ABSTRACT

One of the serious concerns plaguing the world is the limited energy reserves that are on the verge of extinction. In order to preserve these for future generations, it is essential to use remaining energy reserves sparingly and to minimize the losses encountered in energy usage. A majority of losses in the electrical energy sector occur in the distribution side; while transmission and sub-transmission lines account for only about 30% of the total losses In the distribution network, there are two main distribution network lines namely, primary distribution lines feeding High Tension (HT) consumers, distribution transformers and secondary distribution lines (low voltage distribution network, LV network) fed by distribution transformers in India. Hence LV network is the last link connecting the consumers and needs more consideration for optimization.

Although there are many research papers discussing the reconfiguration algorithms for loss minimization of distribution systems hardly any work related to loss reduction in developing countries scenario is reported. Very little work has been done on LV network where the impact of unbalance is predominant due to the presence of single phase loads. It results in current in the neutral line which in turn causes additional line loss in the distribution lines and copper loss in the distribution transformers.

To establish the relevance of the problem of unbalance and its remedy, the existence of single phase consumers in a typical state of India is considered for the analysis. It has been verified that number of single phase consumers is more than the number of three phase consumers. To further

augment the results, a study on the consumption pattern of consumers in a typical city of India is performed for a period of five months in the year 2007. They have been segregated with reference to single phase and three phases. It is observed that the single phase consumption is more than three phase consumption. It also indicates the consistent occurrence of unbalance in low voltage distribution network resulting in line loss, over current and low voltage.

Based on the extensive literature survey, most of the works in the distribution network are related to either primary distribution network or distribution automation. Hence this thesis focuses on LV network and reconfiguration of consumers for load balancing is identified as potential area for the present work.

The main objective of this thesis is to reduce energy losses in LV network and perform node reconfiguration cost-effectively. Taking real time data from three numbers of distribution transformers and the consumption profile of all the connected consumers as input, a technique that determines current unbalance, the time of peak unbalance in a day and correlates the consumers pertaining to it is developed and implemented in this thesis. Main objectives of this thesis are Development of Distribution Simulation Package (DSP) for load analysis of LV network using Lab VIEW, Implementation of Real-time On-line Monitoring System for LV network, Development of Fuzzy-logic based load balancing expert system and Heuristic method Pole-wise load balancing system.

In Real-time On-line Monitoring system, Energy monitoring system study is undertaken in one sample distribution transformer with its LV network of consumers. The data is obtained from energy meter connected to secondary of the distribution transformer with its 34 consumers every 30-minute. Remote metering is done up to consumer end in the sample transformer to get the correct representative samples of individual consumers. From the energy meter readings obtained, energy loss of LV network is computed. Load balancing algorithm is developed to predict the unbalance in the distribution network as well as correct the unbalance by reconfiguring the loads.

DSP has been developed with LabVIEW as off-line distribution monitoring system. This package is capable of displaying the distribution parameters like voltage, current and power factor in any hour of day. Also power and energy measurement for every half-an-hour is displayed. Low voltage distribution network power quality parameters and issues are also studied. DSP forms the basis for off-line analysis of LV network in formulating significant inferences

A fuzzy logic based load balancing is implemented to balance the current in three phases. The input to the fuzzy controller is the individual phase current. The output of the fuzzy controller is the load change value, negative value for load receiving and positive value for load releasing. Expert system performs the optimal interchanging of the load points between the releasing and receiving phases. The effect of load reconfiguration on loss reduction is studied practically in one number urban distribution transformer

(Urban DT1). CYMDIST simulation software is used to study two additional transformers (Urban DT2 and Urban DT3).

Further optimization by reducing neutral current in the LV network is attempted by using the heuristic methodology. For the different combination of loads described, consumers are shifted pole wise so that all the individual poles of the distribution transformer remains balanced after the process and the neutral current in all sections of LV distribution network gets reduced. But in fuzzy method unbalance exist pole-wise, even though total LV network is balanced. Two distribution transformers, Urban DT2 and Urban DT3 are taken for study. Based on the analysis, the result obtained in simulation software by reconfiguring the consumers (nodes) of Urban DT2 and Urban DT3 so as to balance the system is presented in this work. . The proposed load balancing technique effectively meets the criteria to minimize energy loss which has been proved by CYMDIST simulation.

The cost effectiveness and suitability of the work for low voltage distribution network scenario is highlighted with comparisons and possibility of energy saving in terms of few millions of rupees per month is explained. In an era of energy conservation this thesis makes a significant contribution to the economy of the nation.