system operator.

3.UNIFIED POWER QUALITY COMPENSATOR Power quality is the major issue in the power system one should take care of. After the invention of FACTS controllers we are feasible to operate the power system at its maximum limitations. We can achieve the control over power quality of source current and the voltage of load bus by simultaneous usage of both DSTATCOM and DVR. If these two controllers connects to the DC side then they regulates the DC bus voltage (DSTATCOM) and supplies required energy to the load (DVR) when source voltage have transient disturbances. All these advantages can be offered by one device, if these controllers are properly arranged. The configuration of such device can be termed as Unified Power Quality Conditioner (UPQC) which is shown in figure 1

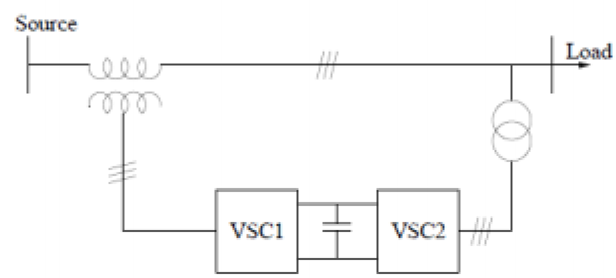

Figure 1: Configuration of UPQC

3.1.OPERATION OF UPQC

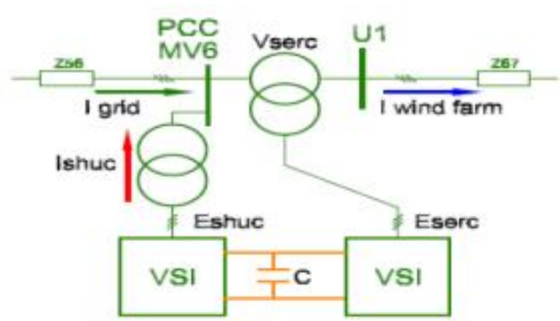

Figure 2 : Block diagram of UPQC

The operation is based on the generation of three phase voltages, using electronic converters either voltage source type (VSI–

Voltage Source Inverter) or current source type (CSI– Current Source Inverter). VSI converter are preferred because of lower DC link losses and faster response in the system than CSI. The shunt converter of UPQC is responsible for injecting current at PCC, while the series converter generates voltages between PCC and U1, as illustrated in the phasor diagram of Fig.4. An important feature of this compensator is the operation of both VSI converters (series and shunt) sharing the same DC–bus, which enables the active power exchange between them.

3.2.DYNAMIC COMPENSATOR MODEL

The dynamic compensation of voltage variations is performed by injecting voltage in series and active– reactive power in the MV6 (PCC) busbar; this is accomplished by using an unified type compensator UPQC In Fig.3 we see the basic outline of this compensator; the busbars and impedances numbering

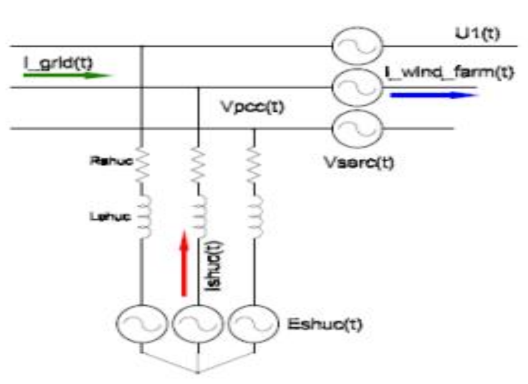

Fig 3:Dynamic Compensator model of UPQC

4.POWER BUFFER CONCEPT USING UPQC

In the proposed strategy the UPQC can be seen as a "power buffer", in the power system grid injected power should be leveled leveling.

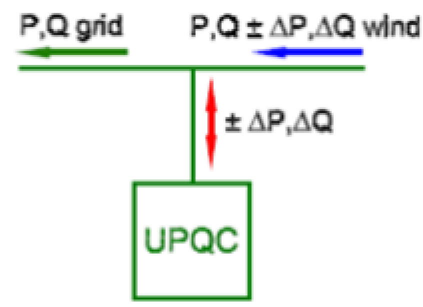

Figure 4 : power buffer concept

The figure represents a theoretical outline of the method of operation are .the comments confronting in UPQC are the average power in the storage element installed in bus when the nonappearance of an outside DC source in the UPQC bus, strengths to look after zero. This is accomplished by a proper design of DC voltage controller. Likewise, it is important to note that the proposed technique can't be executed utilizing different CUPS devices like D–STATCOM or DVR. The usage of reactive power support idea by utilizing a DSTATCOM, yet not utilizing a DVR. Then again, voltage regulation amid moderately substantial disturbance, can't be effectively control utilizing reactive power just from DSTATCOM at this situation a DVR device is more suitable

5.CONTROL STRATEGIES

To storage power there are several different control strategy exist for a power controller. The different control strategies place different ratings on voltage and power fluctuations and therefore to maintain power rating have diverse impact on the size of storage capacity. The two main different types of control strategies are firstly voltage is controlled at the point of common connection and secondly when ones point in the grid as started controlling it may results in the power for smoothing or capacity increase.

5.1 UPQC CONTROL STRATEGY

SERIES CONVERTER CONTROLLER The UPQC serial converter is controlled to keep up nominal value at the WF terminal voltage, accordingly by compensating PCC voltage varieties the voltage disturbances originating from the grid can't spread to the WF offices thus. Block diagram of the series converter controller. By subtracting infused voltage is acquired the PCC voltage from the reference voltage, and is phase– Aligned with the PCC voltage ly. As a reaction, this control activity may expand the low voltage ride–through ability in the event of voltage sags in the WF terminal

SHUNT CONVERTER CONTROLLER: To filter the dynamic and reactive power pulsation generated by WF shunt converter of UPQC is utilized. The WF compensator set infuses power into the grid and consequently it will be free from pulsations, which are the origin of voltage fluctuation that can spread into the system. The primary goal is to accomplish the suitable electrical currents infusion in PCC. Additionally, the regulation of the Direct Current bus voltage has been allotted to converter, block diagram of the shunt converter controller. This controller produces both voltages

CONCLUSION In this project UPQC custom power device is placed at the point of common coupling where the power generated by the wind farm (WF) is compared to the transport capacity of grid. UPQC employs Shunt and series connected voltage source inverters (VSI's). Shunt converter is for injecting current at PCC and series converter is for injecting voltage between PCC for maintaining constant terminal voltage rejecting voltage variations at PCC. The important property of UPQC is the operation of both VSI converters sharing the same DC bus which enables the active power exchange between them. Hence, the voltage fluctuations at grid side are reduced and thus improving the voltage regulation, power quality and stability of wind forms. MATLAB simulink model is designed by connecting UPQC at the point of common coupling. It shows a good performance compared with DVR and D-STATCOM by rejecting power fluctuation due to tower shadow effect and the regulation of voltage due to sudden change in load.

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