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A SUITABLE AND RELIABLE METHOD TO CRITICAL FEEDER SELECTION FOR LOSS REDUCTION PROJECTS IN IRAN LV DISTRIBUTION NETWORK

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Abstract- The aim of this paper is to evaluate some major criteria for selection and contribution of LV feeder in loss reduction projects. In other word in this paper the relevancy of the measuring of the above parameter to detect the critical feeder for loss reduction project is evaluated. The results of analysis and evaluation of relation between LV feeder's lengths, load torque and voltage drop with it loss is considered. All LV feeders in Bonab city of East Azarbaijan in Iran is used as study case as a large real LV network. In this case the data of 539 LV feeders are converted and modeled in DIgSILENT software in details and the correlation between parameters is calculated. The results show that there is not strong dependency between LV feeder's length and feeder load torque with feeder loss, in contrary a strong relation is found between LV feeder's voltage drop and it loss. Based on the results the most reliable and robust criteria to find the critical feeder for loss reduction is its voltage drop.

Keywords: Loss Reduction, Technical Loss, Data Analysis, LV Network.

I. INTRODUCTION

Loss reduction in Iran LV distribution network is important topic. Main portion of power and energy loss in Iran electric network is related to LV distribution section. Also theoretically there are many approaches to find the critical feeder for loss reduction but in practice the implementation of these methods is not accurate or straightforward.

Technical losses in distribution network is a problem related to the distribution network performance [1-3]. Technical losses include the energy loss that arise from the heating of electrical distribution network elements such as MV and LV feeders and transformer windings. In a long and highly loaded feeder with low power factor-lightly loaded distribution transformers, as well as non-optimal allocation of substations can be increase the distribution network technical loss.

Typically, accurate estimating technical losses in a distribution network require extensive network and load data for modeling and simulation. Most of the methods need for extensive data input and accuracy of the system models to compute technical losses, particularly for large utility distribution network.

In [1] and [4] a distribution feeders are modeled based on distribution load profile to model along feeder to establish peak power loss functions associated with each of the different feeder characteristics. Energy loss in percentage terms of each feeder is then calculated by feeder load factor, loss profile and its length. The importance of technical losses for the whole distribution network, with hundreds of feeders is discussed in many literatures [5-7].

In some papers for technical losses of distribution transformers an empirical formulas associated with transformers losses is given [1] and [8]. Voltage drop measuring on a feeder can help network operator to identify and manage the network loss effectively. Voltage management is an important topic for each distribution company. In [9] a voltage management system to measure and evaluation of distribution network voltage has been designed and installed in a pilot project.

The main drawback of most existing materials of technical loss calculation is that the methods are not tested on a real size network. Besides in previously published paper there is not a comprehensive and statistical analysis between LV networks feeders' loss and their corresponding length, load torque and voltage drop.

II. NETWORK MODELING

All models are created in DIgSILENT software with integrate importing of the network data into the analytical software. Loads of costumers is jointed with the costumer geographical and location data from billing files. The load factor and profiles are measured from installed data loggers in different location of the network with different load type. After network modeling load flow program is used to calculate the feeders' loss and voltage drop.

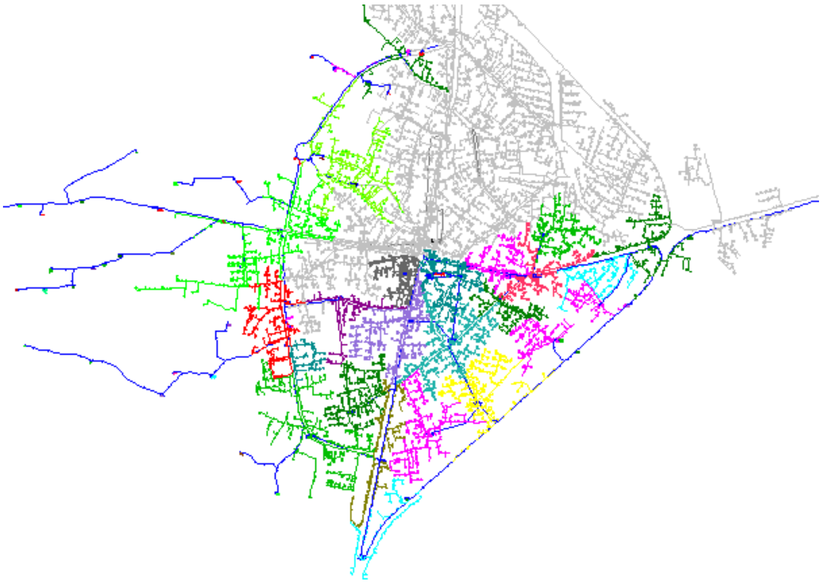

Figure 1. Bonab city LV network model in DIgSILENT for LV feeder loss evaluation

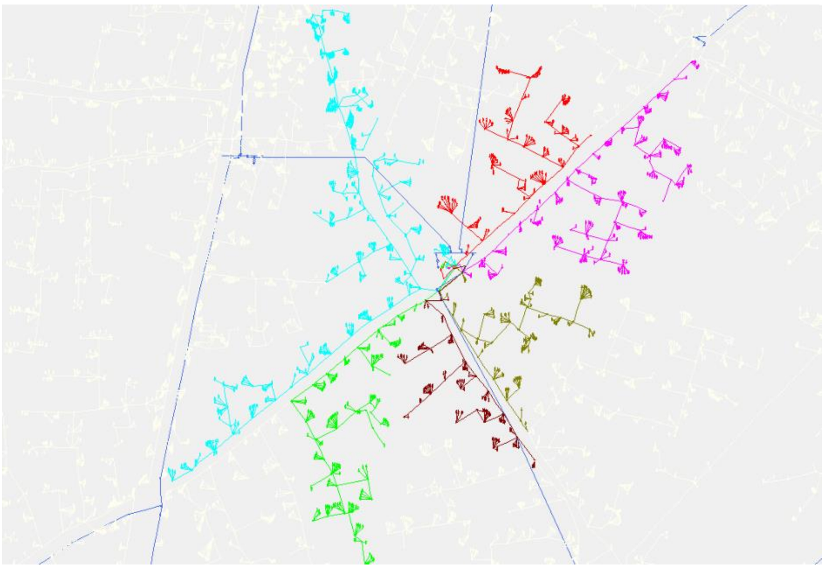

Figure 2. Kouche Ghadim MV substation supply area (6 LV feeders)

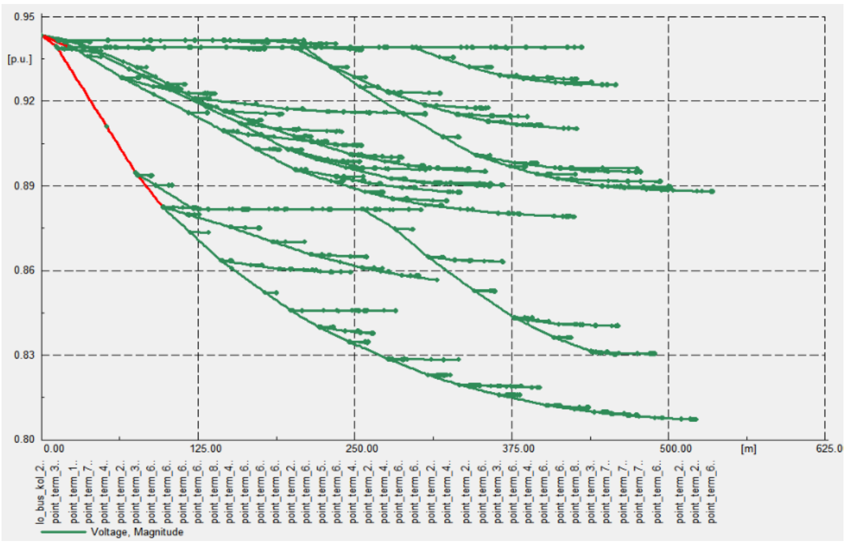

Figure 3. Kouche Ghadim MV substation LV feeders' voltage profile

III. SIMULATION RESULTS

The proposed method is tested on a real size low voltage distribution network a shown in Figure 1. All data including network configuration are directly imported into DIgSILENT software from GIS database. The network includes 539 LV feeders with different length and costumer number. A portion of the network that includes the Kouche Ghadim MV substation supply area with zoom in the network and voltage profile are shown in Figures 2 and 3, respectively.

The main goal of this paper is to establish a relation between LV feeder's loss with their length, load torque and voltage drop in a real size large scale network with 539 LV feeders in Bonab city of East Azarbaijan, Iran. The network model is converted from GIS into analytical software to evaluate the network from loss and voltage drop point of view.

In Figure 4 relations between 539 LV Feeders losses and their Length is indicated. In this figure the upper graph is the feeder's loss and the lower graph is the feeder's length (m) that is divided by 100. The X and Y axes are feeder number and feeder loss/length respectively. In fact, the correlation between feeder length and its loss is shown in this figure.

In Figure 5, data scattering and curve fitting between LV feeders' loss and it length is indicated. A linear curve fitting equation is used to model the dependency of loss-length in 539 LV feeders. In Table 1 the coefficients of this linear approximation are given. The results show that the correlation between loss and length of a feeder in LV distribution network is weak.

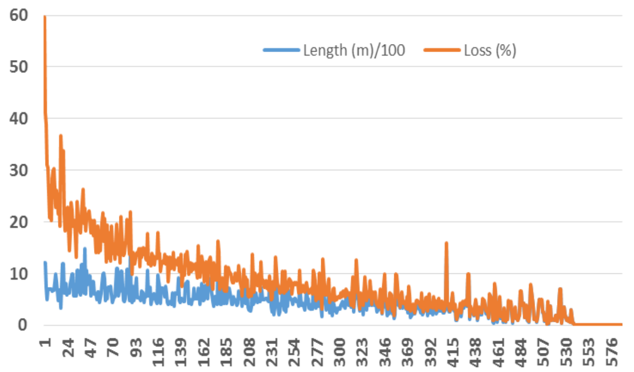

Figure 4. Relations between 539 LV feeders' losses and their lengths

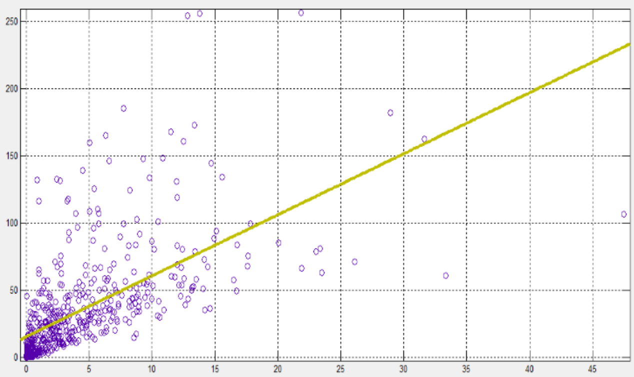

Figure 5. Data scattering and curve fitting between LV feeders' loss and their lengths

Table 1. Coefficients of the linear approximation

Equation	*A*	*B*	*R*-square
*Length = A*Loss+B*	23.61	385.5	0.248

Similar to Figure 4 the relations between 539 LV feeders; losses and their load torque is indicated in Figure 6. In this figure the upper graph is the feeder's loss and the lower graph is the feeder's length (Kw*Km) that is divided by 10. The *X* and *Y* axes are feeder number and feeder loss/torque, respectively.

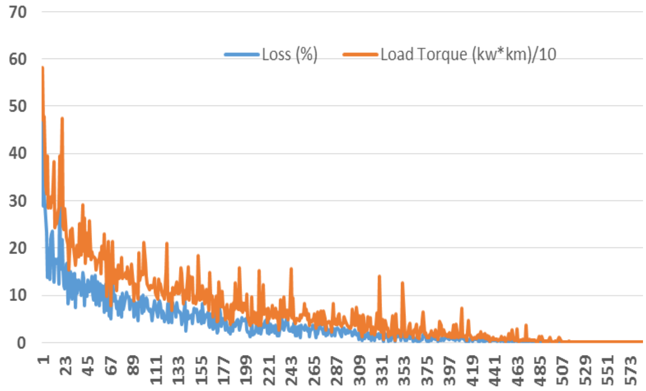

Figure 6. Relations between 539 LV Feeders losses and their load torque

Data scattering and curve fitting between LV feeders' loss and it load torque is shown in Figure 7. A linear curve fitting equation is used to model the dependency of loss-load torque in 539 LV feeders.

In Table 2, the coefficients of this linear approximation are given. The results show that the correlation between loss and load torque of a feeder in LV distribution network is relatively weak.

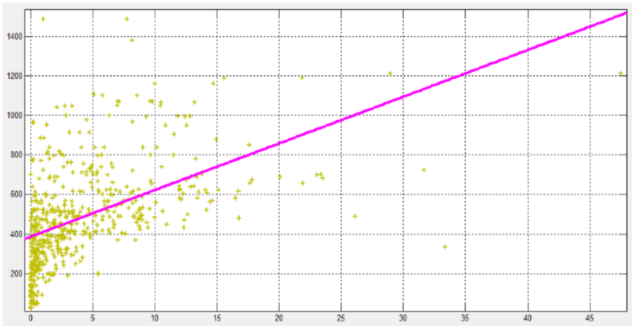

Figure 7. Data scattering and curve fitting between LV feeders' loss and load torque

Table 2. Coefficients of the linear approximation between loss and load torque

Equation	*A*	*B*	*R*-square
*Load Torque = A*Loss+B*	4.55	15.1	0.386

The relations between 539 LV Feeders losses and their voltage drop is illustrated in Figure 8. In this figure the upper graph is the feeder's loss and the lower graph is the feeder's voltage drop in %. The *X* and *Y* axes are feeder number and feeder loss/voltage drop, respectively.

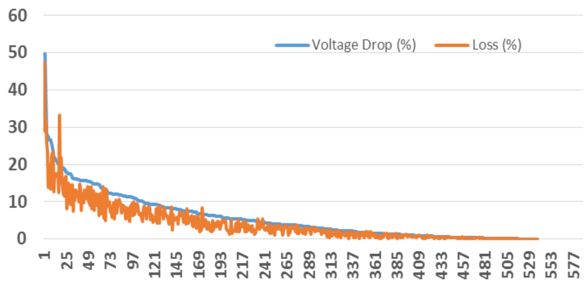

Figure 8. Relations between 539 LV feeders' losses and their voltage drop

Data scattering and curve fitting between LV feeders' loss and it voltage drop is illustrated in Figure 9. A linear curve fitting equation is used to model the dependency of loss-voltage drop in 539 LV feeders. The coefficients of this linear approximation are given in Table 3. The statistic results confirm that the correlation between loss and voltage drop of a feeder in LV distribution network is very strong.

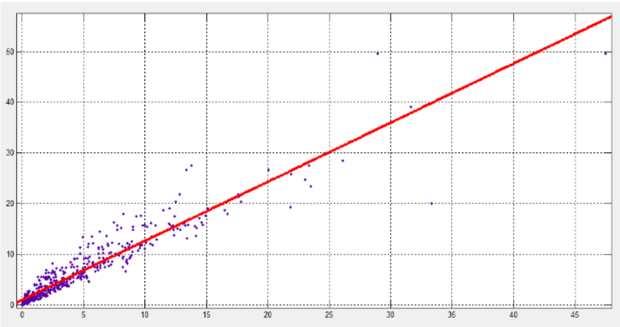

Figure 9. Data scattering and curve fitting between LV feeders' loss and it voltage drop

Table 3. Coefficients of this linear approximation between loss and voltage drop

Equation	*A*	*B*	*R*-square
*Voltage Drop = A*Loss+B*	1.17	0.946	0.902

The evaluation of the results shows that there is a strong relation between LV feeder's voltage drop and their loss. Base on the results the most relevant curve is found between LV feeder's voltage drop and loss. It is clear that the most relevant and robust method to select LV feeder for Loss reduction project is its maximum voltage drop. Just measure the voltage drop on the LV feeder and select it for loss reduction if it voltage drop is beyond its standard value.

IV. CONCLUSIONS

In this paper the relation between LV feeder's loss with their length, load torque and voltage drop is tested on a real large scale network with 539 LV feeders in Bonab city of east Azarbaijan Iran. The network model is converted from GIS into analytical software to evaluate the network from loss and voltage drop point of view. The evaluation of the results shows that there is a strong relation between LV feeder's voltage drop and their loss.

A linear approximation is fitted into three type output data from analytical software to consider the best fitted parameter to LV feeder's loss. Base on the results the most relevant curve is found between LV feeder's voltage drop and loss. Based on the results it is clear that the most relevant and robust method to select LV feeder for Loss reduction project is its maximum voltage drop. Just measure voltage drop on the LV feeder and select it for loss reduction if voltage drop is beyond its standard value.

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BIOGRAPHIES

Karim Roshan Milani was born in Tabriz, Iran. He received B.Sc. degree in Power Engineering from University of Tabriz, Tabriz, Iran and M.Sc. degree in Systems Management from University of Sharif, Tehran, Iran in 1990 and 1999, respectively. He got his second M.Sc. degree in Power Engineering from University of Tabriz in 2009. He is with East Azerbaijan Electric Power Distribution Co., Tabriz, Iran since 1994 as supervisory and design manager. He proposed this idea and method as a result of his several years researches and experiences in electric power network distributions, voltage management system has acquired the certificate and was highly commended for the project of the year award at Middle East Electricity Awards in 2011.

Sajad Najafi Ravadanegh was born in Iran, 1976. He received B.Sc. degree in Electrical Engineering from University of Tabriz, Tabriz, Iran in 2001 and the M.Sc. and Ph.D. degrees in Electrical Engineering from Amirkabir University of Technology, Tehran, Iran in 2003 and 2009, respectively. Currently, he is an Associate Professor of Electrical Engineering Department, Azarbaijan Shahid Madani University, Tabriz, Iran and responsible for Smart Distribution Grid Research Lab. His research interests include power system stability and control, special protection schemes, power system controlled islanding, evolutionary algorithms and intelligence computing in power systems, distribution system planning, energy management, nonlinear dynamic, and chaos. He is also the author and the co-author of over 50 technical papers.