International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, February 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Compensation of Sag by using Distributed Generation

Anuja Kanase[1], Anjum Tamboli[2],Pritam Desai[3]

[1,2]*Department of Electrical Engg.,NMCOE, Peth., (India)*

[3]*Department of Electronics & Telecommunication Engg. NMCOE,Peth, (India)*

ABSTRACT

Power quality (PQ) is one of the most discussed topics in power industry. It is simply the interaction of electrical power with electrical equipment. If electrical equipment operates correctly and reliably without being damaged or stressed, we would say that the electrical power is of good quality. There are numerous types of power quality issues like Transients, Interruptions, Sag or under-voltage, Swell or Overvoltage, Waveform distortion, Voltage fluctuations, Frequency variations which are due to the use of sensitive power electronic equipment's and non-linear loads in industry, commercial and domestic applications. In the thesis we will use Fuel cell and wind generator as DG sources.Boost converter is used for boost the output of fuel cell and then by using inverter it covert Dc to AC. In the wind generation DFIG is used as generator which gives large power output, mostly it used for wind generation.

The scope of this Project covers Power Quality issues of Distributed Generation of Smart grid with Storage devices. MATLAB software is used for simulation. Studied about the types of power quality issues and select one issue sag, which is become common issue. Fuel cells and wind generators are used as a Micro grid which of 0.5 MW and 1.5 MW rating respectively. If sag occurs in the system it will be cover by using injection transformer. To recover sag battery will be used as an inverter input. Control signal will give to the inverter and by using control signal the sag will cover by injecting voltage.

Key words: Voltage Sag, Distributed Generation, MATLAB

I.INTRODUCTION

Distributed generation is a generation of electrical energy through alternate energy-producing resources close to the load sites [1]. It is connected to the utility grid system at a Point of Common Coupling (PCC) to alleviate the expansion of present electric transmission system. Power Systems are experiencing immense growth in the field of Distributed Generation (DG) because of economic benefits, environmental concerns, reliability requirement etc. Today there is rapid growth of the use of DG at distribution level in restructured power system. This is due to the obvious advantages like increase in reliability of supply, voltage profile improved and reduction in transmission loss

IEEE Std.1547-2003 gives the upgraded information on interconnection between distributed generators and the utility grid. In the last few years, due to incredible growth of internet and data centres, industrial loads, power quality is an indispensable aspect for an increasing number of critical loads. Critical loads are the loads which require uninterruptable and quality power supply. So the power quality issue has become a concerning issue [2][3]. How to interconnect the new energy power generation with power system safely and reliably is a major challenge in the development of smart grid. In this work various sources will be used like, Wind Generator, Fuel cell and utility supply. The control circuitry will be used for controlling the supply side and load side. When the load is less, the costly source can be switched off. When supply needs are more then we can use all the generation sources of the grid.

II. TYPES OF POWER QUALITY ISSUES

Any deviation from normal specifications of voltage (either DC or AC) can be classified as power quality issues.

Power quality issues classified as,

- Transients
- Interruptions
- Voltage Sag
- Voltage Swell
- Waveform Distortion
- Voltage Fluctuations
- Frequency Variation

1. Transients: there are two types of transients

i] Impulsive Transients: Impulsive transients have sudden high peak events that raise the voltage and/or current levels in either positive or a negative direction. These types of events can be categorized further by their speed at which they occur (Fast, Medium and Slow).Transients are caused due to lightning, poor grounding, switching of inductive loads, utility fault clearing and Electrostatic Discharge.

ii] Oscillatory Transients: An oscillatory transient is a sudden change in steady state condition of signal's voltage, current, or both, at both positive and negative signal limits, oscillating at the natural frequency. It occurs when we turn off an inductive or capacitive load, such as motor or capacitor bank.

2. Interruptions: An interruption occurs when the supply voltage or load current decreases to less than 0.1 pu for a period of time not exceeding 1 min. Interruptions are caused due to faults on the system. The faults might occur due to deviation from electrical parameters or even due to lightning strikes, animals, trees, vehicle accidents, destructive weather and equipment failure.

3. Voltage Sag: Sag is a reduction in AC voltage at a given frequency for the duration of 0.5 cycles to 1 minute's time. Sags are usually caused by system faults, and are also often the result of switching on loads with heavy starting currents.

4. Voltage Swell: A swell is an increase in AC voltage at a given frequency for the duration of 0.5 cycles to 1 minute's time. Sudden load reduction, High impedance neutral connection and single phase fault on three phase system can cause result into voltage swell.

5. Waveform Distortion: There are five types of wave distortion DC offset, Harmonics, Interharmoics, Notching and Noise.

DC offset: The presence of a dc voltage or current in an ac power system is termed dc offset. Direct current in ac networks can have a detrimental effect by biasing transformer cores so they saturate in normal operation. This causes additional heating and loss of transformer life. Direct current may also cause the electrolytic erosion of grounding electrodes and other connectors [4].

Harmonics: Harmonics are waveforms having frequencies which are multiple of fundamental frequency with reduction in amplitude. Symptoms of harmonic problems include overheated transformers, neutral conductors, and other electrical equipment's, as well as tripping of circuit breakers. n^{th} harmonic will have $n*f_1$ frequency and 1/n times amplitude of the fundamental.

Interharmonics: Voltages or currents having frequency components that are not integer multiples of the frequency at which the supply system is designed to operate (e.g., 50 or 60 Hz) are called Interharmonics [4].

Notching: Notching is a periodic voltage disturbance caused by the normal operation of power electronic devices when current is commutated from one phase to another. Due to notching system halts, data loss and data transmission problems.

Noise: It is unwanted voltage or current superimposed on the power system voltage or current waveform. Noise can be generated by power electronic devices, control circuits, arc welders, switching power suppliers, radio transmitter and so on. Due to noise causes technical problems such as data errors, equipment malfunction, distorted video displays.

6. Voltage Fluctuations: A voltage fluctuation is a systematic variation of the voltage waveform or a series of random voltage changes of small dimensions namely 95% to 105 % of nominal at a low frequency, generally below 25 Hz.

7. Frequency Variation: Frequency variation is extremely rare in stable utility power system, especially system interconnected via power grid.

III. MODELLING OF PROPOSED SYSTEM IN MATLAB

3.1 Proposed System

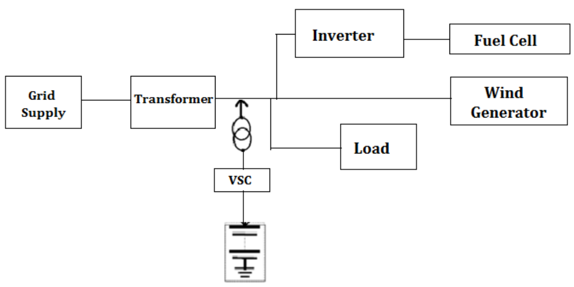

Figure 3.1: Block diagram of Proposed System

Above figure shows a microgrid, this consists of Wind Generator, Fuel cell as a sources used. Wind generator is on another side of the smart grid which is infinite grid and about 1.5 km from the smart grid. In this total system suppose fault occurs, then by using injection transformer, voltage can be injected to clear the fault. A load connected in the system is of dynamic type. Figure 4.1 shows the block diagram of the proposed system which is simulated in the MATLAB Simulink. In the system for conversion purpose the DC to DC and AC to DC converters are used. The load is connected between Supply Grid and smart grid.

When fault occurs at the supply grid side then we clear the fault by injecting the voltage in the system at that time. Sag occurs due to the short circuit and energization of motor. At the time of fault, the current flows through the impedance. At the starting time of motor the current is very high. Wind and hydrogen fuel both are clean energy sources which do not emit hazardous gases in the environment. So from the point of view of environment safety this both DG's are better. This proposed system is simulated in MATLAB Simulink.

3.2 Simulation of Proposed System in MATLAB

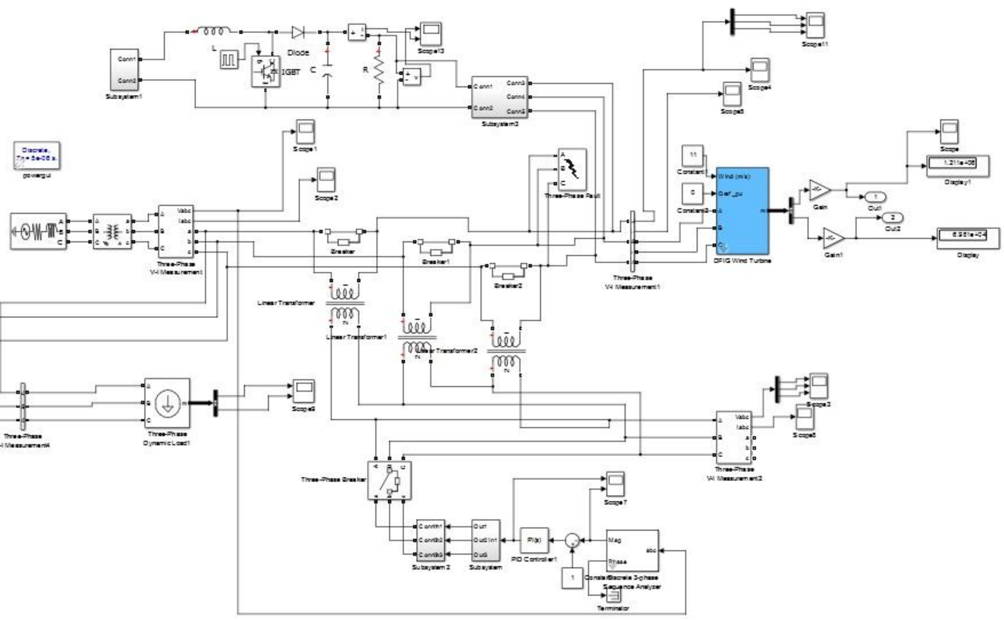

Figure 3.2: Simulation of Proposed System in MATLAB

The proposed block diagram is simulated in MATLAB Simulink as shown in fig. 4.2. The system shows Grid supply, wind generator, Fuel generator, load and converters. Here we have taken the Fuel cell and wind generator as DG's. In the MATLAB Simulnk the fuel stack is of 50 kW, but we want the rating of fuel cell 0.5 MW so we connected the 10 fuel cell stacks in parallel and gets expected power rating and wind generator is of 1.5 MW. The control circutrary is used for recovery of sag. Voltage measurement block is used for the measurement of voltage.

The system consists of DC to DC and DC to AC converter. The load is connected between the Main supply grid and smart grid. For the time of 0.35 second, system is simulated. The load used system is dynamic in nature. The scopes are used for the observing the voltage and current waveforms and floating scope shows value for the quantity which we have to measure. Doubly fed induction type generator is used in wind generation system. There are two types of converters in the DFIG one Stator side converter and another is rotor side converter so it is called as doubly fed induction generator. In the Fuel cell, hydrogen is mainly used as a fuel and some amount of oxygen. Boost transformers are used in the system for injecting the voltage.

Table 3.1: Technical data for wind generator [5]

Input Parameter	Value
Generator rated MVA	1.5 MVA
Voltage	575 V
Electrical Frequency	60 Hz
Rated wind speed	11 m/s
Mechanical output power	1.5 MW
Generator Type	DFIG

3.3 Results in MATLAB

3.3.1 Results of System When no fault in the system

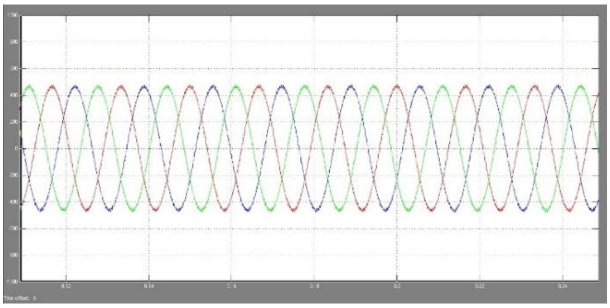

Figure 3.3: Voltage waveforms at normal operating system

Given figure 4.5 shows the three phase voltage waveform when system is in normal condition. It shows voltage upto 470 volts

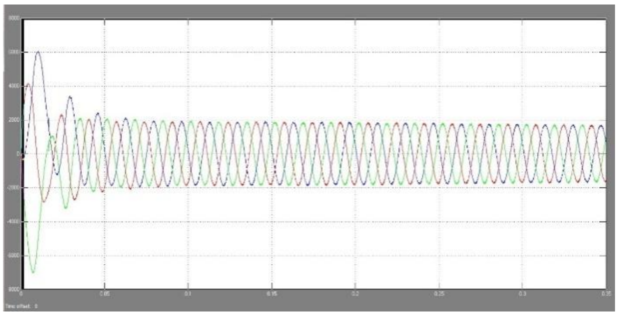

Figure 3.4: Current waveforms at normal operating system

Three phase current waveform is in figure 4.6 shows the current upto 2000 amperes which depends on load characteristics.

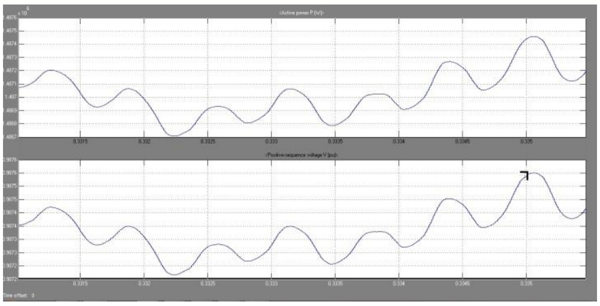

Figure 3.5: Load side results in MATLAB Simulink

Two graphs shown power verses time and voltage verses time in the figure 4.7 of load characteristics. The load is dynamic in nature and showing power upto 1.48 MW.

3.3.2 Results when Fault occurs at Main Grid side

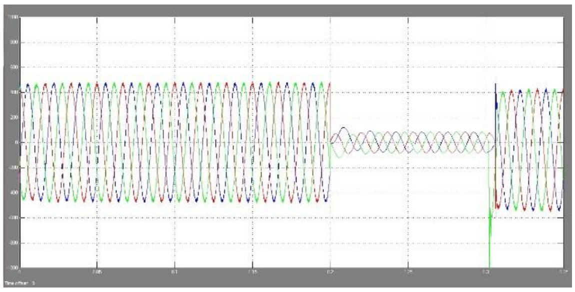

Figure 3.6: When fault occurs at main grid side

Figure 4.8 shows sag from 0.2 to 0.3 seconds, in this period voltage reduces upto to 75 to 80%. Three phase fault occurs between intervals 0.2 to 0.3, which shows sag.

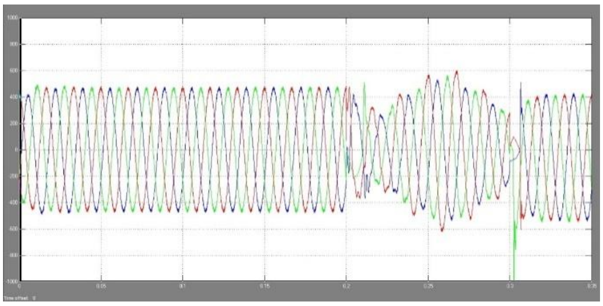

Figure 3.7: Sag recovery using voltage injection method

Figure 4.9 shows the sag recovery by using voltage injection method. When fault occurs 0.2 to 0.3 the breakers become open and the signal gives to the 3 phase sequence analyzer, then PI controller compares the reference voltage and given signal, it gives driver to zero the error. To mitigate the sag required voltage inject in the system by using injection transformer through inverter and control gate pulse.

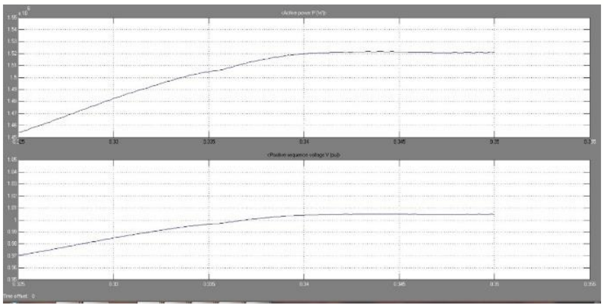

Figure 3.8: Load side results when fault occurs at main grid side

Load is of 1.5 MW, the figure 4.4 shows load characteristics. It contains Power verses time and voltage verses time characteristics. Initially the power is low and increases as time increases. It shows that due to voltage injection method the sag recovers and no any problem to the load i.e it shows no any voltage disturbance in the system.

3.3.3 Results when Fault occurs at Micro Grid side

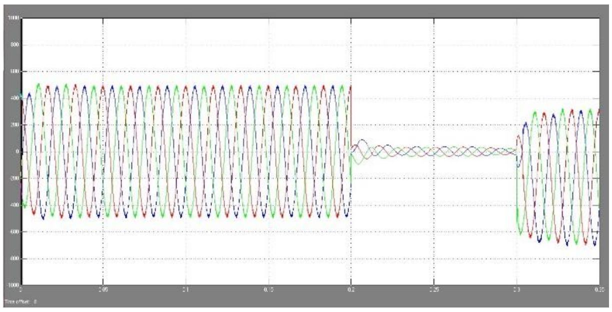

Figure 3.9: when fault occurs at micro grid side

Figure 4.11 shows the Voltage sag between the time intervals 0.2 to 0.3 when fault occurs at microgrid side. Voltage reduces at this 0.2 to 0.3 time intervals.

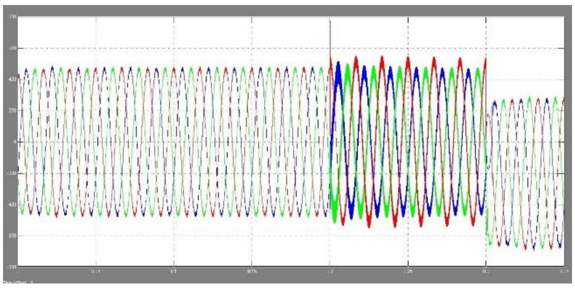

Figure 3.10: Sag recovery using voltage injection method

Figure 4.12 shows the Sag Recovery at time intervals 0.2 to 0.3 by using voltage injection method. Required voltage inserted in the system to restore voltage, control circutrary is used for compensation of sag at given interval.

IJARSE
ISSN: 2319-8354

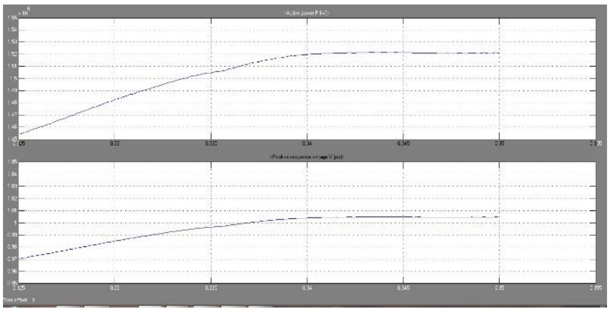

Figure 3.11: Load side results when fault occurs at main grid side

The figure 4.13 shows the power verses time and voltage verses time characteristics of load. At starting the power and voltage is low and it increases as load increases.

IV.CONCLUSION

Wind generator and hydrogen fuel cell are connected to the supply grid at the point of common coupling. To connect the DG sources in the grid converters are used like DC-DC converter and inverter. Fuel cell is of 0.5 MW and wind generator of 1.5 MW capacities. Supply grid is of 11 kV and it will be step down by using Step down transformer. Here we studied in the system about the sag and recover it by using dynamic voltage restorer. For the simulation of the proposed system MATLAB Simulink is used.

In the system the dynamic load is connected in the system of 1.4 MW. Due to the sag occurs in the voltage the sensitive equipment get damaged to avoid this we have to recover the sag. By using dynamic voltage restorer we can recover the sag this is done in this thesis. Fault comes at supply grid side then by using DVR method it can be recovered by smart grid side and if fault occurs at smart grid side it recover by supply grid side.

REFERENCES

[1] Thomas, M.S.; Terang, P.P., “Interconnection Issues for Distributed Resources in a Smart Distribution System” IEEE 5th India International Conference on Power Electronics (IICPE), 6-8 Dec. 2012

[2] Sugirtha, M. G.; Latha, P., “Analysis of Power Quality Problems in Grid Connected Wind Power Plant” International Conference on Recent Advancements in Electrical, Electronics and Control Engineering, 15-17 Dec. 2011

[3] Thomas, M.S.; Terang, P.P., “Interconnection Issues for Distributed Resources in a Smart Distribution System” IEEE 5th India International Conference on Power Electronics (IICPE), 6-8 Dec. 2012

[4] Roger C. Dugan, Surya Santoso, “Electrical Power Systems Quality” McGraw-Hill Second Edition, ISBN-13:978-0-07-026462-5, 2002.

[5]Yazhou Lei, Alan Mullane, Gordon Lightbody, and Robert Yacamini, “Modeling of the Wind Turbine with a Doubly Fed Induction Generator for Grid Integration Studies” IEEE Transactions on Energy Conversion, Vol. 21, No. 1, March 2006.

[6] R. C. Bansal, Senior Member, IEEE, T. S. Bhatti, and D. P. Kothari, "Bibliography on the Application of Induction Generators in Nonconventional Energy Systems" IEEE Transactions on Energy Conversion, Vol. 18, No. 3, September 2003.

[7] Bimal K. Bose, "Modern Power Electronics and AC Drives" ISBN-0-13-016743-6, 2002.

[8] Zanei, G.; Cevenini, E.; Ruff, H; Ulibas, O., "Integrated Systems for UPS: New Solutions in the Power Quality Chain"29th International conference, Telecommunication Energy Conference, 30 Sept. – 4 Oct. 2007

[9] Ke Dang; Huifeng Zhao; Jiqing Yu; Tong Dang, "Study on Interconnection Standards ofPhotovoltaic Power Generation" International Conference on Electrical and Control Engineering (ICECE), 16-18 Sept. 2011

[10] A .Farzanehrafat, Student Member, IEEE, and Neville R. Watson, Senior Member, IEEE, "Power Quality State Estimator for Smart Distribution Grids" IEEE Transactions on Power Systems, Vol. 28, No. 3, August 2013.

[11] Andrzej M. Trzynadlowski, Senior Member IEEE, "Nonsinusoidal Modulating Functions for Three-phase Inverters" IEEE Transactions on Power Electronics, Vol. 4, No. 3, July 1989.