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Asymmetrical Features Microgrids with Traditional Methods of Deployment the Feeder

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Abstract**—** Real-time modelling of the IEEE 13-node test feeder is accomplished with the help of a microgrid implementation. As a consequence, a quantified real-time platform is produced. The IEEE standard provides the basis for this paradigm. Solar photovoltaic panels and wind turbine electricity can both be used in microgrids. Both of these are non-conventional sources of energy. Studying how environmental friendly sources can be integrated into the micro-grid and how the micro-grid and system reliability can be evaluated simultaneously is a main goal of this study work. Secondly, we want to learn how to include ecologically friendly sources and analysis into our daily practises. Radial feeders have an imbalance due to renewable energy sources being connected at the appropriate bus. Solar panels and wind turbines are two examples of these green energy options. A microgrid is a self-contained network linked to the main grid through the distribution system. It is possible to run a micro-grid without relying on the main grid, despite its link. In a microgrid scenario, the modelling software Matlab/Simulink is being used to simulate an imbalanced three-phase power supply. Microgrids are equipped with batteries for power storage. Findings show that a number of distinct time-shifting buses have considerably improved their voltage and current profiles.

Keywords: Solar Photovoltaic, Radial Feeders, Distribution system, Non-Conventional Energy Resources, Distribution energy system.

INTRODUCTION

Recently, energy has emerged as a crucial role in both the growth of scientific knowledge and economic prosperity. This is due to the fact that energy is a major driving force behind both of these developments. Power consumption is increasing at an alarming rate around the world, and current projections predict that this demand will more than quadruple over the next 15 years [1]. Researchers are under increasing pressure to develop distributed generation networks that utilize sustainable and renewable energy sources as a result of the growth in the market for renewable technology. A considerable proportion of distributed generation sources will still be unable to be combined with the distribution network even after that has been achieved. This is because distribution networks can only carry out unidirectional power flow to a limited extent, and the combination of dispersed generation sources may also be limited by the degree of penetration. The utilization of distributed generation in a microgrid has a number of advantages. Benefits for providers include compensation in the case that a transmission breakdown happens, lessening expansion in the transmission system's size, and increasing penetration of alternate kinds of electricity inside it. Because of this, the share of electricity generated by non-traditional sources has been steadily growing over time. Micro-grids are a type of electricity distribution network that may either be connected to a larger power grid or operated independently from it. Micro-grids function in a monitored and coordinated manner regardless of whether they are connected to or disconnected from the larger power grid. Components of a microgrid can include, but are not limited to, controllable loads, distributed generation, and storage devices. In order to undertake credible evaluations of the behavior of the micro-grid when non-conventional energy resources are being used [2]-[3]. As part of this project, a general planned micro-grid that utilizes solar and wind power has been put into operation. Now that this project is complete, a standard 4,16kV IEEE 13 bus test feeder is ready for use. This is a direct effect of the work that was done. But when it comes to potential power grid failures resulting from production, transmission or distribution issues, it is clear that the power grid may be able to meet a considerable amount of the demand for power. Despite the fact that all three of these regions might fail, this is the case. Though it's possible that all three of these factors may fail, this is still true. The response eventually morphs into something that is a great deal more sophisticated. On the other hand, whenever the micro-grid power infrastructure is taken into account, there are fewer transmission losses for non-conventional electricity and power that is helpful to the environment [4].

Real-time modelling of the IEEE 13-node test feeder is accomplished with the help of a microgrid implementation. As a consequence, a quantified real-time platform is produced. The IEEE standard provides the basis for this paradigm. Solar photovoltaic panels and wind turbine electricity can both be used in microgrids. Both of these are non-conventional sources of energy. Studying how environmental friendly sources can be integrated into the micro-grid and how the micro-grid and system reliability can be evaluated simultaneously is a main goal of this study work. Secondly, we want to learn how to include ecologically friendly sources and analysis into our daily practises. Radial feeders have an imbalance due to renewable energy sources being connected at the appropriate bus. Solar panels and wind turbines are two examples of these green energy options. A microgrid is a self-contained network linked to the main grid through the distribution system. It is possible to run a micro-grid without relying on the main grid, despite its link. In a microgrid scenario, the modelling software Matlab/Simulink is being used to simulate an imbalanced three-phase power supply. Microgrids are equipped with batteries for power storage. Findings show that a number of distinct time-shifting buses have considerably improved their voltage and current profiles

PROPOSED METHODS

A. Distribution System for the IEEE 13-Nodes

The data for the line segment was provided by each feeder setup, and it included the arrangement code and the length of the line segment. In addition to this, it offers the node terminations, which are also known as the lines that connect the nodes for each individual line segment.

Capacitors that are Shunted Line-to-ground and line-to-line connections, as well as a three-phase wye or delta, are depicted in the diagram. It has been determined that the rating of these capacitors is kVAr [5-8]. This value can be found in the table below. The IEEE 13 bus feeder is intended to perform each and every one of the same tasks that a genuine feeder would, including emulating all of the real feeder's electrical properties. Figure 1 depicts the IEEE 13bus distribution system, which may be utilised to gain a better sense of how it operates. On the link between node 650 and the mains, the IEEE 13-Bus distribution system does not have any DG installed. The operating voltage and current of the system are respectively 33 kV and 12 MVA, while the frequency of the system is 60 Hz. Additionally, the technology runs at a frequency of sixty hertz. This kind of load may be categorized as either a constant active power load, a constant reactive power load, or a constant distributed impedance load. Different aspects of the load are described by these phrases. It's possible to fit yourself into any one of these categories. Each of the system's forks corresponds to a specific stage in the operational process, and each of these forks is included.

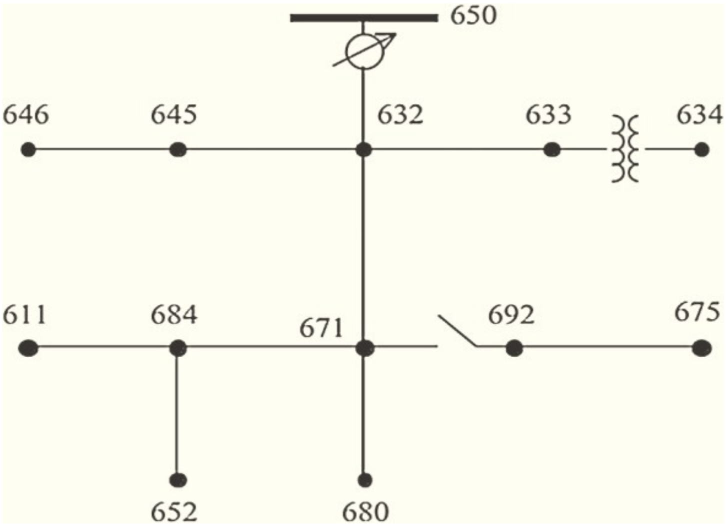

Fig.1. Basic diagram of 13-bus distribution system.

It is necessary for the system to have distributed generation because this sort of generation plays a key part in ensuring that the microgrid can serve the local loads. Distributed generation plays a key role in ensuring that the system has distributed generation. The term "micro grid" refers to a distributed network that frequently contains a wide diversity of distinct types of electricity-generating technologies. The generation that results from the wind is in first position, and the generation that results from the sun is in second place. The microgrid presents the most encouraging opportunity for incorporating a sizeable quantity of renewable energies into the system [8-12]. One 33 kV wind turbine and one 250 kV photovoltaic system will each be integrated with DGsystem as part of the scope of this project. The next section provides a discussion of the sizing problem, as well as an analysis of the power profiles.

SIMULATION DIAGRAM OF MICROGRID SYSTEM

A. Sources of Integrated System

All of the fundamental elements of the micro grid, including generators, power converters, loads, and we las transformers, are described and illustrated in this portion of the document. The idea of a microgrid incorporates not one but two distinct types of power generation in the form of wind turbines and solar photovoltaic plants [13]. Solar photovoltaic (PV) generating systems need a power conversion device in order to permit a power transfer and control process between the various resources and the energy that they provide. This is necessary in order to prevent power loss and maximize efficiency. Because of this, a general recommended inverter has been constructed and modelled, and low frequency harmonics have been taken into mind while doing so. This inverter is simple to scale and adjust for a wide range of generation, and it also has the flexibility to change its control approach in order to meet the needs of a variety of applications for power management. [14-19].

B. Simulation diagram of micro grid system

The block diagram of the fundamental electrical components is being created with the help of the Simulink library, and these components are also serving as the basis for the model they are helping to generate. A Simulink model of a system consisting of 13 nodes was developed thanks to the assistance of the Simulink library. Which are currently being utilised as the feeders for the micro-test grid at this time. In this Simulink model [18], the micro grid may be seen in this particular location. Which include both traditional and renewable energy sources, such as wind and photovoltaic systems, among others? The generation of electricity by wind in this system is connected at node 675, while the creation of electricity by solar cells is connected at node 680 [19] [20]. The simulation is carried out on a computer that has a CPU that has been determined to be an AMD A4-3330MX APU with Radeon (tm) HD Graphics operating at 2.20 GHz. The computer also has Radeon (tm) HD Graphics. It will take 47 seconds for the simulation of the model to complete using that.

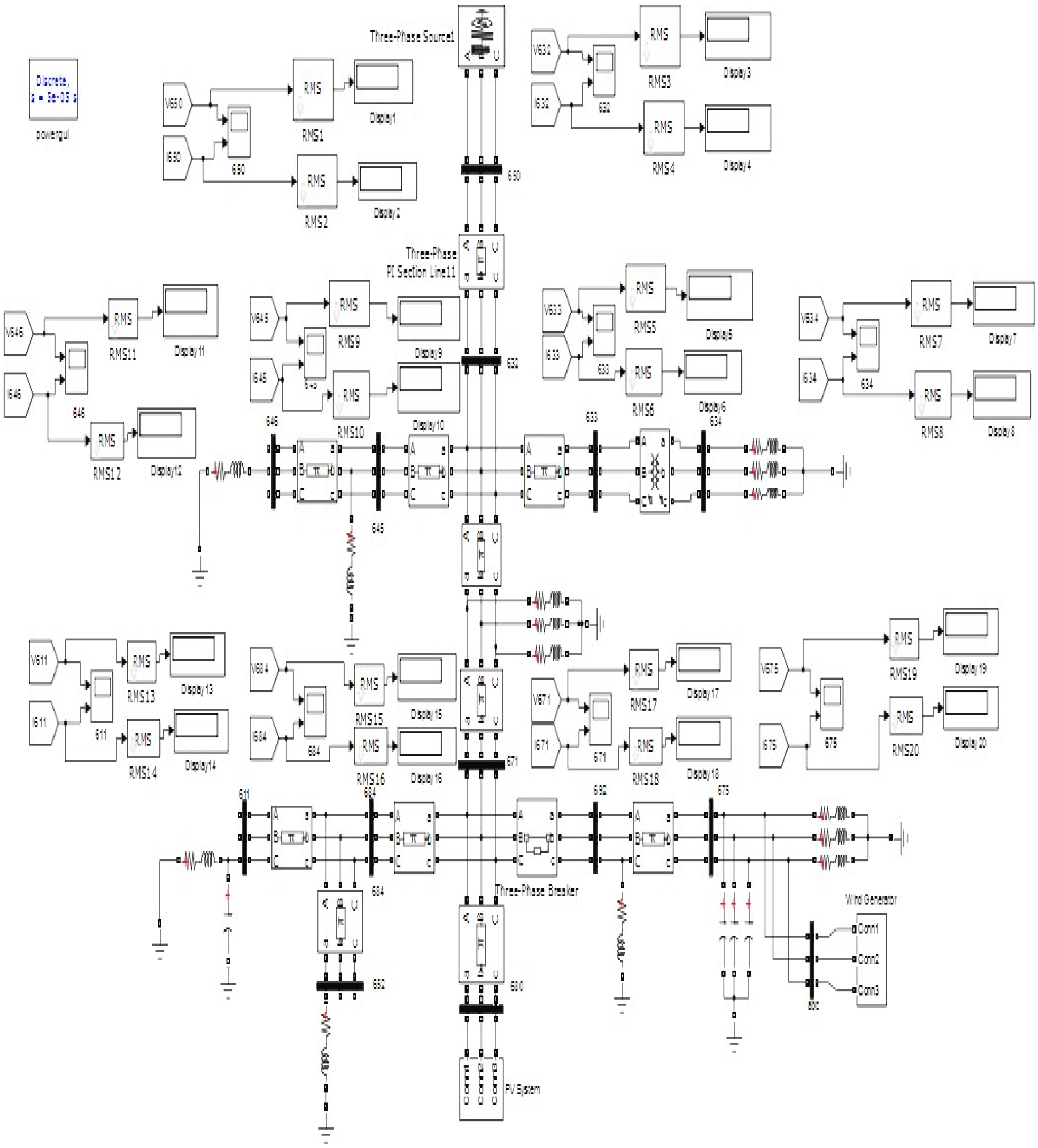

Fig. 2. Simulation diagram of micro grid.

RESULT & DISCUSSION

A. *In the following, a demonstration of the reaction that is caused by an unbalanced three-phase system is offered for your perusal. A listing of the output voltage and current can be found in each of the photos, and* *it is located at each of the nodes that the feeder connects to.*

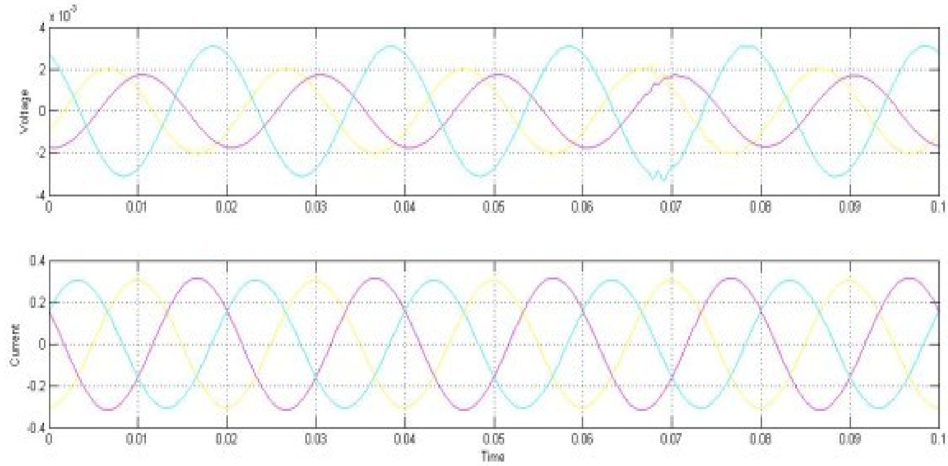

Fig. 3. the result show the wave form of voltage and current at node 632.

The response presents an illustration of the waveform of the unbalanced current and voltage at the node 632 of the test feeder. Figure 3 illustrates, for each phase, the voltage and current readings that were taken during that phase, as well as the waveform. Also shown is the diagram for the phase.

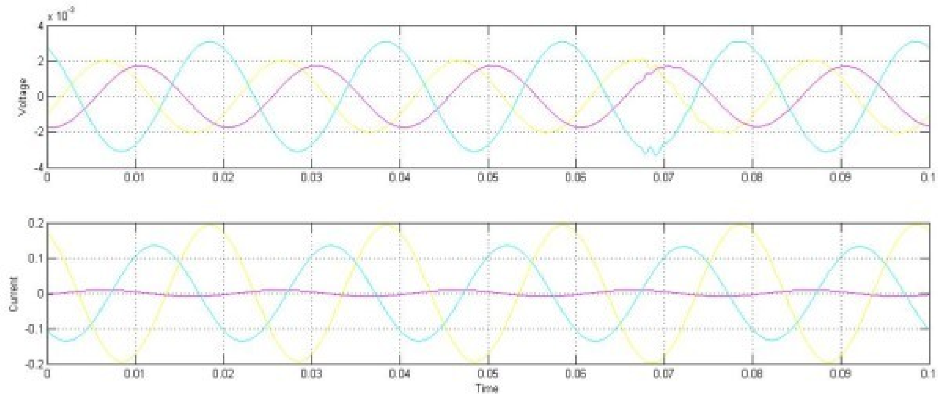

Fig. 4. the result show the wave form of voltage and current at node 633.

A waveform depiction of the unbalanced voltage and current at node 633 of the test feeder is included in the answer to this question. Simply clicking on this link will bring up the graphical depiction. Voltage and current were shown in each step of the experiment in precisely the same manner as they are displayed in Fig. 4.

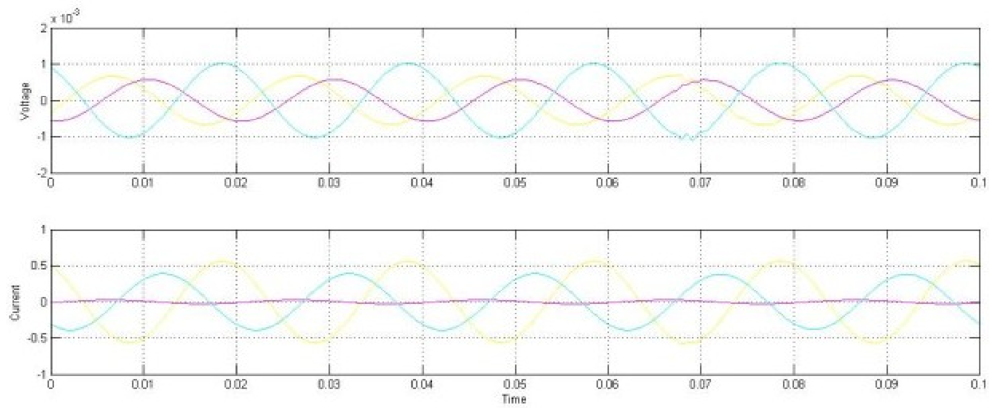

Fig. 5. the result show the wave form of voltage and current at node 634.

A waveform representation that illustrates an imbalance in the voltage and current at node 634 of the test feeder can be seen in the response. This imbalance can be seen at the node. At this particular spot, one may see this unbalance. Figure 5, which may be seen further down this page, depicts the levels of voltage and current that are present when the operation is being carried out.

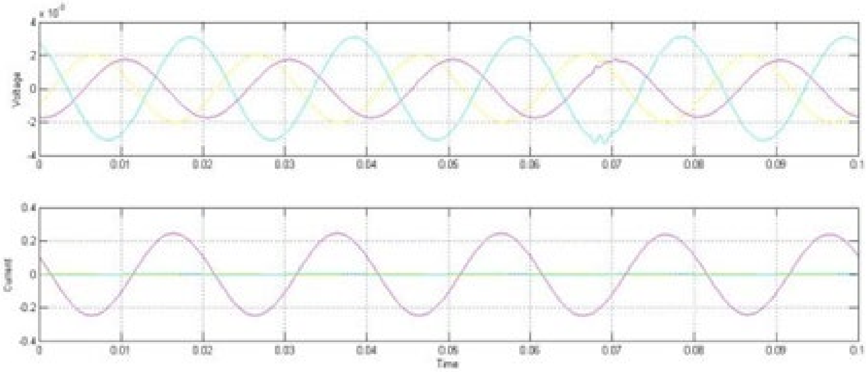

Fig. 6. the result shows the wave form of voltage and current at node 645.

An illustration of an imbalanced voltage and current at node 645 of the test feeder is provided in the form of a waveform graphic, which may be found in the solution. The voltage and current were shown in each phase in the same manner as is seen in Fig. 6.

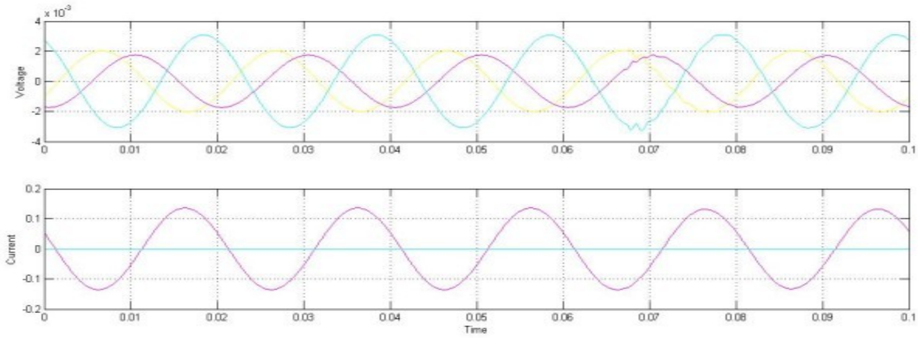

Fig. 7. the result show the wave form of voltage and current at node 646.

As a result of the distribution feeder's reaction to the load at node 646 and the open circuits in the other phases, the unbalanced voltage and current waveforms in one phase remain unchanged, as can be seen in the unbalanced voltage and current waveform shown in Figure 7.

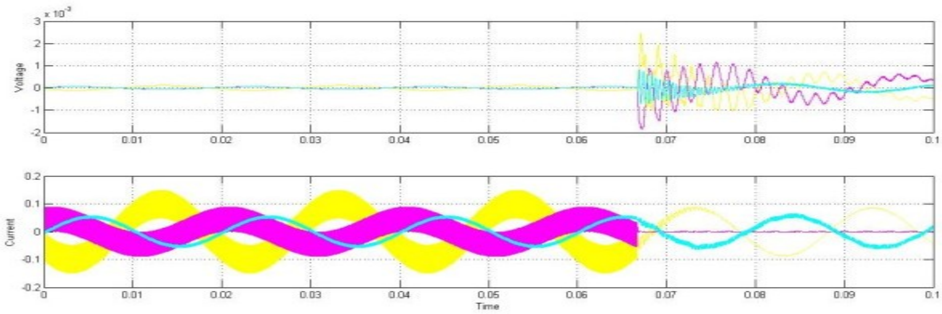

Fig.8 the result show the wave form of voltage and current at node 671.

Figure 8 displays the response of an unbalanced voltage and current waveform. This picture was captured at node 671. The waveform of the voltage reveals that the voltage remains constant for some part of its lifespan, but after some time it provides an unbalanced voltage across all phases. This is shown by the fact that the voltage remains constant. The current waveform demonstrates that the current in this case is not balanced; two phases have maximum current, while one phase has little current. This indicates that the current is not balanced.

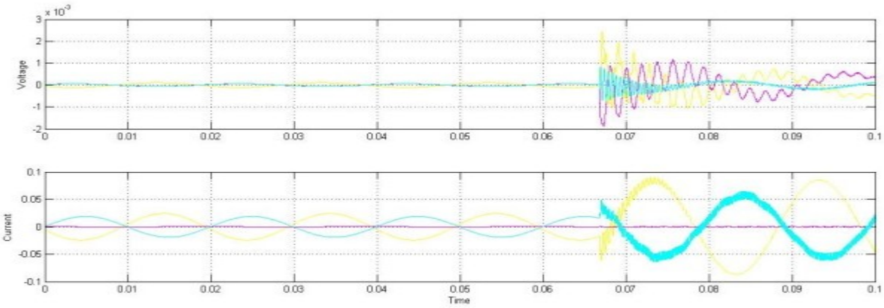

Fig.9 the result show the wave form of voltage and current at node 684.

A waveform graphic demonstrating the imbalanced voltage and current at node 684 of the test feeder can be seen in the response. The voltage and current were shown in each phase in the same manner as seen in Figure 9, which may be found here.

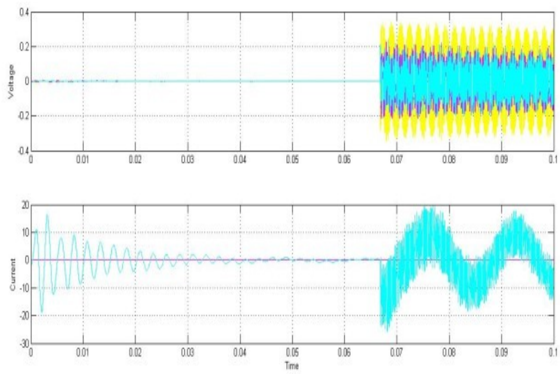

Fig. 10. the result show the wave form of voltage and current at node 611.

Figure 10 shows the reaction of an unbalanced voltage and current waveform. This picture was captured at node 671. The waveform of the voltage reveals that the voltage remains constant for some part of its lifespan, but after some time it provides an unbalanced voltage across all phases. This is shown by the fact that the voltage remains constant. However, the current in one phase first fluctuates for some time until becoming stable, at which point it starts to increase, whilst the current in the other two phases is zero.

An illustration of an imbalanced voltage and current at node 675 of the test feeder is provided in the form of a waveform graphic, which may be found in the solution. As a consequence of the test, one may make this observation. The technique that was used to demonstrate the voltage and current for each phase is shown in Figure 11. You may see this particular figure over here. Fig.12, which was obtained at node 652, displays the response of an unbalanced voltage and current waveform. The waveform of the voltage reveals that the voltage remains constant for some part of its lifespan, but after some time it provides an unbalanced voltage across all phases. This is shown by the fact that the voltage remains constant. However, the current in one phase first fluctuates for some time until becoming stable, at which point it starts to increase, whilst the current in the other two phases is zero. The response of an imbalanced voltage and current waveform is seen in Figure 13, and this image was taken at node 692. In this instance, the voltage waveform illustrates that the voltage stays the same for a specific amount of time; but, after a certain amount of time has passed, it generates an unbalanced voltage at two phases different than the minimum phase like. However, initially there was an imbalance throughout all phases of the current, which only corrected itself after a certain amount of time had elapsed.

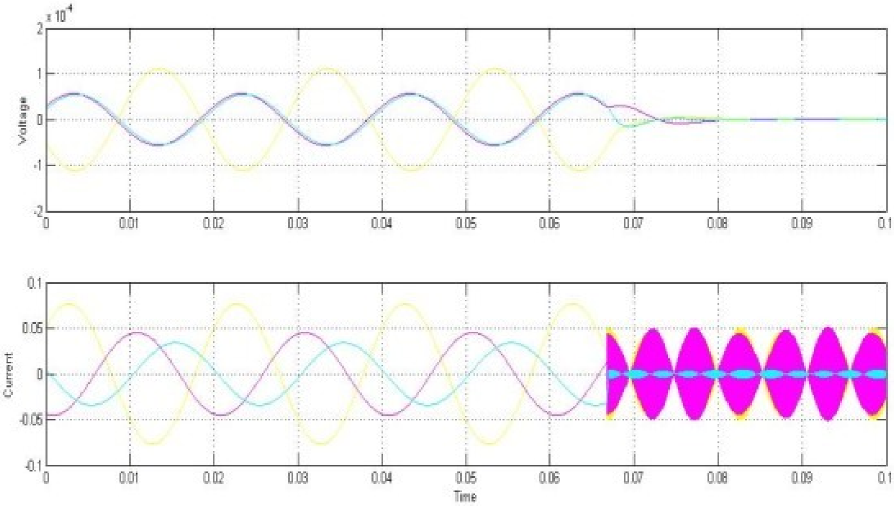

Fig.11 the result show the wave form of voltage and current at node 675.

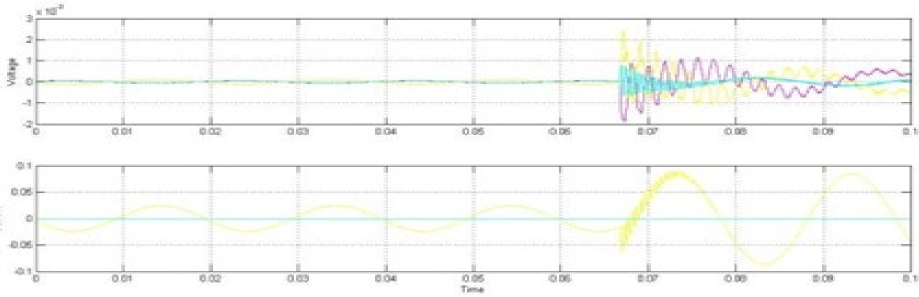

Fig.12 the result shows the wave form of voltage and current at node 652.

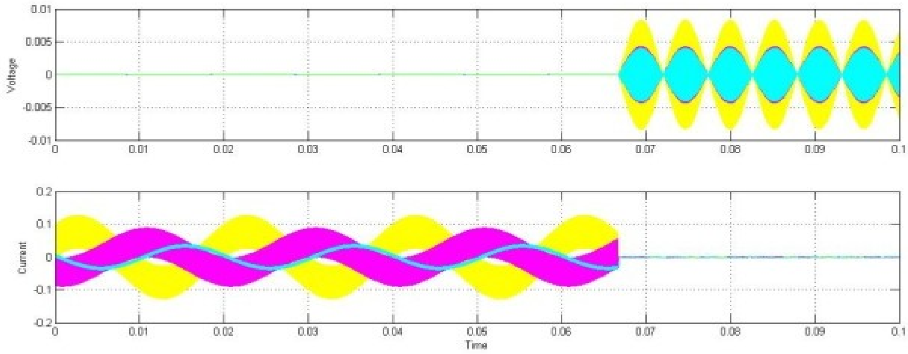

Fig.13 the result show the wave form of voltage and current at node 692

The results of the simulation indicate that the performance of the three-phase unbalanced microgrid is equivalent to that which is shown in Figures 3 through 13. Each of these graphs depicts the various amounts of voltage and output current that may be discovered at each node of the microgrid. These nodes are all connected in series.

B. The following demonstrates the reaction of the three-phase microgrid system that does not have a balanced configuration. In every one of the figures, you'll find a breakdown of the output voltage and current at every one of the micro grid's nodes.

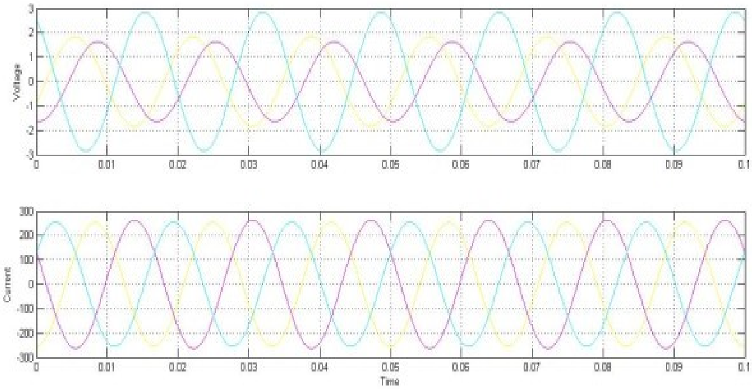

Fig.14 the result show the wave form of voltage and current at node 632.

The response of a waveform that has an uneven distribution of voltage and current is seen in Figure 14. This photograph was taken at node 632 of the distribution feeder, which used a micogrid in its construction. When the feeder is connected to the microgrid, the voltage and the current are both carried out in an imbalanced manner as a result of this configuration.

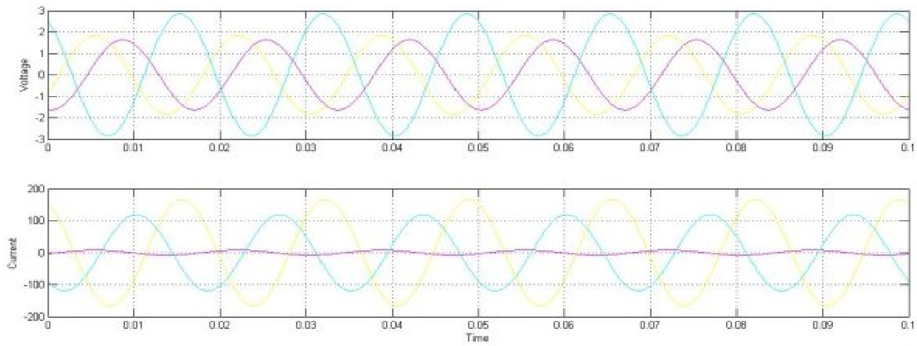

Fig. 15 the result shows the wave form of voltage and current at node 633

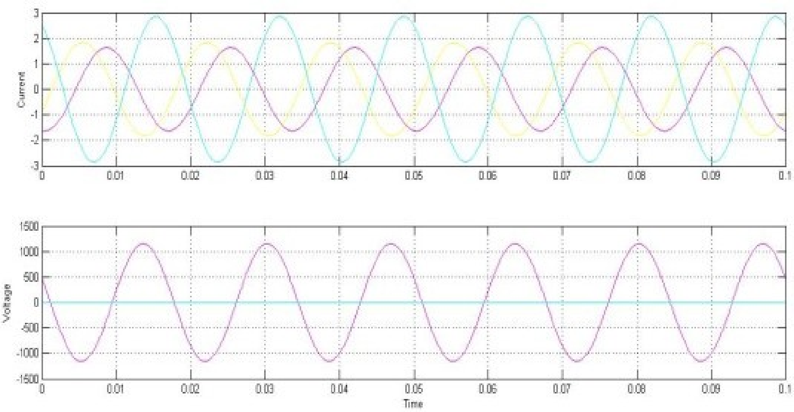

Fig. 16 the result show the wave form of voltage and current at node 646

The response of an unbalanced voltage and current waveform is seen at node 633 in figure 15, which shows that a microgrid is present. This waveform illustrates that the uneven voltage and current across all three phases has been corrected to some degree. The response of a microgrid to an imbalanced voltage and current waveform at node 646, which can be seen in the diagram, is shown in this graphic. Figure 16, which may be seen further down on this page, is an illustration of the reaction of the microgrid. Show the unbalanced voltage here, but also make sure that the current in this phase stays unbalanced at all times and displays it in an imbalanced manner. Even though the load is just on one phase and the other phases have open phases at the same time, you still need to make sure that there is a constant current running through the other phases.

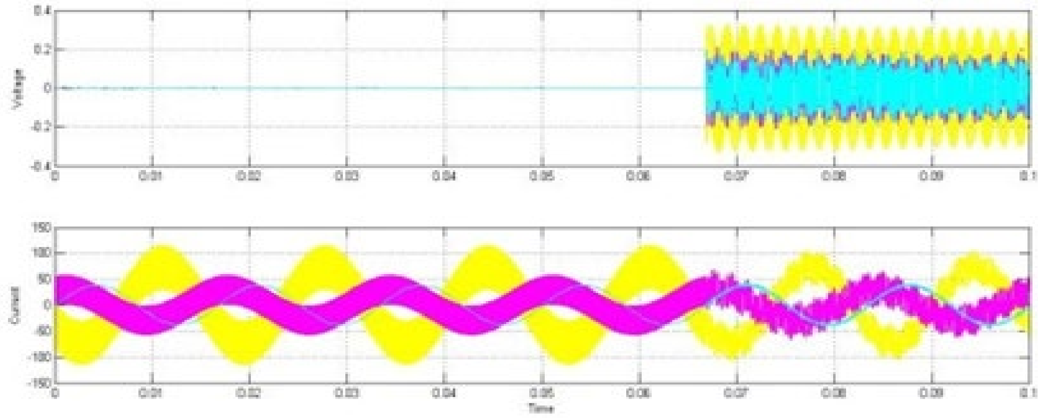

Fig. 17 the result show the wave form of voltage and current at node 671

Figure 17, which was produced with the use of a microgrid at node 671, displays the reaction of an unbalanced voltage and current waveform. The waveform of the voltage reveals that the voltage remains constant for some part of its lifespan, but after some time it provides an unbalanced voltage across all phases. This is shown by the fact that the voltage remains constant. The current waveform demonstrates the existence of an unbalanced current at this location; two phases have the highest current, while one phase has the lowest current.

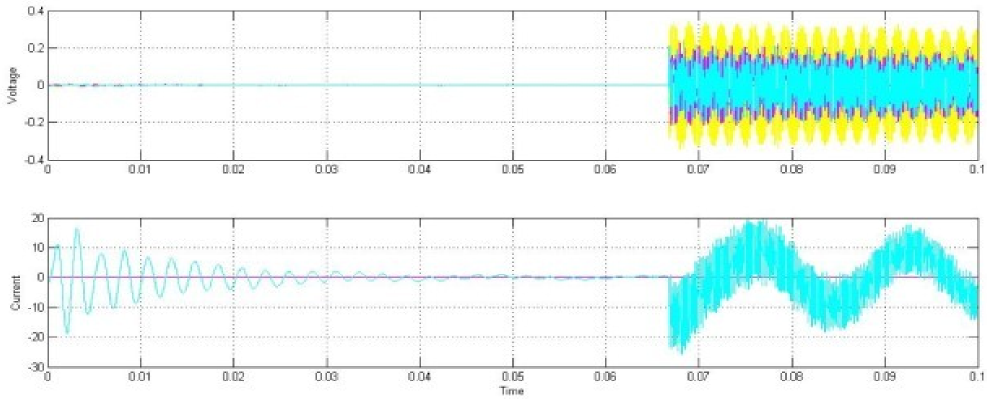

Fig. 18 the result show the wave form of voltage and current at node 611.

Fig.18, which was recorded at node 671 and includes a microgrid, displays the response of an unbalanced voltage and current waveform. You may see this response by looking at the diagram. The waveform of the voltage reveals that the voltage remains constant for some part of its lifespan, but after some time it provides an unbalanced voltage across all phases. This is shown by the fact that the voltage remains constant. However, the current in one phase first fluctuates for some time until becoming stable, at which point it starts to increase, whilst the current in the other two phases is zero.

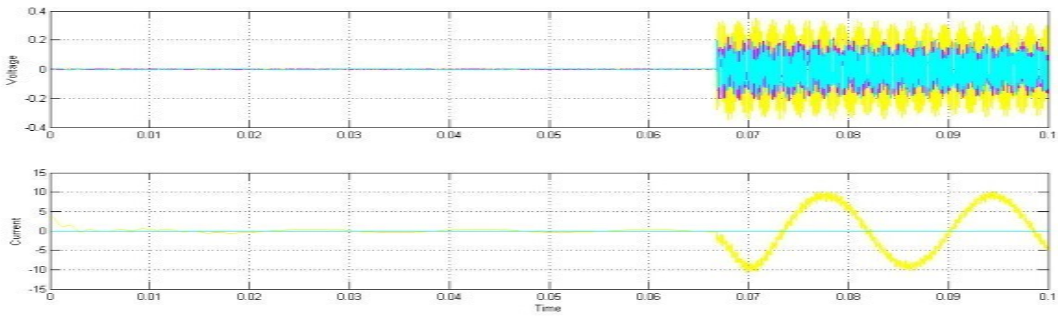

Fig.19 the result show the wave form of voltage and current at node 652.

The reaction of an unbalanced voltage and current waveform may be observed in Fig.19, which was produced using a microgrid at node 652, as shown in the figure. The waveform of the voltage reveals that the voltage remains constant for some part of its lifespan, but after some time it provides an unbalanced voltage across all phases. This is shown by the fact that the voltage remains constant. However, the current in one phase first fluctuates for some time until becoming stable, at which point it starts to increase, whilst the current in the other two phases is zero.

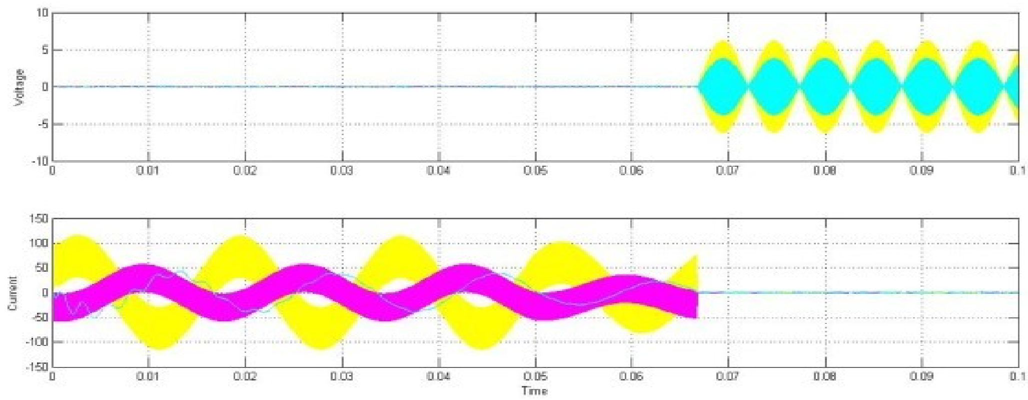

Fig. 20 the response of the voltage and current at the node 692.

The response of a microgrid to an unbalanced voltage and current waveform as measured at node 692 is seen in Figure 20 below. In this particular case, the voltage waveform demonstrates that the voltage remains constant for a given length of time; but, after a certain amount of time has elapsed, the voltage begins to change, it generates an unbalanced voltage at two phases different than the minimum phase like. However, initially there was an imbalance throughout all phases of the current, which only corrected itself after a certain amount of time had elapsed. The results of the simulation indicate that the performance of the three-phase unbalanced microgrid is equivalent to that which is shown in figures 14 through 20. Each of these graphs depicts the various amounts of voltage and output current that may be discovered at each node of the microgrid. These nodes are all connected in series.

CONCLUSION

The microgrid model Simulink, a solar array, and a wind turbine were all implemented as part of this project. ieee-13 bus radial distribution lines have been installed in the solar system bus 680 and the wind generator bus 675. After going through the appropriate setup processes, the microgrid is now ready to operate in a mode of operation known as grid-linked. This mode of operation allows the microgrid to serve as an extension of the larger grid. On the system with unbalanced nodes, measuring the voltage and current on multiple buses and phases. This was done. These readings were obtained from the system when it was functioning normally. The methodology that was supplied illustrates that there is a decrease in the losses that occur in the power system in contrast to the system that does not employ DER. This can be seen when comparing the two systems side by side. Matlab/Simulink is the software programme that is being used in order to run a simulation, with the help of which the system's usefulness may be assessed. The 13-Node distribution model needed to be validated, the multi-core simulation was completed with an accuracy of less than 1.5% relative absolute voltage. Simulations of a real-time inverter system using a DFIG wind generator and an array of PV panels have been constructed on a platform, and a battery. Additionally, the platform has a model of a PV array. In addition to that, these models have already been put into action.

REFERENCE

1. H. E. Brown, S. Suryanarayanan, G. T. Heydt, " Some characteristics of emerging stributdiion systems considering the Smart Grid Initiative ," *The Electricity Journal*, v. 23, no. 5, June 2010, pp.64-75.
2. T. Ackermann and V. Knyazkin, "Interaction between distributed generation and the distribution network: Operation aspects", Second Int. Symp. Distributed Generations: Power System Market Aspects, Stockholm, Sweden, 2002.
3. Jatin jangra and shelly vadhera,"load flow analysis for three phase unbalanced distribution feeder using matlab", ICCT, 2017.
4. S. Suryanarayanan, M. Steurer, S. Woodruff, R. Meeker, " Research perspectives on high fidelity modeling, simulation, and hardware-in-the-loop for electric grid infrastructure hardening," in *Proc. 2007 IEEE Power Engineering Society (PES) General Meeting* , 4 pp., Jul2007.
5. T. Ackermann and V. Knyazkin, "Interaction between distributed generation and the distribution network: Operation aspects", Second Int. Symp. Distributed Generations: Power System Market Aspects, Stockholm, Sweden, 2002.
6. C. Abbey, F. Katiraei, C. Brothers, "Integration of distributed generation and windenergy in Canada", Invitedpaper IEEE Power EngineeringSociety General Meetingand Conference, Montreal, Canada, June 18-22,2006.
7. W. Kersting, "Radial distribution test feeders," *Power Systems, IEEE Transactions on*, vol. 6, no. 3, pp. 975–985, Aug 1991
8. P.A Upadhyay and S.k Joshi", Optimal Summation of Natural Power Distributed Resources in Grid Connected Micro Grid", ICIT, 2019.
9. N. Hatziargyriou, H. Asano, R. Iravani, C. Marnay, "Micro-grids- Anover view of ongoing research, development and demonstra- tion projects", IEEE Power and Energy Magazine, pp. 78-94, July/August2007.
10. Dr. K. Ravi chandrudu, M.Manasa, Mr. P.Yohan Babu, G.V.P. Anjaneyulu " Design of Micro- grid System Based on Renewable Power Generation Units", International Journalof Scientific and Research Publications, Volume 3, Issue 8, August 2013 ISSN2250-3153.
11. N. Pogaku, M. Prodanovic, T. C. Green, "Modeling, analysis and testing of autonomous operation of an inverter-based microgrid," *IEEE Trans. Power Electron.*, vol. 22, no. 2, pp. 613 625, Mar.2007.
12. Akshay K. Rathore, "Hybrid Micro-grid (μG) Based Residential Utility Interfaced Smart Energy System: Applications for Green Data Centers and Commercial Buildings", 7th IEEE Conference on Industrial Electronicsand Applications, Singapore, July 2012, pp. 2063- 2068.
13. H. Yan, N. Lv, F. Zhuo, H. Yi and Z. Wang, "Energy Management of Household microgrid with Multiple Energy Resources for Rural Area," 2019 10th International Conference on Power Electronics and ECCE Asia (ICPE 2019 - ECCE Asia), Busan, Korea (South), 2019, pp. 1 -6.
14. Roshen Tariq and Ahmad Hamdi," Solar cell system simulation using Matlab-Simulink", Kurdistan Journal for Applied Research kjar.spu.edu.iq Volume 2, Issue 1, June 2017.
15. Kumar, Y., Mishra, R.N. and Anwar, A., 2020, February. Enhancement of Small Signal Stability of SMIB System using PSS and TCSC. In 2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC) (pp. 102-106). IEEE.
16. Dr. K. Ravi chandrudu, M.Manasa, Mr. P.Yohan Babu, G.V.P. Anjaneyulu " Design of Micro- grid System Based on Renewable Power Generation Units", International Journalof Scientific and Research Publications, Volume 3, Issue 8, August 2013 ISSN2250-3153.
17. J.N. Paquin, J. Moyen, G. Dumur, V. Lapointe, " Real-Time and Off-Line Simulation of a Detailed WindFarm Model Connected to a Multi-Bus Network", *IEEE Canada Electrical Power Conference 2007*, Montreal, Oct. 25-26,2007.
18. J. Arai, K. Iba, T. Funabashi, Y. Nakanishi, K. Koyanagi, and R. Yokoyama, " Power electronicsand itsapplications to renewable energy in Japan," *IEEE Circuits Syst.*, vol. 8, no. 3, pp. 52-66, Sep.2008
19. Kumar, Y. and Gupta, H., 2022, April. Load Flow Analysis of Distribution generator using the unsynchronized Measurement. In 2022 Second International Conference on Advances

in Electrical, Computing, Communication and Sustainable Technologies (ICAECT) (pp. 1-5). IEEE.

20. A. Paudel and G. H. Beng, "A Hierarchical Peer-to-Peer Energy Trading in Community Microgrid Distribution Systems," 2018 IEEE Power & Energy Society General Meeting (PESGM), Portland, OR, 2018, pp. 1-5, doi: 10.1109/PESGM.2018.8586168.
21. Y. Kumar, M. Pushkarna and G. Gupta, "Microgrid Implementation in Unbalanced Nature of Feeder using Conventional Technique," 2020 3rd International Conference on Intelligent Sustainable Systems (ICISS), 2020, pp. 1489-1494, doi: 10.1109/ICISS49785.2020.9316024.
22. Sharma, K., & Shukla, M. (2014). Molecular modeling of the mechanical behavior of carbon fiber-amine functionalized multiwall carbon nanotube/epoxy composites. New Carbon Materials, 29(2), 132–142. https://doi.org/10.1016/S1872-5805(14)60131-1