



A new stratified random sample customer selection for load research study in distribution networks

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ABSTRACT

Distribution network decision makers need accurate and reliable information about load characteristics to plan, estimate and control the system properly. Load information is generally extracted from the collected load data of selected sample customers and, therefore, a proper sample customer selection is the pillar of any load research study. In this regard, this paper presents a new stratified sampling technique which includes three stages of sample size determination and customer stratification, sample size assignment to determined strata (subgroups), and sample customer selection. The sample size assignment to determined strata is done by considering the compatibility between load research objectives and sampling design and preparing the way to use the data and information provided by previous load research studies. Furthermore, sample customers are selected by considering the energy consumption (kWh) range of customers, their activity classification, and their locations in distribution feeders. The numerical results from a real data of an electric power distribution system in Esfahan-Iran verify the efficiency of the proposed technique when compared to the conventional method.

1. Introduction

Load research is the process of measuring, collecting and studying the customers' electric load characteristics in order to provide the reliable and thorough information for any company related to the production, distribution and management of electricity [1,2]. One of the major applications of load research analysis is the design and setting of retail tariffs for electricity supply [3,4]. This information can improve the accuracy of forecasting the future demand [5]. The other applications are the usage of load profiles of customers in capacitor placement and the reconfiguration of distribution networks [6], state estimation [7], and load modelling [8]. In this regard, the proper operation and control of distribution system requires all the information available on customers' patterns. This in turn helps the operator take proper action for both normal and atypical cases [9].

Since a large number of customers in different electricity tariffs are usually connected to a distribution network, the only possible way to study load characteristics of these customers is to use the statistical analysis. The development of the load research study consists of three steps; 1-sampling selection, 2-metering, and 3-analyzing the collected load data to extract information. The reliability and accuracy of load research results depend on how well these steps are taken. Among these steps the metering part has been facilitated by using the automated meter infrastructure (AMI) systems with a high degree of confidence.

Regarding the third step, after collecting the load data in the first two steps, well-developed data mining approaches including pattern recognition methods and clustering algorithms [10,11] are used to extract the load information from the collected load data. However, few researches are done on sampling technique design, and in this regard this paper presents a new method.

Customers in distribution networks have a number of distinct traits that can be divided into some homogeneous, independent and non-overlapping subgroups. These are known as stratification variables which are electricity tariffs, contract power, geographical position and region type. Stratifying customers into subgroups increases the precision of the estimates and reduces the overall required sample size. In this regard, the stratified sampling technique can be used and includes three stages of sample size determination and customer stratification, sample size assignment to determined strata, and sample customer selection [12]. Sample size used in load research is limited based on company's budget to spend on metering and collecting load data. In this way, an optimal method to allocate samples to subgroups should be adopted to increase the accuracy and reliability of the collected data.

Refs. [13–16] give the implementation of the load survey system to identify the load characteristics of customers, by using the stratified sampling concept, to support system planning and operation. In [13], the load profiles of low voltage customers are analysed and a clustering algorithm based on billing data is proposed. Ref. [14] investigates the

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