A WIND ENERGY POWER CONVERSION BY UTILIZING STATCOM FOR POWER QUALITY PROBLEM

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ABSTRACT

The wind power generated electrical power can creates the power quality issues. The quality of the wind turbine performance is calculated and identified by the standard guideline technologies are developed on the basis of production of required sufficient voltages at the grid side. The wind turbine affected by the different causes such as voltage sags, swells, flicker, distortions and electrical performance of the operating frequency ranging conditions are discussed by different guidelines. The power quality issue is generated by the association of wind turbine in the grid. In this paper implemented the STATCOM based implementation to compensate the power quality issues in the grid side we are connected the STATCOM to a point of common coupling to the battery energy storage system (BESS). The integration BESS with the grid to maintain the required real power at the time of fluctuating wind power generations. Additionally we are provided the shunt capacitance in order to improve the power factor of the wind power plant then the harmonic contents will be reduced. The wind energy generation with the STATCOM control strategy improved the power quality of the implemented system these are designed in the MATLAB/ SIMULINK. The Simulink results are tested and verified in the MATLAB there is proper reactive power compensation is also generated. The implementation of grid connected wind energy system and the power quality improvement is developed in this project.

Index Terms: Wind Energy Power System, Battery Energy Storage System, STATCOM, Power Quality Improvement.

I. INTRODUCTION

Now a day we are facing too many concerns about environmental issues, such as damaging the urban and rural pollution as well as energy troubles, automobile and industrial sections are required to shift their attention towards to clean vehicle technologies. In the continuous energy conversion are produced by using the renewable energy sources are important resources such as wind, solar, bio gas, tidal are presented. The integration of renewable energy source like as wind energy system to functioned and possible to generate the power without the restrictions like as environmental conditions we have maintained in this manner. The integration of wind power energy system in that manner we are necessary to take some challenges to produce continuous power with the use of voltage controlling technique, stability considerations and power quality problems. The power quality is a major issue for affecting the operations in the case of both transmission and the distribution networks. The problem of power quality is main consideration in the case of wind turbine. In the last years there

lot of improvement in the wind energy developments and extensive methods to produce the energy. Every individual unit has the capability to produce the energy up to 2MW. In the world more than 28,000 of the wind turbines are used to satisfy the customer requirements they are successfully completed their operating principles close to the proximity ranges for the customers. In the case of steady state operation conditions of the wind turbine, all the parameters of wind turbine are distortions with respect to the wind speed and they are transmitted fluctuations in the in the mechanical torque and hence the electrical power generation on the grid side is also leads to develop the large fluctuations. In the general normal operating conditions the wind turbines are produced the continuous variable maintained they produce variable output power. These types of variations in the generation of power are mainly due to the effect of the instability, tower gloominess and the wind mechanism and the organize system of the wind turbine. Therefore the power reliability performance of the complete system is decreased because of these fluctuations in the generating networks that required proper controlling arrangement for the turbine. In the power quality problems are can be considered in case of wind generations and also in the distribution and transmission networks are affected by the voltage sags, swells and flicker and the voltage fluctuations and harmonics etc. Even though the wind generations are influenced the distortions like as disturbances in the distribution network. One way to connect the wind generator that is induction machine is directly connected to the grid of the wind power plant. The induction generator has the various advantages like as cost less and simplicity for the production of power. Nevertheless the wind turbine generator necessities reactive power necessary to produce the electrical power from the induction generator. If the induction generator produced variable output because of it doesn't have proper reactive power for the induction generator, or due to wind, and terminal voltage of the induction generator can be highly affected.

An effective control arrangement is necessary in the wind generation system under normal working conditions of turbine to produce constant active power production. In the increment of voltage disturbances in the grid side we need to compensate these fluctuations by placing a battery energy storage system for the wind generating system to overcome these disturbances. In this system one SATCOM is proposed to control oscillations in the turbine to enhance the power quality under the different power levels associated with wind power generation turbines. The implemented STATCOM connected grid energy system the control system improves the power quality for the following objectives.

- It can maintain the power factor close to Unity in the grid side by the association shunt capacitance in the grid side.
- Reactive power requirement can support only from the STTCOM to wind generator and the load.
- The dynamic performance of the wind generating system is improved by the placing of simple bang-bang controller in the grid side.

1.1 Power Quality Problems

1.1.1 Voltage Variation

The voltage dissimilarity problem consequences from the wind speed and generator torque. The voltage distinction is straight related to real and reactive power consequences. The voltage deviation is frequently classified as below:

- Voltage Swells.
- Voltage Sag/Voltage Dips.
- Long duration voltage variation.

- Short Interruptions.

The major drawback in voltage flicker problem explains dynamic fluctuations in the arrangement affected by wind turbine or by unstable loads. Thus the power distortions from wind turbine occur at the time of continuous mode of operation. The magnitude of energy changes depended on grid competence, system association impedance, and subdivision angle and power factor considerations of the wind turbines has to be calculated. It is definite as a oscillation of voltage in a frequency variations between the 10–35 Hz. The IEC ordinary specific 61400-4-15 works a flicker indicator that be able to be work to measure flicker automatically.

1.1.2 Harmonics

The harmonic contents residential due to the presence of semi conductor power electronic devices. The harmonic content based voltage and current necessity be inadequate to the acceptable height at the point of wind turbine association to the system. To make sure the harmonic voltage contained by limit, each resource of harmonic current can permit only a incomplete involvement, as per the IEC-61400-36 principle. The rapid power electronic switching generates a large decrease in lower order harmonic current contents checked to the line commutated type of converter, but the construction there will have elevated occurrence present and can be effortlessly filter-out.

1.1.3 Wind Turbine Location in Power System

The way of concerning the wind operating system into the power classification exceedingly affects the power quality performance. Accordingly the process and it's organize on power system depended on the agreement of the adjacent power network.

1.1.4 Self Excitation of Wind Turbine

The self excitation performance of wind turbine generating scheme (WTGS) with an asynchronous generator functioned with place after disengagement of wind turbine generating system monitors (WTGS) with confined load. The possibility of self excitation comprises particularly when WTGS is prepared with compensating dc-link capacitor. The capacitor associated to induction producer provides reactive power recompense. Though the voltage and occurrence are strong-minded by the balancing of the coordination. The difficulty of self excitation is the protection characteristic and equilibrium between real power and reactive power.

1.1.5 Consequences of the Issues

The voltage difference, flicker, distortions effects the breakdown of equipment devices specifically microprocessor worked control system operations, programmable logic controller users; adaptable speed control drives, gleaming of brightness and divider. It may delivers to graceful of con- tractors, elegant of protection devices, go-slow of sensitive equipments like personal computer, programmable logic control system and might be stop the procedure and still can damage of responsive elements. Consequently it affects the power quality performance in the grid.

II. GRID COORDINATION ARRANGEMENT

The American Wind Energy Association (AWEA) lead the exertion in the united state for acceptance of the grid code for the interconnection of the wind power plants to the usefulness system. The most important grid arrangement is alert on the delivery level, after the pass out in the United State in August 2003.

The United State American developed wind energy manufacturing took a situate in increasing its own grid operation for causative to a steady grid operation. The regulations for understanding of grid process of wind processing system at the allocation net- work are distinct as-per IEC-61400-21. The grid quality individuality and restrictions are given for principles that the customer and the effectiveness grid could expect. Recording to Energy-Economic Law of action, the operative of communication grid is dependable for the association and operation of organized arrangement.

2.2 Voltage Rise (U)

The voltage augment at the point of ordinary coupling can be selected as a function of greatest evident power of the turbine, the grid performances based on the impedance R and X at the point of common coupling point and the phase angle, specified in (1)

$\Delta u = S_{max}(\mathrm{R}\cos\varphi - X\sin\varphi)/U^2$

Where Δu represents -voltage increment, S_{max} – maximum Apparent power, φ —phase differentiation bet between the voltage and the current, U —is the supposed voltage at the grid. The preventive voltage augment value is % 2.

2.3 Voltage Dips (D)

The voltage dips are presented due to starting condition of wind turbine controlling and it affected a sudden decrease of voltage. It is the comparative % voltage alteration due to working procedure of wind turbine arrangement. The diminish of supposed voltage transform is specified in (2).

$D=K_u \frac{S_n}{S_k}$

Where d denotes relative voltage regulate, S_n obligatory rated perceptible power production, short circuit circumstance .

2.4 Flicker

The capacity are made for greatest number of particular switching procedure of wind turbine through 10-min time and 2-h time are specific, as specified in (3)

$P_{lt} = C(\psi_k)\frac{S_n}{S_k}\frac{1}{2}\rho A V_{wind}^3$

Where P_{lt} appearance invention of flicker. $C(\psi_k)$ Flicker stringer coefficient parameters considered from Rayleigh allocation of the required wind speed. The preventive Value for flash coefficient is about ≤ 0.4, for standard time of 2 h .

2.5 Harmonics

The harmonic deformation is positioned for variable momentum turbine with a electronic power contribution of the converter at the point of common coupling connection. The total harmonic distortion voltage contents distortion of voltage is prearranged as in (4): $V_{THD} = \sqrt{\sum_{h=2}^{40}\frac{V_h^2}{V_h^2}}$

Where V_n denotes the nth harmonic voltage and V_1 is the fundamental frequency (50) Hz. The THD boundary for 132 KV is$\leq$ 3%.

THD of in progress I_{THD} is specified as in (5)

$I_{THD} = \sqrt{\sum \frac{I_n}{I_1}} * 100$

Where I_n is the nth harmonic current and I_1 is the elementary fundamental frequency (50) Hz. The Total Harmonic Distortions of current and bound for 132 KV is $represents\ as \leq 2.5\%$.

2.6 Grid Frequency

The grid regularity in India is individual in the assortment of 47.5–51.5 Hz, for airstream farm relationship. The wind farm should be able to survive change in frequency variations up to 0.5 Hz/s.

2.7 Topology for Power Quality Improvement

The STATCOM depended current control strategy voltage source inverter injects additional required the current into the network in such a arrangement that the supply current are harmonic contents are eliminated and their phase-angle represents with deference to foundation voltage has a preferred value. The injected additional current will abandon out the reactive power consequence and harmonic content of the load side and induction generator developed current, thus it enhances the power factor availability and the power quality performance in the grid side. To achieve these performances, the grids voltages are functioned and are harmonized in produce the current authority for the inverter. The implemented grid associated organization is for power quality development at position of common coupling (PCC), as exposed in Fig. 1. The network associated system illustrated in Fig. 1, includes of wind energy production system and the requirements of battery energy storage system BESS with STATCOM.

2.8 Wind Energy Generating System

In this arrangement, wind generations power plant are based on steady state speed technologies with playing field control of wind turbine. The induction generator performs is used in the projected proposal since of its effortlessness, it does not necessitate a disconnect field circuit arrangement, it can recognize steady and uneven loads, and has accepted defense adjacent to short circuit. The obtainable control of wind energy arrangement is accessible as below in (6).

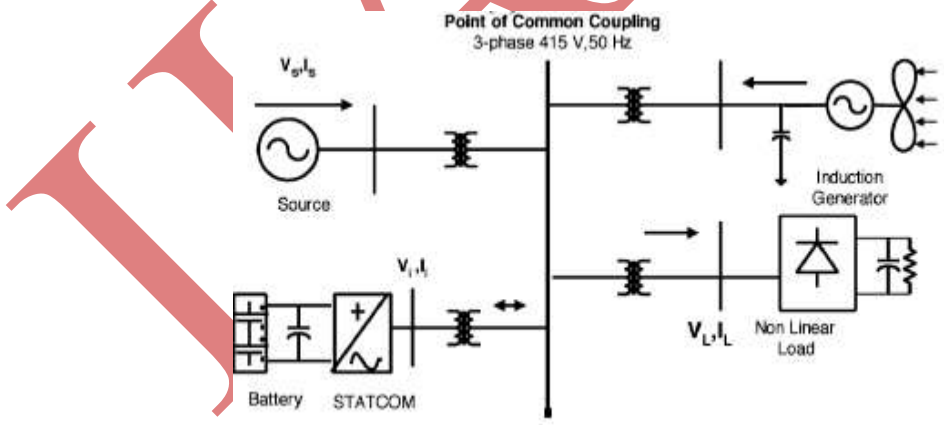

Fig.1. Grid Connected System for Power Quality Improvement

Where (kg/m) represents the air density availability and A (m) is the group of people swept away by turbine blade $angle\ at\ the\ wind\ turbine\ V_{Wind}$, is the wind speed in mtr/s. It is not achievable to dig out all kinetic energy of wind speed, therefore it haul out a segment of authority in wind, treat power coefficient preparations *Cp* of the wind turbine connected, and is gritty in (7).

$$P_{mech} = C\rho_{\ Wind}$$

Where *Cp* is the power parameter value, depended on category and in service situation of wind turbine. These coefficient parameters can be communicated as a profession of tip momentum eigen value λ and pitch angleθ $coefficient$. The emotionless power generate by wind turbine is given in (8)

$$P_{mech} = \frac{1}{2}\rho\pi R^2 V_{Wind}^3 C_\rho$$

Where R denotes the radius of the utilized blade (m).

III. BESS STATCOM

The major battery energy storage system consists (BESS) of an energy storage system parameters for the reason of voltage instruction. The BESS will obviously sustain dc-link capacitor maintains voltage steady and is best appropriate in STATCOM while it rapidly injects the additional required or fascinated reactive power requirement to neutralize the grid connected system. It also regulates the transportation side and distribution system arrangement in an extremely fast speed. While power oscillation produced in the system, the BESS can be use to level the influence variation by modulating and discharging circumstances. The succession is related in equivalent to the dc capacitor arrangement of STATCOM. The STATCOM connected in a three-phase voltage source converter consisting of the capacitance on its DC link and related at the point of common coupling arrangement. The STATCOM supplementary additional the necessary the compensating in progress of changeable amplitude and frequency contents at the bus connected in the point of common coupling.

IV. CONCLUSION

The paper develops the STATCOM-depended monitoring system for power quality development in grid associated wind operating arrangement and through non linear load conditions. The power quality problems and its contents on the costumer and electric effectiveness are obtainable. The working operation of the organize system implemented for the STATCOM associated BESS system is connected with the shunt capacitance connected to increase the power factor in the grid side. The corresponding results are presented in MATLAB/SIMULINK. It has an ability to cancel out the harmonic content of the load current. It regulates the sending end voltage and current in-phase and sustain the reactive power contents require for the wind turbine and load at PCC in the grid connected arrangement, Consequently it creates an prospect to increase the operation factor of transmission line system arrangement.

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