PRESERVATION AND EFFECT OF DISTRIBUTED SOLAR GENERATION AND FAULT CHARACTERISTICS

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ABSTRACT

Inverter-based distributed energy sources (DERs) are inverter-based distributed instruments for power, with a low current defect, negligible negative, and null series currents. In the analysis and protection of relays, an understanding of the fault properties of DER is necessary. Despite considerable work on DER modeling, no study was performed on the fault behavior of DER during actual fault events. This text addresses instances of faults of Dominion Energy. Stopper flaws are examined to show that the true response to DER errors could be different than before.The lock on the current relay is replaced by a counter-set lock, entirely triggered by the current relay until the cap is three times crossed. The current relay is now not closed for longer periods but only for small transient errors. For the different circumstances, the analysis is checked with the DER (PVA) on the counter-set reclosure over the actual relay.A sophisticated simulation platform was used to simulate any contribution with the MATLAB setting to this analysis. Verification shall be given where the simulation findings can be checked with other results published. However, more research is needed to prototype and validates rigorously the theories built using real-world networks so that the efficiency of the contributions made to this thesis can be thoroughly evaluated.

Keyword: - *DER System, MATLAB, Simulink Solar Power Generation Fault.*

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1. INTRODUCTION

The future active network would easily and securely link small to medium-sized energy sources to consumer requirements. As a backup power, DG is often used to improve capacity, delay maintenance in transmission and distribution networks, avoid network costs, reduce line losses, defer the development of large-scale generation projects, shift the expensive power from the grid supply system, provide customer alternatives and deliver environmental benefits. However, based on system architecture and management, these advantages cannot be valid. In recent years the DG has become an effective and fast-track alternative to traditional power sources, and modern technologies have made DGs commercially Table [1].

The term distributed or distributed generation refers broadly to any technology for an electric generation, which is applied near the point of use in distribution systems. The DG model compares with a traditional central electricity generation system in which power is produced and transmitted to end customers through transmission and distribution lines. Although central power systems remain essential to the global energy supply, they have diminished versatility in order to satisfy changing power demands. Central power consists of a large power plant with capital strength and the T&D grid for electricity dispersion.

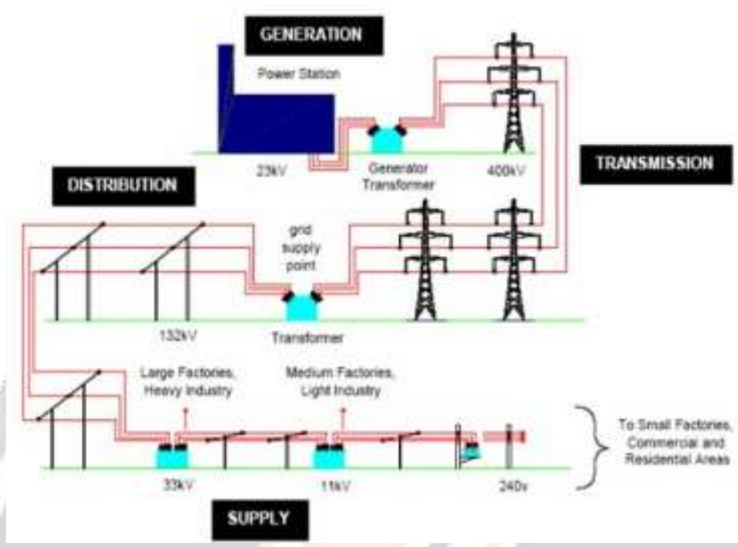

Figure 1 An electric power system

2. LITERATURE REVIEW

An analysis of different types of defects in distributed solar production, the safety gaps of traditional solutions, and existing methods for failure identification, classification, and protection solutions is addressed in this chapter. These current methods also discuss and compare the advantages and limitations.

(Kuna et al., 2020) [2] Evaluating past events for the fault of Dominion Energy. Power supplies of inverters, DERs, and Zero negative and 0-series feature low current loss. In the case of fault analysis and secure relay implementation, the knowledge of DER fault properties is important. While there was ample DER modeling work, there were few inquiries into DER failure behavior.

(Shinde and Deore, 2020) [3]Impact analysis and identification of defects in real-time are achieved by Back propagation in his article. The efficiency of a flawed electric, solar photovoltaic module has been compared with its dynamic and complex process model by quantifying the correct differential residue that could be connected to it by simulating various failure conditions. In order to produce data for neural network analysis of the various forms of defects, the deformations and defects caused by I-V and P-V curves were analyzed.

(Christopher, Rengaswamy and Prakash, 2020) [4] proposed to evaluate the grid PV system with new PR controllers for fast sync, and the hybrid swarm cuckoo search optimization algorithms (HSCS) are used to select the best parameter for control pulses. The proof is performed according to the SIMULINK model. This research is performed by the solar- based distributed generator. The photovoltaic grid-related, the grid will absorb the energy from the photovoltaic panel and disperse the energy in the dark. As a distributed electricity supply, the grid and PV frame can be applied.

(Kasulkaret al., 2020) [5] aim is to detect fault positions from the point of development of the delivery and transmission system by power system engineers. Simple or rapid identification of faults can help to protect the system by allowing the disconnection of defective lines before significant harm is done, as energy leakages have been one of the major problems the organization has faced in recent times. The electricity transmission lines, which run millions of miles across the world, are virtually impossible to solve this difficulty is to come up with a system that can identify the error in a voltage conduction line without human intervention and intimate the authorities with a detailed position.

(Alsafasfehet al., 2019) [6] Develops the basic node-system and power-system analysis principle for PV energy sources with voltage fluctuations restrictions of the Institute of Electrical and Electronics Engineers (IEEE) for usable capability maximizations problems. For performance review and assessment of the work performed, a simulator MATLABR2017B is used. The potential integration spectrum of PV electric power is evaluated by simulation of the 33-node IEEE system, and the overall integration potential of PV power is measured at each node, which provides a logical decision- making system for the preparation of the integration of the distributed PV electricity into a limited power grid.

(Faria, 2019) [7] Discusses energy delivery resource management that is becoming more and more necessary to ensure that energy and energy networks are reliable and efficient. The emphasis is on methods and strategies for efficient activity, aggregating and rewarding capital by virtual energy players. The key route to the effective utilization of energy is also discussed in the introduction of dispersed capital in power markets. At the delivery level, but at the power system management level too, the role of distributed energy infrastructure on the operation of power and energy networks is now undeniable. There is a need for greater versatility in the intermittent generation and charging for electric vehicles.

Distributed Generation is generation of electrical power from renewable energy, situated near to clients or loads, is transmitted here. Distributed generation installations may enhance the voltage and energy efficiency, alleviate stress slumps, minimize congestions, and provide more competitive renewable energy resources power. However, high Distributed Generation penetration in the current national grid system may have many consequences, including failure level and power protection efficiency.

3. CONTROL STRATEGY

The principal distinction between a traditional plant and a solar plant is that it is difficult to control the primary energy source even though it is unpredictable. In addition to the seasonal and regular cyclic shifts, the level of solar radiation often relies on atmospheric conditions such as cloud cover, moisture, and air clarity. As a result, certain issues that are not faced in other thermal power stations must be dealt with in a solar plant. The control mechanism in a dispersed collector area aims, considering the disruptions such as changes in the solar irradiance level (caused by clouds), mirror reflectivity, or inlet oil temperature, at maintaining the outlet oil temperature of the loop (or the highest outlet oil temperature reached by one of the collectors per time sampled). The available means for this can be by fluid flow modification, and the regular features of the solar power cycle result in significant adjustments in the flow of oil during service. This leads to substantial variations in the dynamic characteristics of the sector, such as the response rate and dead time, which make the operational range with a fixed parameter controller difficult to achieve adequate output. [8]

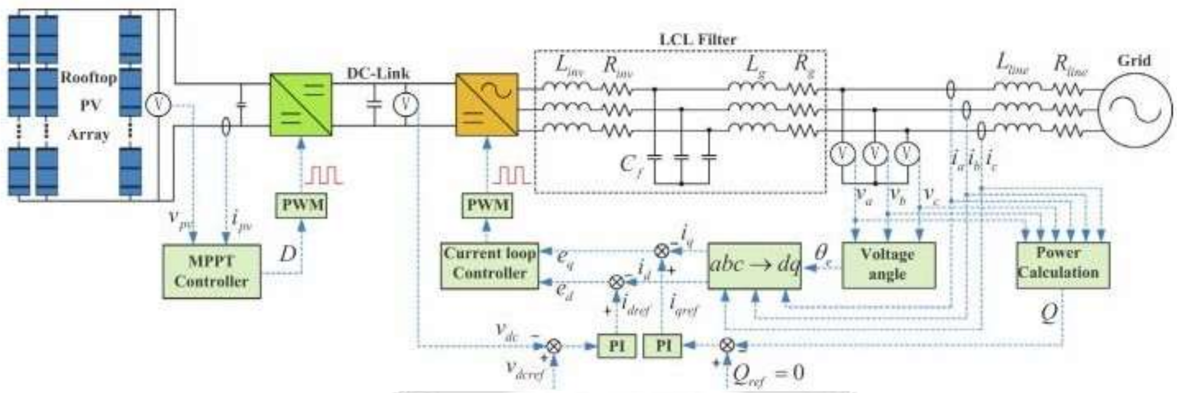

Figure 2 Conventional control diagram of a domestic solar PV power generation system

3.1 Working of Photovoltaic Cell.

A photovoltaic cell (PV) cell is known as a p-n crossover diode with the occurrence of sunlight on its p-n crossing. A variety of classes of photovoltaic cells consist of semiconductor processes. The polycrystalline and mono-crystalline diodes of silicone are currently primarily used in numerous applications. Silicon PV diodes are composed of a thin sheet of silicone or a thin silicone film electrically plugged in. Doping is carried out in p-n semiconductor form on one side Si PV surface. The sun-faced side of the cell, as seen in the Figure, is shielded by a thin metallic film. The photoelectric effect is the concept of photovoltaic cell operation that causes the electron to be released from the conductive band as sunlight falls into the PV cell. The semiconductor layer absorbed part of the photon energy in the PV cell when the sun events happened on its surface. If the absorbed energy is greater than the semiconductor belt energy, the electron leaves the valence band and is then formed in the semiconductor material with pairs of holes electrons. Now, these electrons can move freely and are forced to move in a certain direction by applying the electric field, produced electricity that can be taken from the bottom and top side of the photovoltaic cell via a metal plate [9].

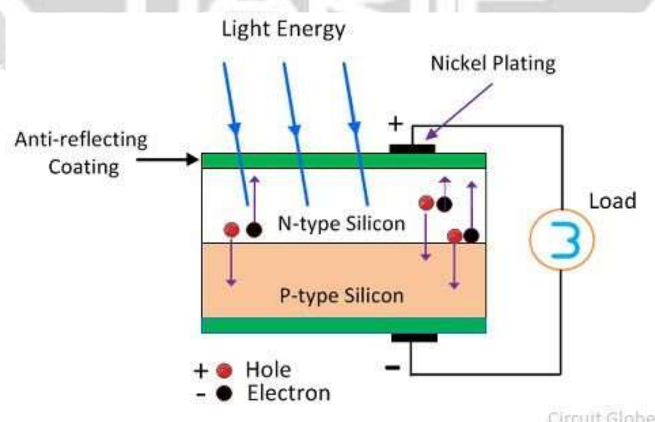

Figure 3 Photovoltaic Cell

3.2. Relay

A relay is a changeover mechanism, and it is used to separate or change the status of the electrical circuit between states. The relay is an automated defensive system that can detect anomalous states in electrical circuits. This is used as a reaction to one or more electricity quantities like voltage and current to open or close load contacts. The relays of energy networks, home appliances, motorcycles, automotive machinery, digital computers are all used for a wide range of applications [10].

Figure 4 Different types of relay

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5. WORKING

The simulation of a three-phase photovoltaic transmission system is integrated by a preview technique of a courant short circuit PVA and load controller. The technique is based on the current rise and the magnitude in a DER-based solar PV device. A standard feeder is the model of the study method. The transmission line delivers electricity from power sources to the load centers with limited losses. It's the most common approach used by electric grids worldwide for power transmission and a form of polyphase scheme. Next, the feeder is connected to the transmission line with a coupling transformer known as a transformer. In the electrical energy grid, transformers hold large positions as they are the critical connections between electricity generators and electricity usage points. The feeder from the transformer is then supplied with fuel. A feeder is a kind of transmission line that carries energy to the distribution point from the source station. They are similar to distributors in that there is no intermediary pressing, so both the transmitting and the receiving end have the same current flow. Power from the feeder is supplied to DER by means of POI reclosure and transformer. POI reclosure detects short, open, or back feed conditions of short circuits. The POI is an important predictor for the safety and control systems of the microgrid. Before DER, the POI recalibration is related to DER with the coupling transformer known as phase-down transformer. In the future, the DER stores PVA power. A PV array can provide direct power to light loads such as DC motors or lighting systems through the output current and stress.

6. RESULT

MATLAB is used to apply the proposed algorithm (R2016). The signal processing toolbox can be used for different approaches such as windows, rotating, scaling, etc., in MATLAB Library functions.

For this research work, the simulation is performed by using MATLAB. Here Sim Power System Toolbox is also used for designing the project. The table given below shows various parameters which have been used during this study and their values are also mentioned in the table. Some parameters are supply voltage, power, step-up down transformer, frequency, temperature, capacitor, resistance, etc.

Table 1 Different simulation parameters

Name of parameter	Unit and Value
Supply Voltage	132KV
Power	2500KVA
Step-up down Transformer	132KV/34.5KV
Power rating of step-up transformer	47MVA
Frequency	50Hz
Phase to phase voltage	34.5KV
Active Power	100KW
Reactive Power	50KVAR
Circuit Breaker Resistance	0.01 Ohm
Solar irradiation	1000 W/m^2
Temperature	35 Degree
Duty Cycle	0.5
Capacitor	1000 Micro Farad
Resistance	0.005 Ohm
Inductor	5Mh

6.1 Simulation Results

A simplified system schematic is shown in Fig.5. The studied faults are on the feeders and external to the solar sites. Fault data is collected by POI reclosers, which measure fault current contribution from DER inverters. The coordinated control system consists of a group of sensing devices, equipment controllers, data input devices and systems, as illustrated in figure shown below. None of the sites were operating at full power capacity when the fault events occurred.

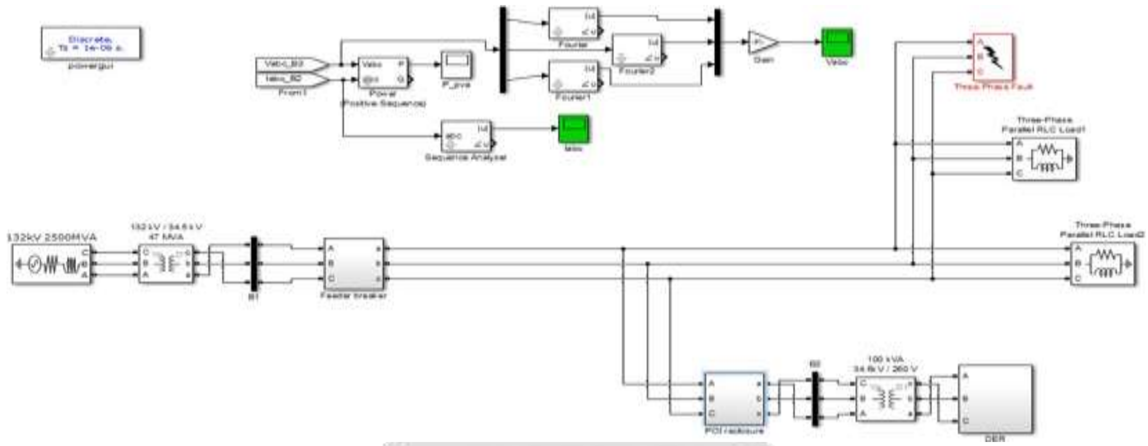

Figure 5 Simulation model without relay

A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current from an overload or short circuit. Its basic function is to interrupt current flow after a fault is detected. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.

Circuit breakers are made in varying sizes, from small devices that protect low-current circuits or individual household appliance, up to large switchgear designed to protect high voltage circuits feeding an entire city. The generic function of a circuit breaker, or fuse, as an automatic means of removing power from a faulty system is often abbreviated as OCPD (Over Current Protection Device).

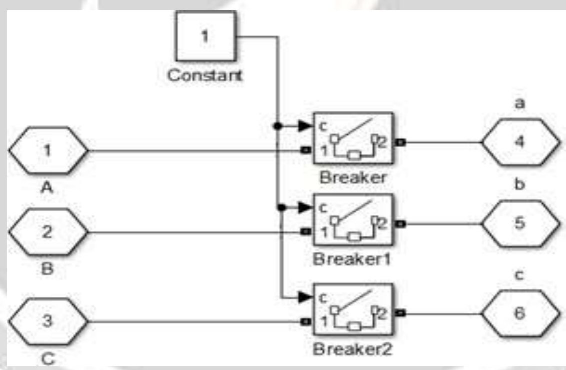

Figure 6 Circuit breaker with no relay protection system

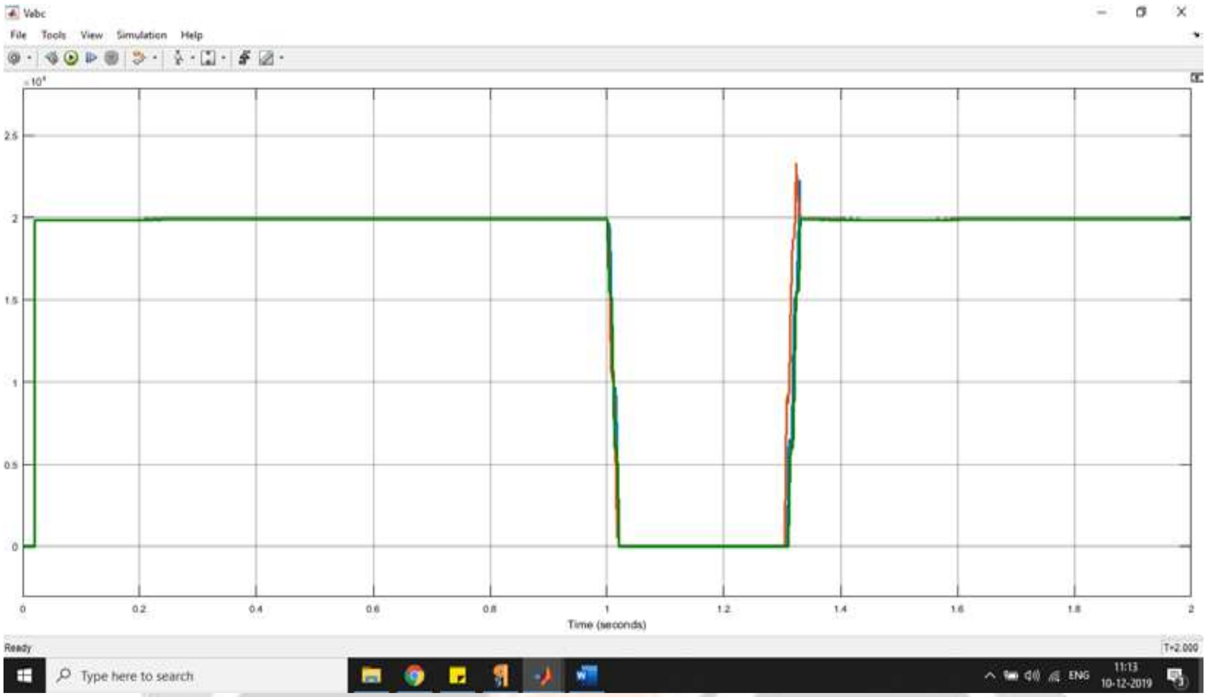

Figure 7 PVA voltages with no relay protection with fault from 1 to 1.3sec

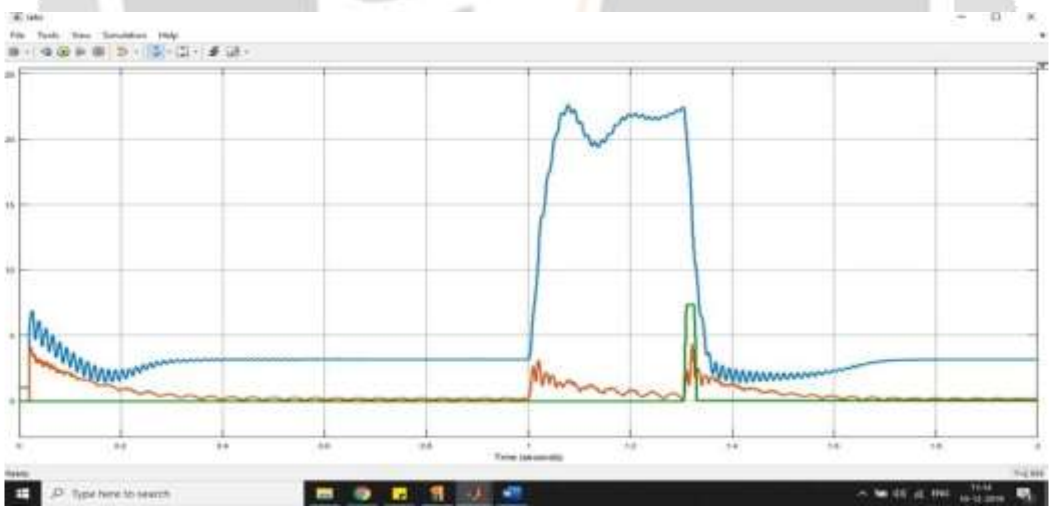

Figure 8 Sequence currents with no relay protection with fault from 1 to 1.3sec

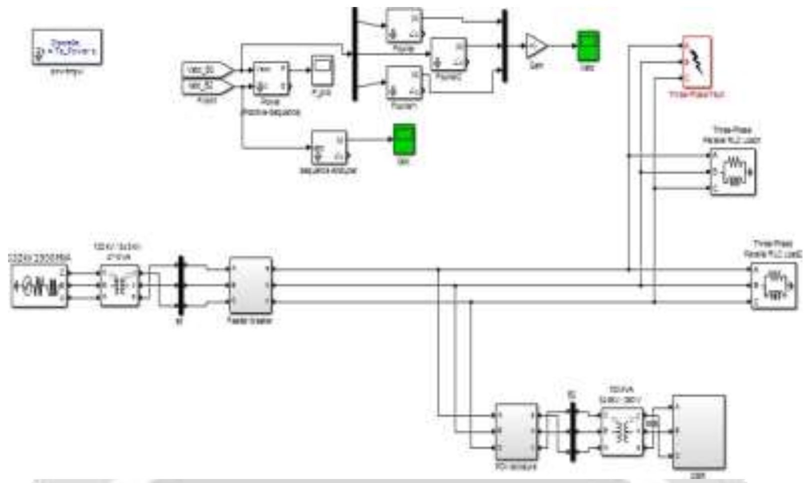

Figure 9 Proposed simulation model of counter set reclosure over current relay

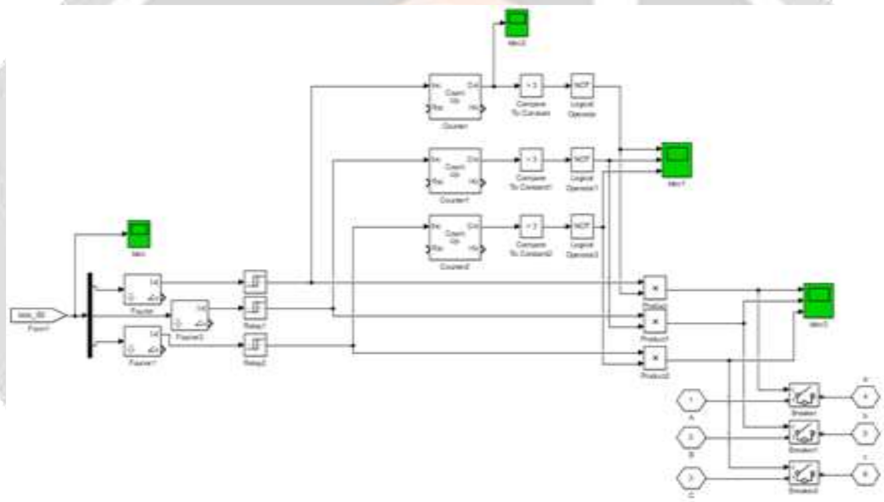

Figure 10 Circuit breaker with counter set reclosure over current relay

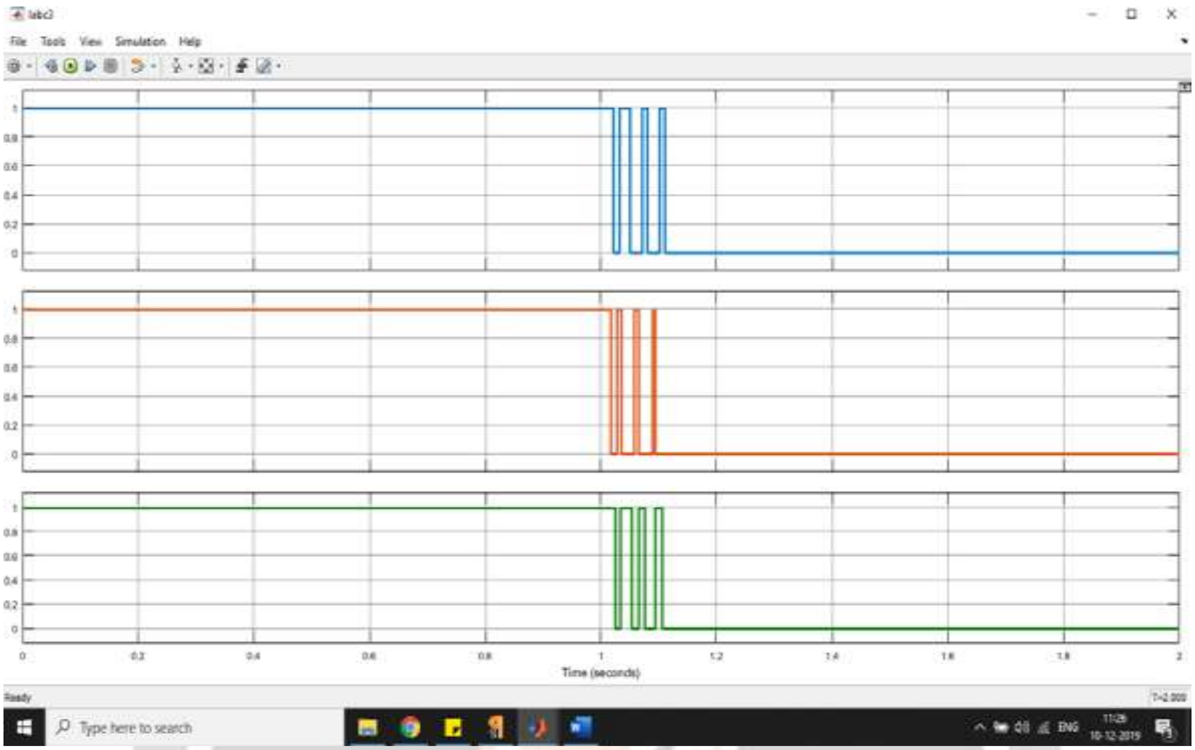

Figure 11 Triggering pulses of over current relay

The restricting times is limited to 3, after three times the relay completely triggers OFF and eliminate the fault from DER.

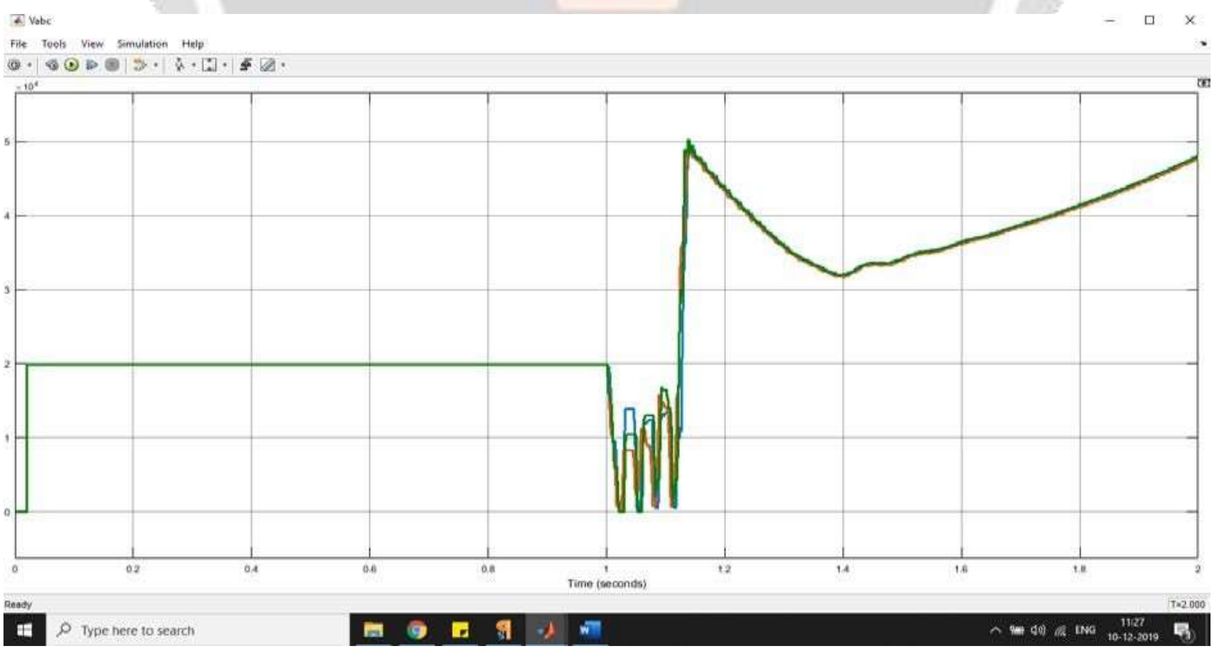

Figure 12 PVA voltages with over current relay protection with fault from 1 to 1.3sec

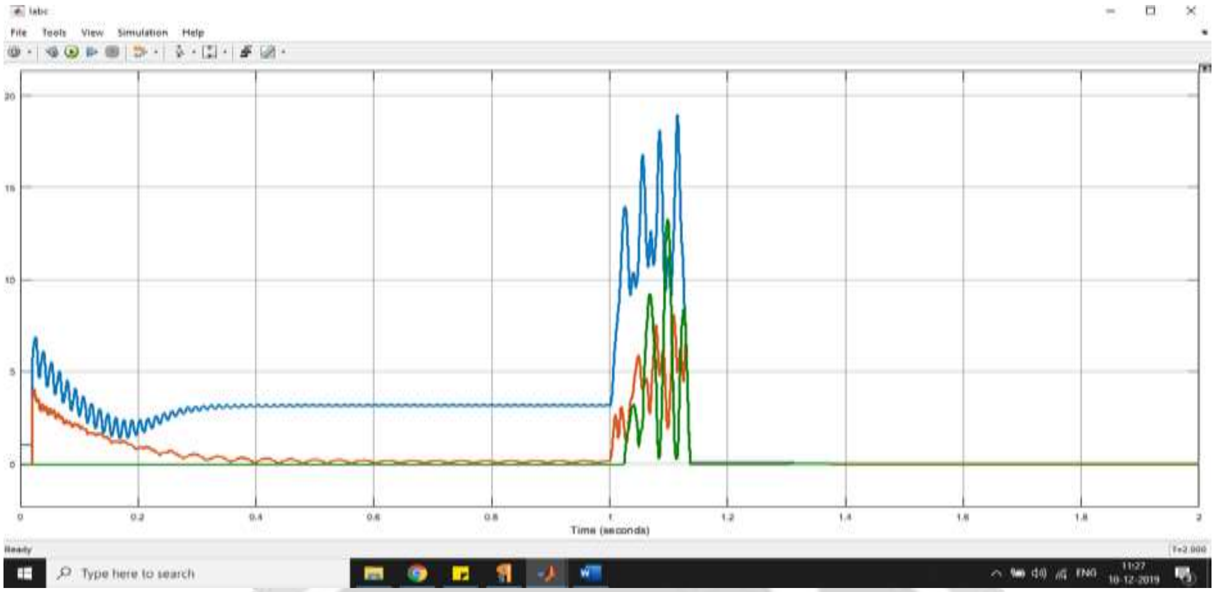

Figure 13 Sequence currents with over current relay protection with fault from 1 to 1.3sec

With the counter set reclosure over current relay is shown in fig 5.14 the number of restricting are limited with 3 times, which trigger the circuit breaker completely OFF when the fault is persistent beyond 3 times of reclosure.

7. CONCLUSION

Any numerical models, i.e. mathematical simulation models have limitations. A mathematical simulation model will provide correct simulation results to the type of phenomena to be observed or examined by including appropriate individual model component (such as protections, controls and capabilities). Thus, the proper selection of the mathematical simulation model needs to be performed by power system engineers in academia as well as in industry. However, the proper selection of the mathematical simulation model is not an easy task.

Distributed generation is expected to play a greater role in power generation over the coming decades, especially close to the end-use low voltage consumer side. There is a growing interest on the part of power consumers for installing their own generating capacity in order to take advantage of flexible DG technologies to produce power during favorable times, enhance power reliability and quality, or supply heating/cooling needs. The range of DG technologies and the variability in their size, performance, and suitable applications suggest that DG could provide power supply solutions in many different industrial, commercial, and residential settings. In this way, DG is contributing to improving the security of electricity supply.

Renewable technologies like photovoltaic still appear to be an expensive investment. On the other hand, the continuous reduction in their price combined with their low operation and maintenance costs will provide an environmentally friendly means of producing electricity. An important aspect of their operation is also that they produce electricity in hours of the day that most of it can be directly used avoiding storage losses.

Energy storage devices such as batteries and fuel cells are controllable components, with flexibility of operation and they can contribute in increased reliability and power quality.

The expansion of customers' potential investments in distributed generation in low voltage networks could be assisted in two general ways. One would be to standardize and clarify the rules and procedures governing the installation and operation of distributed generators and their interconnection with the grid. That approach could assist the approval process and help to reduce uncertainty about the requirements and costs of compliance. The second would be to set the prices that operators of distributed generators pay and receive for electric power, connection to the grid, and transmission and distribution services at levels consistent with the actual costs borne by utilities to provide those services. That change could give operators incentives to install and operate distributed generators at a level that would help to ensure the lowest cost of electricity for all customers.

If DG does take a large share of the generation market, the role of distribution utilities will become vastly more important than currently. There will be a need to reform distribution system design requirements to accommodate DG. Undertaking further studies to identify the technical capabilities, the operating strategies, and the skill requirements of distribution network operators would help prepare electricity markets for a more decentralized electricity system.

8. REFERENCES

[1] S. Singh, J. Østergaard, and N. Jain, "Distributed generation in power Systems: An overview and key issues," 24th Indian Eng. Congr. NIT Surathkal, Kerala, no. January, p. 8, 2009.

[2] P. Shinde and S. R. Deore, "Solar PV Fault Classification using Back Propagation Neural Network," Int. J. Recent Technol. Eng., vol. 8, no. 6, pp. 5568–5574, 2020, doi: 10.35940/ijrte.f9790.038620.

[3] A. V. Christopher, R. Rengaswamy, and P. Prakash, "Grid Variables Synchronization using Optimization Algorithm for Distributed Generation System under Grid Fault Conditions," Int. J. Recent Technol. Eng., vol. 8, no. 5, pp. 2658–2665, 2020, doi: 10.35940/ijrte.e6024.018520.

[4] P. P. S. Kasulkar, N. Thakur, S. Bankar, S. Rakhade, and A. Donge, "SMART OVERHEAD TRANSMISSION LINE PHYSICAL FAULT DETECTION BY IOT," pp. 2259–2263, 2020.

[5] Q. Alsafasfeh, O. A. Saraereh, I. Khan, and S. Kim, "Solar PV grid power flow analysis," Sustain., vol. 11, no. 6, pp. 1–25, 2019, doi: 10.3390/su11061744.

[6] P. Faria, "Distributed energy resources management," Energies, vol. 12, no. 3, pp. 10–12, 2019, doi: 10.3390/en12030550.

[7] E. F. Camacho, F. R. Rubio, M. Berenguel, and L. Valenzuela, "A survey on control schemes for distributed solar collector fields. Part I: Modeling and basic control approaches," Sol. Energy, vol. 81, no. 10, pp. 1240–1251, 2007, doi: 10.1016/j.solener.2007.01.002.

[8] A. Kumar, M. Lal Azad, and R. Kumar Chandi, "Modelling of PV Arrays-An effective approach," Int. J. Appl. Eng. Res., vol. 14, no. 12, pp. 2850–2854, 2019.

[9] M.Biswal and S. Sabyasachi, "A Study on Recent DC-DC Converters," Int. J. Eng. Res. Appl., vol. 2, no. 6, pp. 657–663, 2012.