ISSN XXXX XXXX © 2017 IJESC

Research Article Volume 7 Issue No.8

Dynamic Switching of Residential Customers among Three Phases by Low Voltage Feeders

G. Lakshmi Tirupathamma[1], I. Vijay Kumar[2]
PG Scholar[1], Assistance Professor[2]
Department of EPS[1], Department of EEE[2]
Anurag Group of Institutions (Autonomous), Hyderabad, Telagana, India

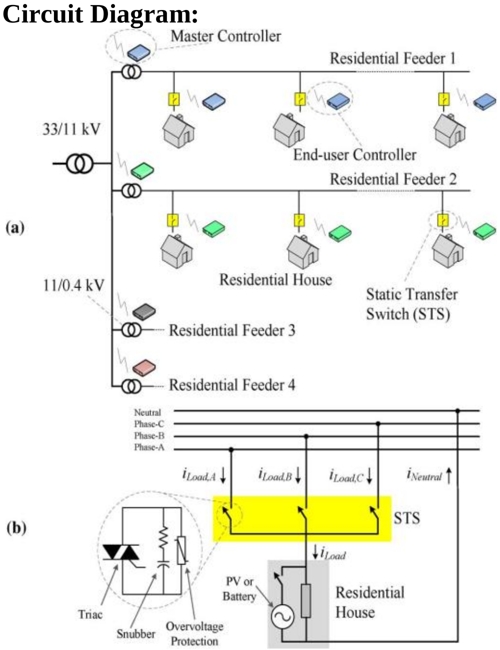
Abstract:
To dynamically reduce voltage unbalance (VU) along low voltage distribution feeders, a distributed intelligent residential load transfer scheme is proposed. In this scheme residential loads are transferred from one phase to another to minimize VU along the feeder. The central controller, installed at the distribution transformer, observes the power consumption in each house and determines the house(s) to be transferred from an initially connected phase to another. The transfer is carried out by the help of a static transfer switch, with a three-phase input and a single-phase output connection, through which each house is supplied. The steady-state and dynamic performances of the proposed load transfer scheme are investigated by MATLAB analyses and PSCAD/EMTDC simulations**.** Open circuit characteristic. Due to different behaviors at harmonic frequencies, specific harmonic mitigation methods shall be developed for current controlled and voltage-controlled DG units, respectively.

Keywords: Distribution feeder, load transfer, static switch, voltage unbalance. Distribution feeder, load transfer, static switch voltage unbalance.

I. INTRODUCTION:

In many parts of the world (including Australia, Asia, Europe, and Africa), the Low Voltage (LV) residential feeders are usually three-phase, four-wire systems, supplied by Dyn three-phase transformers Majority of the houses have single-phase power supply (i.e., one of the three phases and neutral) but larger houses may have three-phase connections. Note that this type of system is not common in North America. Current unbalance and Voltage Unbalance (VU) are one of the main power quality problems in these feeders.VU can be very High in feeders with voltage drops close to the allowable limits, especially if the houses are distributed unequally among the three Phase The growing penetration of rooftop Photovoltaic generators (PV) in these LV feeders has increased the VU problem. The output power of the rooftop PVs is intermittent and the PVs are randomly distributed amongst phases as their installation depends on the customers. Therefore, penetration level, rating and location of PVs in the feeder significantly affect the growing penetration of plug-in electric vehicles will contribute to further unbalance. In it is shown that they can lead to high VU in both of the charging and discharging modes. Currently, the utilities minimize the unbalance problem in LV feeders by manually changing the connection phase of some of the costumers to equalize the distribution of the loads amongst the phases. Different methods are proposed for unbalance reduction in LV feeders. In some conventional improvement methods such as feeder cross-section increase or capacitor installation are investigated. In the application of custom power devices such as Distribution Static Compensator (DSTATCOM) is been proposed. It is shown that such devices can balance voltages at their connection terminals. If the terminal voltage is made balanced, the current drawn from the upstream network will be balanced, provided that the supply voltage is balanced. This will prevent the flow of large unbalanced current from the upstream network. In utilization of roof top PV inverters for exchanging reactive power is proposed for balancing their terminal voltage. Although this is an effective method, it requires PV inverter Standards to evolve to accommodate this in future. In modern distribution networks, sectionalizing switches and normally open tie switches are often used for reconfiguration of the network at Medium Voltage (MV) levels. The main benefits of reconfiguration for the network are reducing the power loss facilitating higher penetration level of distributed generation units improving power quality and faster restoration of service following a fault. In it is shown the network reconfiguration can be carried out by simply changing the phase Connection of the three phases in the primary side of the distribution transformer, for VU and power loss reduction. Therefore, Based on the known load pattern for each distribution transformer, the optimum phase balancing is carried out. However, this practice is carried out only once and is not dynamic. In it is shown that using Static Transfer Switches (STS), a sensitive load can be supplied from two different feeders by quickly transferring the load from one three-phase feeder to another, to prevent voltage sag/swell affecting it. A similar network reconfiguration and Load Transfer (LT) scheme, derived from can be applied in LV feeders to reduce VU in the network. In this paper, an intelligent dynamic residential LT scheme is proposed. The proposed scheme consists of a central controller, several distributed end-user controllers and STSs. In this scheme, an end-user controller, installed at each house, transmits the power consumption of the house to a central controller, installed at the distribution transformer. The central controller then analyzes the network VU and total power consumption in each phase and determines the house(s) to be transferred from an initially connected phase to another. Commands are then issued to the end-user controller in the selected house(s). Upon receiving a command from the central controller, the end-user controller activates the STS to change the phase connection.

Circuit Diagram:



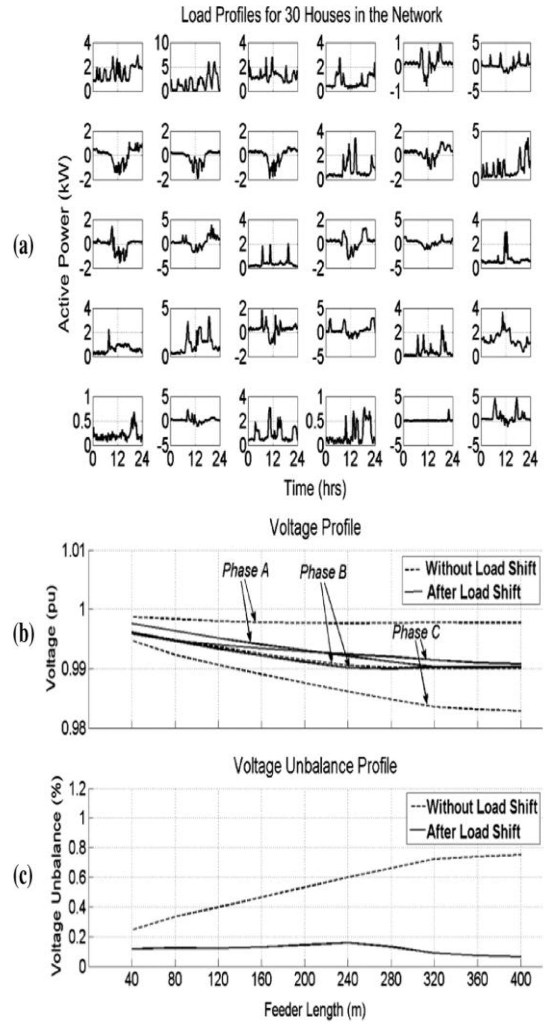
The main contribution of this paper is in proposing the idea of dynamically transferring the single-phase residential loads from one phase to another, within a three-phase system, to reduce VU along the feeder and power mismatch amongst phases. A practical and readily implementable dead band control algorithm is developed which reduces LT frequency versus VU. The method can be further refined using any standard optimization method such as GA. A new STS connection strategy is also developed for implementation of the proposal.

A. Load transfer control algorithm*:*

A three-phase four-wire LV feeder is assumed to have several single-phase loads, distributed unequally among the phases. It is necessary to determine the preferred LTs that minimize VU.A LT in any bus will result in the voltage magnitude and angle change in all phases and all buses. Therefore, the assumption of independency between all the three phase voltage magnitudes and angles is invalid. Hence, the VU sensitivity analysis, discussed in Section, cannot be used. Equation is based on the assumption of a balanced voltage source. However, in reality, it is quite possible that the voltages at any bus are already unbalanced due to other loads connected to the upstream side of the feeder. In addition, the problem is even more complicated by the diversities and unequal distributions of the loads, along the feeder. Therefore, the vector analysis, discussed in Section, is also not suitable.

B. Genetic Algorithm-Based LT:

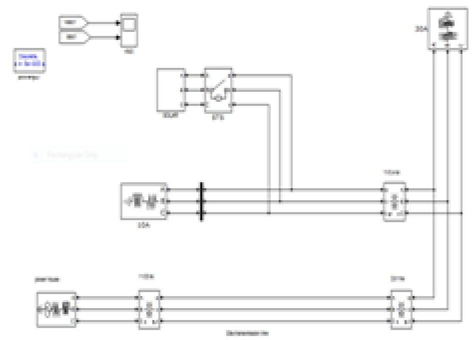
VU can be reduced even further if a general optimization is carried. Any optimization tool can be used for this purpose. In this paper, a GA-based method is chosen. This method is based On assuming a vector with column number equal to the number of the houses in the network. The value of each vector array (Cell) can be 1, 2, or 3 which represents respectively Phase-A, B. and C connection for each house. Each cell must have a value Between 1 and 3, at any time, to indicate that it is connected to one phase.

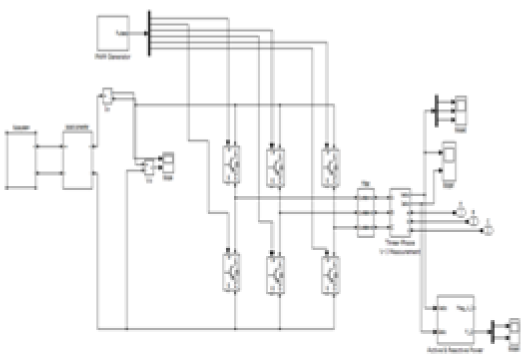


II. SIMULATION REULTS

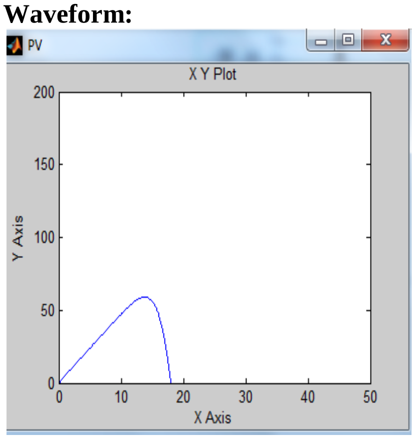
In this section, a few MATLAB-based steady-state analyses are presented, followed by dynamic simulation results using PSCAD/EMTDC. Only one residential feeder is considered. The residential feeder is assumed to be supplied by a three-phase, 100 kVA, 11/0.4 kV, 50 Hz, Dyn1 distribution transformer, with per-unit impedance of 4%. The LV feeder is an aerial, three-phase, four-wire system which is composed of 4 similar Mercury conductors with The overhead line has a length of 400 m, distributed over 120 cm cross-arms, with ABCN horizontal configuration. This feeder supplies 30 houses through 10 poles (Buses) with equal separations (i.e., 40 m) along the LV feeder (i.e., 1 house per phase per pole). The utilized residential load profiles in this analysis, are based on the data from smart meters, installed in a suburban area in Perth, Australia, that are received in 15-min intervals. From this figure, it can be seen that some loads have negative load profile at some periods which is due to their installed PV units. The loads are assumed to be constant PQ loads for this study. For steady-state analyses, the main program is comprised of two sub-programs - the intelligent LT program and a load flow program. In this study, an unbalanced load flow analysis based on backward/forward sweep Concept is developed for the radial three-phase four-wire system. The effectiveness of the proposed LT scheme is studied through steady-state case studies. A few of these are described below.

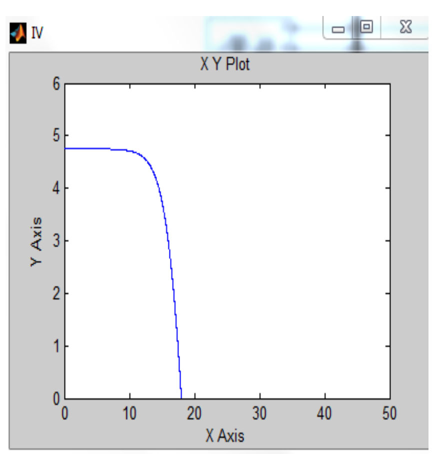
III. SIMULATION DIAGRAM:





Waveform:





Controllers:

In the proposed scheme, there are two types of controllers a central controller is installed at the distribution transformer and analyzes the network VU and power mismatch between three phases after receiving the power consumption data from the smart meters. Then, it chooses the candidate house(s) in which LT is required and subsequently sends a control command to the selected house(s). An end-user controller is installed at each LT participating house. This controller activates the STS once it receives a control command from the central controller. The end-user controllers in one feeder only correspond with the central controller of that feeder.

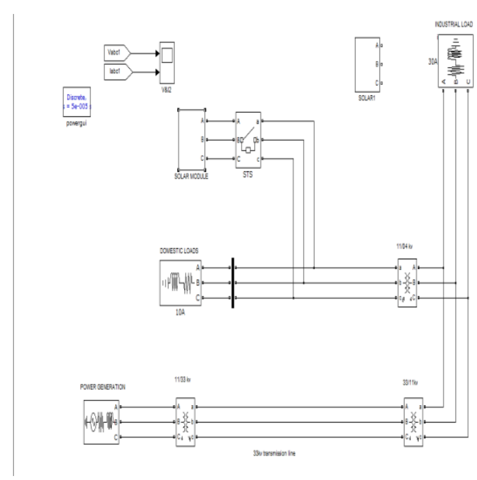
Effects of voltage unbalance:

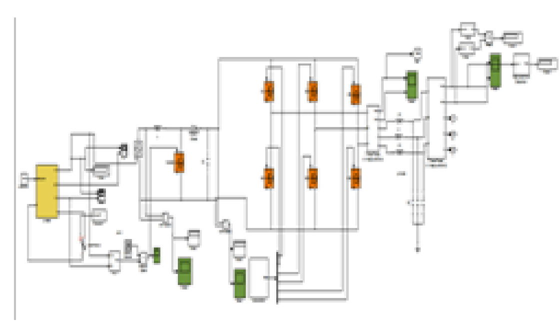
Resistive loads are relatively unaffected by voltage unbalance, but it causes additional heating/losses with three phase motors. Motor torque and speed will be negatively affected and the motor may produce excessive noise. The voltage unbalance also causes an increase in current unbalance well in excess of the voltage unbalance percentage. Variable speed drives (VSD) may trip off due to an increase in AC line currents caused by a compensation for the voltage unbalance. Increased thermal stress of VSD diodes and dc link capacitors and additional triple harmonics can also occur.

Existing system:

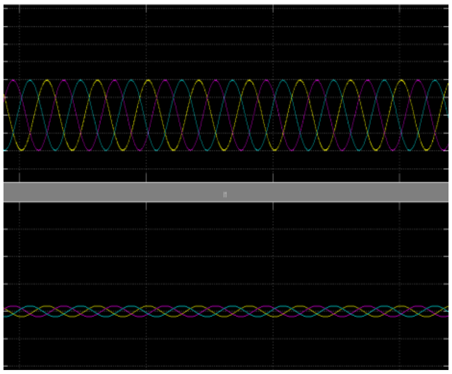
Current unbalance and Voltage Unbalance (VU) are one of the main power quality problems in three phase four wire feeders. VU can be very high in feeders with voltage drops close to the allowable limits, especially if the houses are distributed unequally among the three phases currently; the utilities minimize the unbalance problem in LV feeders by manually changing the connection phase of some of the costumers to equalize the distribution of the loads amongst the phases

IV. SIMULATION DIAGRAM:





Wave form:



The PV unit, modeled based on the voltage-current characteristic of PV cells is assumed to be connected to the load through a single-phase inverter, as discussed in shows the load active power demand while the abovementioned LTs are applied again. This figure shows that, even in the case of a reverse power flow, the voltage variations are within the acceptable regions of the ITI curve. The simulation results verify successful dynamic performance of the proposed LT for residential applications using the new connection strategy for the STS

V. CONCLUSION:

An intelligent dynamic residential load transfer scheme is proposed in this paper. Houses can be transferred between phases based on the commands from a central controller and with the help of a static transfer switch. The central controller utilizes the proposed highly-loaded to low-loaded phase transfer algorithm to define the candidate load(s) to be transferred, while keeping the number of load transfers to minimum. The load transfer scheme is discrete and operates on 15-min intervals. A dead band controller is developed to reduce the number of load transfers by allowing a small but acceptable level of voltage unbalance in the network. It can also utilize a GA-based optimization for voltage unbalance and power mismatch reduction among the three phases but will lead to much larger number of load transfers. The effectiveness of the proposed method is been verified through MATLAB analyses of a typical Australian LV distribution feeder using the load profile data available from smart meters. The analysis results for a 24-h period showed how effectively the voltage unbalance is reduced by applying the developed load transfer scheme. Similarly, the results for a 7-day period showed that a minimum of 2 and a maximum of 13 load transfers are applied for each house of the system under consideration to achieve minimum voltage unbalance along the feeder. The dynamic simulations of the static transfer switch demonstrates that the voltage disturbance during each load transfer falls within the acceptable region of the input voltage for the electrical appliances, based on the ITI curve. The vector analysis method, introduced in this paper, can be developed into a selection algorithm to identify the LT candidate load(s). In addition, some future work can be carried out to investigate the dynamic performance of single-phase motors and inverter type loads.

VI. REFERENCES:

[1].T. A. Short, *Electric Power Distribution Handbook*. BocaRaton,FL, USA: CRC, 2004.

[2]. A. Ghosh and G. Ledwich, *Power Quality Enhancement Using Custom Power Devices*. Boston, MA, USA: Kluwer Academic, 2002.

[3]. F. Shahnia, R. Majumder, A. Ghosh, G. Ledwich, and F. Zare, “Voltage imbalance analysis in residential low voltage distribution networks with rooftop PVs,” *Elect. Power Syst. Res.*, vol. 81, no. 9, pp. 1805–1814, Sep. 2011.

[4]. F. Shahnia, A. Ghosh, G. Ledwich, and F. Zare, “Predicting voltage unbalance impacts of plug-in electric vehicles penetration in residential low voltage distribution networks,” *Elect. Power Compon. Syst.*, vol. 41, no. 16, pp. 1594–1616, Oct. 2013.

[5]. F. Shahnia, A. Ghosh, G. Ledwich, and F. Zare, “Voltage unbalance improvement in low voltage residential feeders with rooftop PVs using custom power devices,” *Int. J. Electr. Power Energy Syst.*, vol. 55, pp. 362–377, Feb. 2014.

[6]. A. Faruqui, D. Harris, and R. Hledik, “Unlocking the 53 billion savings from smart meters in the EU: How increasing the adoption of dynamic tariffs could make or break the EU’s smart grid investment,” *Energy Policy*, vol. 38, pp. 6222–6231, 2010.

[7]. J. Zhu, *Optimization of Power System Operation*: Wiley,2009.

[28]. Olex Aerial Catalogue [Online]. Available:http:// www.olex.com.au/ Australasia/2012/OLC12641_AerialCat.pdf

[8]. “Western power distribution construction standards handbook,” Part 6-Low Voltage Overhead 2007 [Online]. Available: http://www.western power.com.au/ documents/ net work contractors/ distributionconstruc/ we_n5115114_v2_ distribution_construction_standards_handbook_.pdf

[30] Y. Li and P. Wolfs, “Hybrid model for residential loads in a distribution system with high PV penetration,” *IEEE Trans. Power Syst.*, vol. 28, no. 3, pp. 3372–3379, Aug. 2013.

[9]. W. H. Kersting, *Distribution System Modeling and Analysis*. Boca Raton, FL, USA: CRC, 2012.

[10]. F. Shahnia, R. Majumder, A. Ghosh, G. Ledwich, and F. Zare, “Operation and control of a hybrid microgrid containing unbalanced and nonlinear loads,” *Elect. Power Syst. Res.*, vol. 80, no. 8, pp. 954–965, Aug. 2010.

VII. AUTHOR PROFILE’S:

Lakshmi Tirupathamma Gattu, B.tech in Electrical and electronics engineering in 2013 from RVR&JC College of Engineering and M.tech in Electrical power systems in 2016 from Anurag group of institutions(autonomous), Ghatkeshar

affiliated to JNTUH, Hyderabad E-mail id: lakshmigattu7 @gmail.com

Vijay Kumar Itham, B.Tech in Electrical & Electronics Engineering from QIS COLLEGE ENGG& TECH, Affiliated to JNTUK Ongole, Prakasam and M.Tech in EPE from JNTU, Hyderabad. Working as Assistant Professor in Anurag group of institutions (autonomous), Ghatkesar, RR district, Telangana, India. E-mail id: vijayakumar6 87@gmail.com