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1819 - Energy Losses Estimation Tool for Low Voltage Smart Grids

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Introduction

To meet the EU energy efficiency goals, Distribution System Operators (DSOs) needs to estimate energy losses levels in Low Voltage (LV) smart grids. This becomes in a challenging task due to the particularities that presents theses networks. So, in this paper an energy losses estimation tool is proposed to overcome those difficulties.

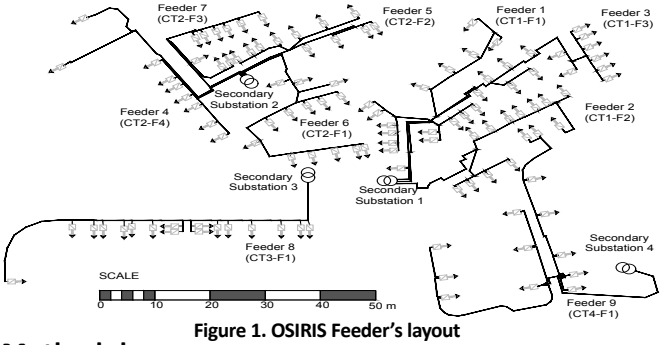

Figure 1. OSIRIS Feeder's layout

Methodology

The methodology proposed consists of the following five steps:

1. Generate a **set of feeder characteristics based on network data gathered from the Advanced Metering Infrastructures (AMIs)** that represents the network topology and operation.

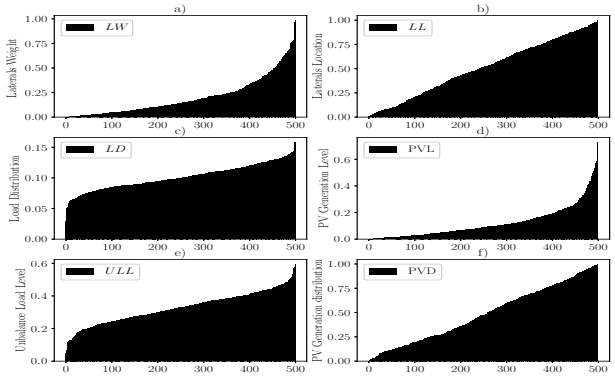

Figure 2. Characteristics parameters of the synthetically generated feeders

2. Perform a **Monte Carlo simulation** generating **synthetic feeders** based on the above characteristics and obtaining the corresponding energy losses by means of power flow (Fig. 2).

3. Obtain a meaningful representation system throw **Principal Component Analysis (PCA)** by creating for each feeder sample two coordinates (the two Principal Components) (Fig. 3).

4. Carry out a **K-means-based clustering** process to classify the feeders in representative clusters (feeder's groups) (Fig. 3).

5. Perform a **regression analysis** between the feeder input energy and the energy losses under 3 scenarios: 1/ expected value, 2/ expected value + standard deviation and 3/ expected value - standard deviation (Fig. 4).

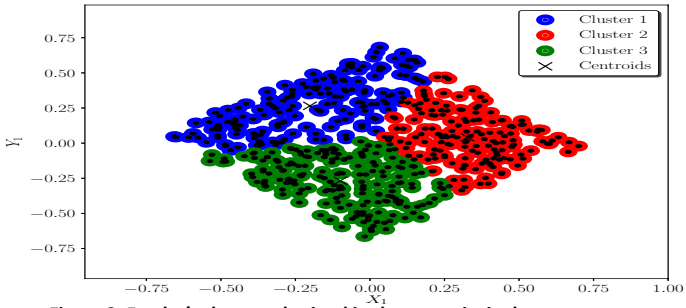

Figure 3. Feeder's clusters obtained in the two principal components with K-means algorithm and PCA analysis

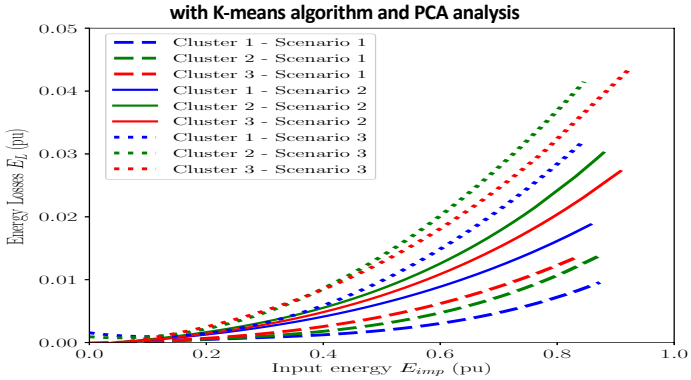

Figure 4. Energy losses curve for each cluster and scenario

Case Study

The proposed tool is applied in the Spanish demonstration project OSIRIS. The project scenario concerns a primary substation that supplies power to **31,000 residential and commercial customers** in a region located in the south of Madrid (Spain) with a total contracted power of **155 MW distributed in 750 feeders** having an accumulated length of 164 km. A selection of the OSIRIS feeders is shown in Fig. 1. Each Feeder is classified in the 3 clusters obtained and the energy losses are estimated with the corresponding losses curve obtained by the regression analysis given the input energy as indicted in Fig. 5.

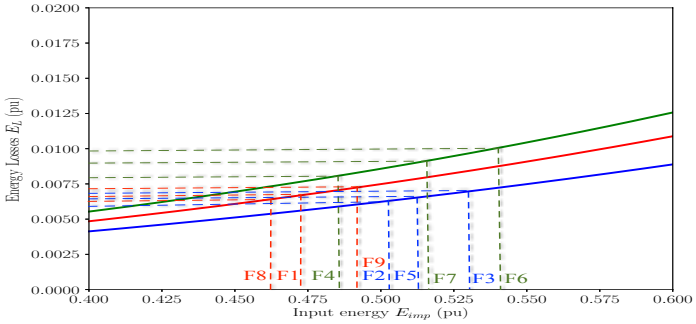

Figure 5. Energy losses estimation of OSIRIS feeders selection

Conclusion

The proposed losses estimation tool allows the estimation of the energy lost in a LV smart grid given only the input energy and the cluster from which the feeder belongs.