Exploration of Measurement Data from Smart Meters for the Management of Power Distribution Systems

Guilherme de Oliveira Custodio*, Fernanda Caseño Trindade Arioli.

Abstract

Recently, in several countries, the electromechanical energy meters have been replaced by an advanced metering infrastructure, which main components are the smart meters, communication systems, and data management systems. Smart meters create opportunities to provide power, voltage and current magnitudes at the connection points of customers. The communication systems allow accessing these measurements in real or near real time, and the management systems are essential for processing the data and obtaining relevant information from them. Although the cost of implementing such infrastructure is high, it becomes economically attractive when considering the gains related to a better management of the distribution systems. In this context, this work aims to investigate the use of a methodology that employs smart meters data to detect and locate non-technical losses in distribution networks. The pros and cons of the methodology are evaluated employing real measurement data as well as load flow studies.

Key words:

Smart meters, Data Analytics, Distribution Management System.

Introduction

With the advance of technology in the last years, new features has been integrated to the traditional energy meters, resulting in what is called smart meter, benefiting several functions of the Distribution Management System. In this context, this work analyzes the application of a single method to detect and locate the non-technical losses (NTL) – more specifically, energy theft –, in the secondary distribution networks. Data from smart meters installed in a Canadian network as well as data synthesized from power flow studies are used to evaluate the method and its pros and cons.

Results and Discussion

The applied method consists in verifying the voltage at the Point of Common Coupling (PCC), V_{PCC} , estimating it either using the impedance values of the conductors and the voltage, active power and reactive power data collected from smart meters or using data retrieved from power flow studies. After that, the voltages for each PCC are calculated, normalized by the average, and compared. Those that present different values are considered suspect of NTL.

When using real data from smart meters, communication noises can affect those values and then a threshold is adopted. Customers whose voltages surpasses that threshold are considered suspects of NTL, as shown in Image 1. In this image, the dashed red line represents the threshold and the V_{PCC} estimated for a given customer is represented by the blue line.

For the evaluated cases, the method is able to detect accurately cases of NTL. However, it is important to observe that the stipulated threshold influences the quality of the results. For instance, if the threshold value is not properly chosen, some of the estimated voltages may be considered within the limits and a possible NTL will not be detected.

Image 1. Estimated voltage at PCC based on smart meter data.

Conclusions

The results show that the methodology is highly sensitive allowing, under ideal conditions, immediate detection of the NTL. For the cases using real data from smart meters, the detection is more complex. Even though, the methodology is effective. The studies also showed that the methodology is more effective for higher values of power consumption of the NTL. In summary, the results show that it can be considered a useful solution for the electric sector, as it is not intrusive to the customer and relatively simple to apply.

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