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POWER QUALITY IMPROVEMENT METHODOLOGY IN MICROGRID: A REVIEW

[1] Ayushi Meshram

[1]PG Student, Department of Electrical Engineering, Government College of Engineering, Amravati-444604, India.

ABSTRACT -: The renewable energy sources play an important role in electric power generation with growing environmental concerns. Power electronics converters are used to connect renewable energy sources in order to improve power quality at the point of common coupling (PCC). So, in this paper, we reviewed power quality issues and their underlying causes, as well as STATCOM, which can meet all of these demands for voltage sag and swell compensations. A controller unit based on a modified Icos algorithm is proposed for STATCOM, which performs reactive power compensation and power factor correction while also providing real power support from renewable energy sources via STATCOM.

Keyword: ***Solar photovoltaic, Wind energy, Hybrid PV-Wind system, STATCOM, Voltage stability.***

1. Introduction

With the nonstop need for safe, dependable and quality electricity force, more protean styles of power generation are being enforced world-wide. Two technically grueling generalities to achieve the over stated thing are stated then. originally, renewable energy sources are made use of, due to the rising problems with the conventional reactionary energies and environmental factors. Secondly, a custom power device similar as STATCOM is used as an interfacing unit between grid, cargo and renewable energy source. The renewable energy source and STATCOM unit are driven by a simple algorithm called modified Icosφ algorithm, which provides the necessary reactive power compensation, power factor correction and also control of real power inflow from the source(grid) and renewable energy.

The theme of the paper is to ameliorate the power quality of force in locales where electric grids are weak or sensitive loads need to be defended against problems similar as low power factor, voltage regulation, and reactive power compensation. This paper also compares the performance of proposed modified Icosφ algorithm with the modified IRPT algorithm for STATCOM control.

The STATCOM is a power electronics device grounded on the principle of injection or immersion of reactive current at the point of common coupling(PCC) to the power network. The main advantage of the STATCOM is that the compensating current doesn't depend on the voltage position of the PCC and therefore the compensating current isn't lowered as the voltage drops. The other reasons for preferring a STATCOM rather of an SVC are overall superior functional characteristics, faster performance, lower size, cost reduction and the capability to give both active and reactive power, thereby furnishing flexible voltage control for power quality enhancement.

When a renewable energy source is used with power electronic interface, the need for the operation of fresh transformers and power exertion outfit's arises. The downsides of using these fresh circuits are high switching loss, increased costs and a largish system; hence the proposed scheme replaces the need for fresh transformers with a STATCOM unit.

The STATCOM unit is intended for reactive power compensation as demanded by the cargo; the STATCOM unit is an inverter with DC link capacitor which gets its control beats from a regulator circuit. The control beats are generated using modified Icosφ algorithm, which in turn causes the STATCOM to give the real power support from the renewable energy source and reactive power compensation as and when needed by the cargo.

2. Solar PV Management System

Number of PV cells are needed to produce high power in solar power generation system so for advanced power demand they're connected in series or in parallel for conformation of Solar Module or Solar panel and also form Array.

• PV Module

A group of PV cells are in series connection to form solar panel or module. A photovoltaic module is a methodical arrangement of series connected PV cells.

• PV Array

A group of solar panels or modules connected together electrically in series and resemblant structure to form

solar array and this solar array is responsible to produce advanced quantum of power.

The following figure 1 shows the conformation of solar model and solar array.

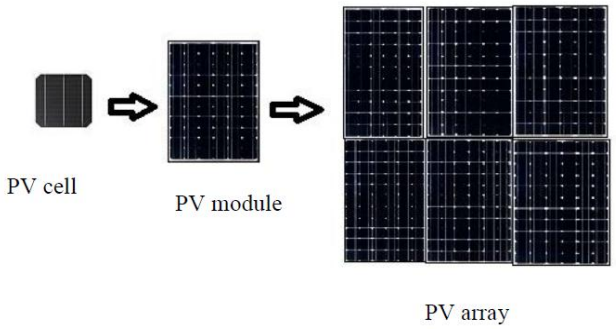

Figure. 1. Formation of solar Module and solar Array

Individual PV cells must be modelled in order to model a PV array. These PV cells are combined to form the PV array that is used in the MPPT technique. The physical appearance and mechanism of a solar cell are used to create an equivalent electrical circuit. Generally, two circuits are accepted as equivalent electrical circuits of solar cells: one is a simplified model of a single diode solar cell and the other is a circuit with two diodes, one for reflecting diffusion and the other for carrier. The equivalent circuit of a single diode solar cell is shown in Figure 2.

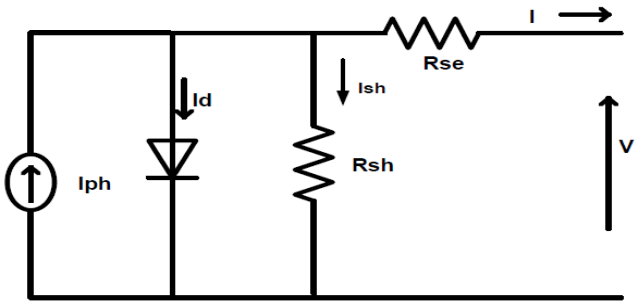

Figure.2. Equivalent circuit of single diode solar cell

Where, I_{ph} - Photocurrent
Id - Reverse saturation current of diode
I - Cell output current
K - Boltzmann constant (1.38 × 10-23 J/0K)
R_{se} - Series resistance of cell
R_{Sh} - Shunt Resistance
T - Temperature
V- Cell output voltage

The main effect of series resistance is to lower the fill factor, and extremely high values may also lower the short-circuit current. When Rse is very high, the MPP voltage drops. As a result, the resulting decrease in efficiency can be offset by lowering series resistance in PV cell applications. Power losses in PV cells are caused by low shunt resistance, which provides an alternate current path for the light-generated current. As a result of such a diversion, the amount of current flowing through the PV cell junction decreases, as does the voltage from the solar cell. Figure 2 depicts the use of the node equation.

$$I=I_{ph}- Id- Ish \quad (1)$$

$$I=I_{ph}-Isat(exp(q(V+I*Rse/aKT))-1)-(V+I*Rse/Rsh) \quad (2)$$

Where, ' a ' is the ideality factor and its value is between 1 and 2.

36 solar cells having 9 modules (85 watt each) are connected in series and resemblant connection to form a PV array with 1000 w/ m ² insulation using MATLAB/ SIMULINK.

3. Wind System

3.1 Basic of Wind System

Wind power is the conversion process of kinetic energy from wind into further useful forms similar as electricity by using wind turbines. utmost ultramodern wind power is generated in the form of electricity by converting the gyration of turbine blades into electrical current by means of an electrical creator. In windmills(a much aged technology), wind energy is used to turn mechanical ministry to do physical work, similar as pumping water. Wind power is used in large scale wind granges for public electrical grids as well as in small individual turbines for furnishing electricity to pastoral places or grid- insulated locales like in Sweden. Wind energy is generous, renewable, extensively distributed, cleans, and reduces poisonous atmospheric and hothouse gas emigrations if used to replace reactionary- energy-deduced electricity.

All wind systems correspond of a wind turbine, a palace, wiring, and the "balance of system " factors regulators, inverters, and or batteries. Home wind turbines correspond of a rotor, a creator mounted on a frame, and(generally) a tail. Through the spinning of turbine blades, the rotor captures the kinetic energy of the wind and converts it into rotary stir to drive the creator. Rotors can have two or three blades and the common wind system is using three blades type. The stylish suggestion of how important energy a turbine will produce is the periphery of the rotor, which determines

its " swept area, " or the volume of wind cut by the turbine. The frame is the strong central axis bar onto which the rotor, creator, and tail are attached. The tail keeps the turbine facing into the wind.

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4. Static Synchronous Compensator (STATCOM)

4.1 Basic Concept of STATCOM

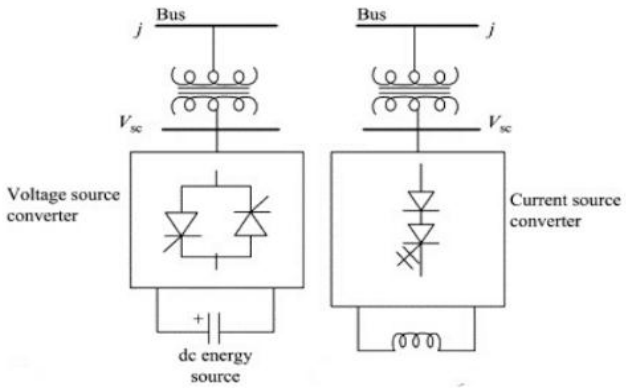

Figure. 3. Basic structure of STATCOM

STATCOM's basic structure is depicted in Figure 3. A Static synchronous Compensator (STATCOM) is a fast-acting device that can provide or absorb reactive current, thereby regulating the voltage at the point of connection to a power grid. It falls under the category of Flexible AC transmission system (FACTS) devices. The technology is built around a voltage source converter (VSC) with semiconductor valves in a multi-level modular configuration. The dynamic reactive current output range is symmetrical (under normal disturbed network conditions), but non-symmetrical designs are possible by incorporating mechanically or thyristor switched shunt elements with unified control systems to cover the majority of conventional applications. The STATCOM design and quick response make the technology very useful for maintaining voltage during network faults (because STATCOMs can provide fast fault current injection limited to the rated current), enhancing short-term voltage stability. STATCOMs could also provide power factor correction, reactive power control, damping of low-frequency power oscillations (typically via reactive power modulation), active harmonic filtering, flicker mitigation, and power quality enhancements. Typical applications include electric power transmission, distribution, heavy industrial plant electrical networks, arc furnaces, high-speed railway

systems, and other electric systems where voltage stability and power quality are critical.

4.2 Technology of STATCOM

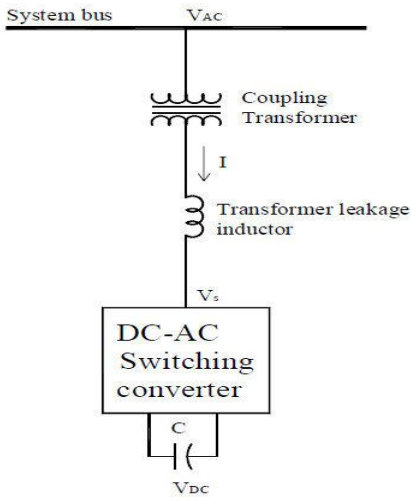

Figure. 4. Basic Configuration of STATCOM

Figure 4 depicts the fundamental configuration of STATCOM. A typical STATCOM configuration includes IGBT-based multi-level VSC, phase reactors, and a step-up transformer. It is grid-connected via shunt. A controlled internal voltage waveform is used to provide or absorb reactive current. The majority of STATCOMs on the market today operate as grid following converters and require a grid voltage reference to function (with a defined level of grid strength). The response of the voltage waveform is adjusted in relation to the grid connection point voltage. In general, STATCOMs operate as AC current controlled devices, though control of the output current is accomplished through amplitude regulation of the STATCOM internal voltage (behind the phase reactor), with the angle close to 90 degrees with respect to the grid connection point voltage. Capacitive reactive power is provided to the grid if the STATCOM voltage amplitude is greater than the system voltage amplitude. If current flows from the system to the STATCOM in the opposite direction, inductive reactive power is provided. The amount of reactive current is limited by the thermal limits of the IGBTs and is determined by the transformer short circuit reactance and voltage difference. When the system voltage is within certain limits, both voltage amplitudes are equal, and no reactive power is exchanged with the grid, the system is operating normally. If the grid voltage exceeds a certain threshold, STATCOM control will reduce the amplitude of the STATCOM voltage waveform, causing the STATCOM to act as an inductive element and absorb reactive power from the grid. When the grid voltage exceeds a certain threshold, the magnitude of the voltage waveform increases, causing the STATCOM to act as a capacitive element and supply reactive current to the grid.

5. Comparison of Series and ShuntControllers

• Series controllers are used to control current or power flow as well as dampen oscillations.

• Given MVA size, series controllers are several times more powerful than shunt controllers.

•Shunt controllers are current sources that can draw or inject current into a line. To learn more

• Shunt controllers are preferred for managing voltage at and near the point of connection because they effectively regulate voltage and dampen voltage oscillation. These controllers inject reactive currents that are either leading or lagging, or both active and reactive currents.

•Shunt controllers service the bus node regardless of the lines connected to it.

Table 1: Comparison for Different Facts Controllers

S.NO	CONTROL ATTRIBUTES	FACTS CONTROLLERS					
		TCSC	SSSC	TSSC	STATCOM	SVC	UPFC
1.	Power flow control	✓	✓	✓			✓
2.	Voltage profile improvement				✓	✓	✓
3.	Line commutated	✓		✓		✓	
4.	Forced commutated		✓		✓		✓
5.	Voltage source converter		✓		✓		✓
6.	Current source converter	✓	✓	✓	✓	✓	
7.	Transient and dynamic converter	✓	✓	✓		✓	✓
8.	Damping oscillation	✓	✓	✓	✓	✓	✓
9.	Fault current limiting	✓		✓			✓
10.	Voltage stability	✓	✓	✓	✓	✓	✓

6. Methodology

In this paper, the detailed comprehensive performance analysis of Wind Photovoltaic mongrel energy systeminter-connected to the grid via power- electronic interfacing were shown. To gain a more practical script, variable AC cargo is employed in the system along with intermittent power sources of solar PV and WEC system in an attempt to introduce severe dynamics into the mongrel system. This basically drives a necessity for a source of variable reactive power so as to maintain a voltage profile at the cargo machine. In these circumstances, STATCOM is imaged to be a choice of the device as the same has been vindicated to ameliorate the voltage regulation in insulated mongrel systems as suggested by several studies.

Figure 5 shows the block illustration of methodology to ameliorate the power quality issue similar as voltage slack and swell of wind- solar mongrel power system. The affair of solar PV array are given to the DC to DC motor for boosting purpose and the affair of wind turbine is given to the PMSG to induce the AC force, afterword it given to the Rectifier to convert it into DC because affair of solar is DC. The affair of both(wind and Solar) are given to the 3 phase Inverter which is grounded on set of firing angle which initiated by direct axis and quadrature axis factors of cargo current and reference current comparisons. That affair power of Inverter is also fed to the coupling motor for synchronization with power system. Coupling motor is coupling the power system and main AC grid transmission lines.

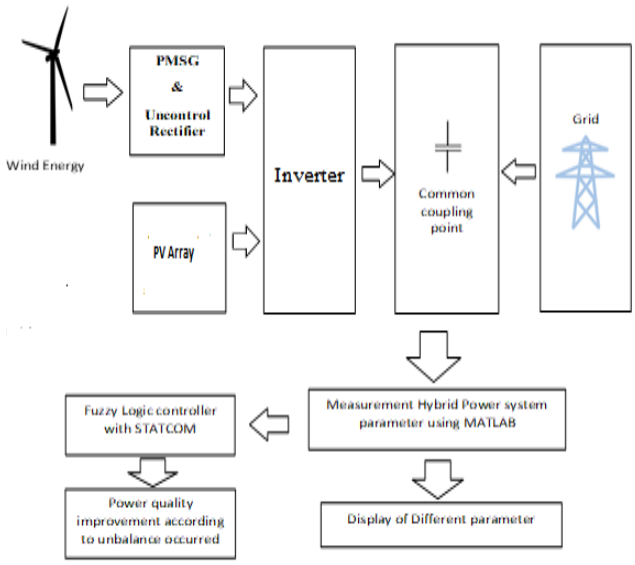

Figure. 5. Block Diagram Of Methodology To Improve The Power Quality Issue

CONCLUSION

This study provides a complete review of the methodology to ameliorate the power quality issues of the solar and wind mongrel system. The complete study of Solar and wind system were bandied collectively. The Wind and Solar mongrel system uses a STATCOM grounded regulator to enhance the system's power quality. This study shows the introductory idea that how well the STATCOM bettered voltage regulation and the responsibility of similar systems. Its effectiveness in each case state is estimated using both the dynamic terrain and flash responses. A tubular comparison study on the variety of different Data regulator bias. From the comparison table it shows that the STATCOM is a much better and further suitable for perfecting the systems power quality issues. Also, STATCOM mitigates the actuality of fresh reactive power inflow on the road and suppresses its negative goods, allowing the voltage profile to be successfully maintained. therefore, it's shown that STATCOM is necessary for the mongrel system to operate in grid integrated mode in order to indeed modestly increase system performance and STATCOM can stabilize the voltage at the connecting machine by conforming reactive power and might give the serviceability with a astounding response if these systems serve as anticipated and are held responsible. This approach only took into consideration direct stacks that were precisely still, these heaps are uncommon in power networks. Non-linear and inductive motor stacks make up the maturity of wise stacks, and any system disturbances like harmonious injections and current unbalance are added. unborn studies may indeed incorporate the integration of similar intelligent piles into a mongrel grid- integrated RES terrain to exploration the goods on system dynamics and probe the eventuality for different Data regulators to perform a variety of tasks against harmonics and current imbalance.

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