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A Review Article of PV Based Power Generation and Power Quality Improvement Using SSSC Power Compensation

Amarkant Shukla, Dr. Arvind Kumar Sharma
Department of Electrical Engineering,
Jabalpur Engineering College, Jabalpur, Madhya Pradesh
amarkant1293@gmail.com, arvindksharma_2000@rediffmail.com

***Abstract*- In this paper we investigate the controlling and enhancing power flow in a transmission line using a Static Synchronous Series Compensator (SSSC). The Static Synchronous Series Compensator is used to investigate the device in controlling active and reactive power as well as damping power system oscillations in transient mode. The SSSC device is equipped with SOURCE ENERGY to absorb or supply the active and reactive power to or from the line. Various IEEE bus systems have been stabilized using this FACTS device. The results are obtained by simulating the various power systems in MATLAB/SIMULINK.**

***Keywords*- Static Synchronous Series Compensator (SSSC), FACTS, Active and Reactive Power, IEEE Bus System, Voltage Source Converter (VSC).**

I. INTRODUCTION

Power engineers consider rising power quality and giving certain power at the lowest cost a major situation. Achievable solutions to power distribution difficulties have been recommended in the form of a number of power electronic based devices for enhanced power quality. Distribution Static Compensator (SSSC), Distribution Voltage Regulator (DVR), Unified Power Quality Compensator (UPQC), BESS, HVDC Light is few of the prominent custom power devices employ at distribution level.

The Distribution Static synchronous Compensator (SSSC) is a chief member of the FACTS family of power electronic based controllers. It has been studied for many years, and is probably the most widely used FACTS device in present's power systems. The SSSC voltage and reactive power compensation are normally related through with the magnetic of the D-SSSC. This traditional power flow framework of the SSSC neglects the impression of the high frequency effects and the switching diagnostics of the power electronics on the active power losses and the reactive power insertion.

The SSSC has appeared as a hopeful device to offering not only for voltage sag reduction but also for a host of other power quality solutions such as voltage stabilization, flicker suppression, power factor correction, and harmonic control. SSSC is a Series device that produces a balanced 3-Φ voltage or current with capability to control the magnitude and the phase angle. Generally, the SSSC configuration consists of a typical 12-pulse inverter arrangement, a dc energy storage device. A coupling transformer linked in Series with ac system and connected control circuits.The simulation results show the enhancement in current control response. These methods are tested in MATLAB, and their results are obtained.

II. PROBLEM IDENTIFICATION

The power system is a non-linear network dependent on many parameters such as generator output, transmission parameters, active key specification etc. that vary continuously. The strength of a power system can be divided into stable, transient state and dynamic stability. An unstable system can lead to the collapse of an entire system or part of a system. The type of error or distortion can be a small or large scale ranging from short to long when measured on a time scale.

Strengthening of energy quality through the use of multilevel inverter topology and power installation in the solar and air hybrid conversion system grid investigated by Sharma et al.

III. LITERATURE REVIEW

1. Application of Battery Energy Operated Systemt to Isolated power Distribution Systems:

Bhim Singh, A. Adya, A.P. Mittal and J.R.P Gupta This paper [1] manages model of battery energy worked system for a 42.5kVA DG set utilizing Simulink and Power System Square set in MATLAB environment. Battery energy storage System (BESS) is utilized for pay alongside a little synchronous generator of 42.5kVA limit

coupled to a diesel motor as a prime mover. The DG set sustains a wide mixed bag of loads. The system execution is reproduced for straight, non-direct adjusted and lopsided loads. Simulation results justify upgraded power quality of the system with BESS application.

2. Adaline Based Control of Battery Energy Storage System Fordiesel Generator Set:

Bhim Singh, Jitendra Solanki, and Ambrish Chandra This paper [2] presents the operation of battery energy storage system (BESS) with diesel generator (DG) set. The DG's execution set is watched best when worked at full load or close full load (upto 70-80% burden) condition. For this reason a BESS is utilized which guarantees the load on the generator stays in the middle of 80% to 100% of full load. Under light load condition (stack under 80%) the battery is being charged and in substantial load condition (stack more than 100%) energy from battery is additionally used to nourish additional energy to the load. Alongside load administration, BESS gives the reactive power, consonant and unequal load current remuneration. The control of BESS is accomplished utilizing slightest mean square (LMS) based Adaline. The Adaline is utilized to separate the parity positive succession genuine principal recurrence segment of burden current. The exchanging of voltage source converter (VSC) forcing so as to function as BESS is accomplished source streams to take after reference ebbs and flows utilizing hysteresis based PWM control. The plan is recreated under MATLAB environment utilizing SIMULINK and PSB square sets. The demonstrating is performed for 3-stage 4-wire star associated synchronous generator, alongside the 4-leg VSC acting as BESS. The outcomes confirm the viability of the Adaline based control of BESS to meet load compensation and ideal operation of DG set.

3. A Solid State Compensator with Energy Storage for Isolateddiesel Generator Set:

Bhim Singh, JitendraSolankil, Ambrish Chandra, Kamal-A1-Haddad This paper [3] presents the control of battery energy storage system (BESS) with diesel generator (DG) set. The DG's execution set is watched best when worked at full load or close full load (up to 80-100% load) condition. For this reason a BESS is utilized which guarantees the load on the generator stays in the middle of 80% to 100% of full load. Under light load condition (stack under 80%) the battery is being charged and in substantial burden condition (stack more than 100%) energy from battery is used to bolster additional energy to the load and when burden is in the middle of 80 to 100% battery stay in skimming condition. Alongside burden administration, BESS gives the responsive force, consonant present and lopsided load current remuneration. The control of BESS is accomplished utilizing synchronous reference outline hypothesis (SRF) to remove the parity positive succession genuine essential recurrence segment of load current. The exchanging of voltage source converter (VSC) forcing so as to file in as BESS is accomplished source streams to take after reference ebbs and flows utilizing hysteresis based PWM controller. The complete system is reproduced under MATLAB environment utilizing SIMULINK and PSB piece sets to exhibit the system abilities.

4. Operation of Sssc for Voltage Control in Distributionnetworks with a New Control Strategy:

Dipesh. M .Patel, Dattesh Y. Joshi, Sameer H. Patel, Hiren S. Parmar This paper [4] presents SSSC (Dispersion Static Compensator) is utilized for pay of receptive power and unbalance brought on by different burdens in distribution systems. This paper addresses the demonstrating and investigation of custom power controllers, power electronic-based gear went for upgrading the unwavering quality and nature of power streams in low voltage dispersion systems utilizing SSSC. Another PWM-based control plan has been suggested that just obliges voltage estimations and no responsive force estimations are needed. The operation of the proposed control system is exhibited for SSSC. Reproductions and examination are completed in PSCAD with this control strategy for two proposed systems.

5. A Real And Reactive Power Control Approach For Battery Energy Storage System:

C. E. Lin, Y. S.Shiao C. L. Huang , P. s. Sung This paper [5] Battery energy storage system (BESS) consolidates high innovations in battery, converter hardware and continuous PC control, offers high ability for burden administration. It understands a useful strategy for burden administration in power circulation system or interest side burdens. A BESS works in real power supply for load moving: while the BESS can furthermore be stretched out in responsive control for reactive power compensation. Another control method for BESS to work in genuine force mode and reactive power mode is examined. Reproductions for an interest side BESS are exhibited, together with investigations on a working framework set-up in power research facility utilizing constant control usage. It tests the genuine and reactive power control of BESS utilizing a 10 KVA/30 KWHr lab reactive power compensation. There until delineated at the proposed strategy is powerful and simple in this study.

6. Design and Commissioning of a 5 Mva, 2.5 Mwh Battery Energy Storage Systems:

N.W. Miller (SM), R.S. Zrebiec (NM), R.W. Delmerico (M), and G. Hunt (NM) This paper [6] portrays the outline and charging of a 5 MVA, 2.5 MWh BESS which is presently in operation at the GNB Battery Reusing Plant in Vemon, California. The BESS at Vemon gives the obliged power consolidated with both voltage and

frequency control to permit the plant to endure detachment from the utility network without agony inadmissible effects on basic loads.

7. Using Battery Energy Storags System in a Deregulated Environment to Improve Power System Performance:

K.K. Leung and D. Sutanto This paper [7] epitomizes late work at the Hong Kong Polytechnic College on the use of energy storage all in all and BESS specifically in four ranges: control of active and reactive power, load leveling, power quality change and force stream controller. The exploration goes for creating novel systems for controlling those dynamic issues and researching the points of interest and constraint of BESS for the applications investigated. This paper will talk about the equipment arrangement and programming innovations presently being utilized to actualize an above's portion targets, specifically, the quick control of dynamic and responsive force interest and era when a Battery energy Storage System is joined with the network. The proposed three-stage multi-reason Battery active and reactive power will give active and reactive power autonomous of the supply voltage with amazing power quality as far as its waveform.

8. Power Quality Improvement of Distribution Lines Using Dsssc under Various Loading Conditions:

Veeraiah Kumbha, N. Sumathi The paper [8] study exhibits the power quality trouble due to installing of wind turbine with the grid. In this projected strategy STATIC COMPENSATOR (SSSC) is attached at a point of common coupling with a battery energy storage system (BESS) to mitigate the power quality issues. The battery energy storage is incorporate to continue the real power source under fluctuating wind power. The SSSC control strategy for the grid affiliated wind energy generation system for power quality betterment is simulated using MATLAB/SIMULINK in power system block set. Finally the projected strategy is applied for some balanced and unbalanced linear non linear loads.

9. Ann Controlled Battery Energy Storage System For Enhancing Power System Stability:

M.W. Tsang and D. Sutanto This paper [9] describes a utilization of an adaptive Artificial Neural Network (ANN) controller to endlessly control the charging and discharging of a Battery Energy Storage System (BESS) to modify the stability of an electric power system. The simulation studies have enclosed a elaborate model of the generator excluding its excitation controller and governor, as well as a comprehensive BESS model, excluding the DC battery model and the switch operation connected with the power converter. An on-line training Artificial Neural Network controller is endlessly disciplined to directly control the BESS activity to dampness power system oscillation in different power system operational conditions. Simulation results display that this ANN controller can adaptively acquire and inform its control strategy to modify the scheme stability under various system operational conditions.

10. Improvement of Dynamic Behavior and System Stability by Using SSSC:

Ghazanfar Shahgholian, Mehdi Mahdavian, Afshin Etesami, Sepehr Moalem, Masoud Jabbari This paper [10] analyzes the event of the SSSC on little signal power system stability in a single-machine infinite-system (SMIB). Non-linear and linear frameworks of a single machine have been concluded. The SSSC is modeled as the voltage source converter backside a step down transformer by a first order differential equation. Eventually, the function SSSC showed in enlarging transmission capability and improving transient stability is displayed by simulation outcomes and parameters fluctuation on system effect are discussed.

11. Power Quality:

Power quality is a term that means different things to different group. Institute of Electrical and Electronic Engineers (IEEE) Standard IEEE1100 defines power quality as "the concept of powering and grounding sensitive electronic equipment in a manner suitable for the equipment." As appropriate as this description might seem, the limitation of power quality to "sensitive electronic equipment" might be subject to disagreement. Electrical equipment susceptible to power quality or more appropriately to lack of power quality would fall within a seemingly boundless domain. All electrical devices are prone to failure or malfunction when exposed to one or more power quality problems. The electrical device might be an electric motor, a transformer, a generator, a computer, a printer, communication equipment, or a household appliance. All of these devices and others react adversely to power quality issues, depending on the severity of problems.

IV. FACTS DEVICES

The AC transmission system has different limits classified as stationary limits and dynamic limits. These inherent power system limits restrict the power deal, which guide to the beneath utilization of the active transmission resources. Conventionally, fixed or mechanically switched Series and series capacitors, reactors and synchronous generators were being used to solve much of the difficulty. Though, there are limitations as to the use of this conventional equipment. Wanted performance was not being able to attain efficiently. Wear and tear in the mechanical apparatus and sluggish response were the heart of the trouble. There was better requiring for the substitute technology made of solid state devices with quick

response characteristics. They require was extra fuelled by universal reformation of electric utilities, rising environmental and efficiency regulations and difficulty in realization authorize and accurate of technique for the construction of overhead transmission lines. This, jointly with the development of Thyristor switch (semiconductor gadget), opened the gate for the growth of power electronics devices known as Flexible AC Transmission Systems (FACTS) controllers. The path from historical Thyristor based FACTS controllers to present state of the skill voltage source converters based FACTS.

There are different forms of FACTS devices, a few of which are linked in series with a line and the others are linked in Series or a mixture combination of series and Series. The detail description of different FACTS devices including their functional ethics can be establish found in. FACTS controllers have been controllers, was ready possible due to fast advances in high power semi conductors devices.in use in utilities almost the planet since 1970s, Thyristor-controlled FACTS devices, such as static var compensator (SVC) and thyristor-controlled series capacitor (TCSC), have effectively been used to get better both steady state and dynamic performances of a power system. The above FACTS devices necessitate fully rated capacitor and reactor banks to generate and absorb reactive power. Yet, these needs can be escaped by employing solid-state synchronous voltage sources. The FACTS devices that belong to this type are static synchronous compensator (SSSC), static synchronous series compensator (SSSC), unified power flow controller (UPFC), etc.

Advantages of using FACTS devices in the power system:

- Superior consumption of active transmission system assets.
- Increased transmission system consistency and availability.
- Increased dynamic and transient grid stability and decrease of circle flows.
- Improved quality of supply for sensitive industries.
- Environmental benefits Superior consumption of existing transmission system benefit.
- Offer dynamic reactive power support and voltage control.
- Decrease the require for construction of fresh transmission lines, capacitors, reactors regulatory concerns.

V. CONCLUSION

A model of SSSC has been developed in MATLAB environment using Power System Block-set. The performance of the developed model is tested under a wide variety of loading conditions. It is found that SSSC is capable of minimizing the harmonics and reactive power compensation. Indirect current control technique has been applied over the sensed and reference supply currents for SSSC and it has been found to be a simple technique. Only one PI controller is required to regulate terminal voltage and thus reduces computation effort.

The control algorithm of the SSSC is flexible and has been tested for power quality improvement for linear as well as nonlinear and Induction motor loads.D-SSSC is able to reduce harmonics in voltage at PCC and supply currents to less than 5% IEEE 519 standards. SSSC reduces harmonics in load current to a large extent and provides quality power.

Future Implications:

- The simulation has been carried out in MATLAB/SIMULINK environment and power factor is unity for supply voltage and current.
- To analyze the effect of non-linear loads, linear loads and Motor loads on Distribution system when feeding a generation with wind and solar.
- Modelling of reactive power theory and compare results with ICCT.
- To Study and Simulation of Fuzzy and ANN based controller on behalf of PI controller.
- In a future work, the obtained simulation results will be compared with experimental results, to be measured in a developed D-SSSC prototype.

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