ICEEE2018

Energy Losses Estimation in Low Voltage Smart Grids by using Loss Maps

J-A. Velasco[1], H. Amarís[1], M. Alonso[1] and M. Miguelez[2]

[1]Universidad Carlos III de Madrid (Madrid, Spain)

[2]Union Fenosa Distribucion (Madrid, Spain)

International Conference on Energy, Environment and Economics
14-16 August 2018, Heriot-Watt University, Edinburgh

Contents

1. Introduction
2. Methodology
3. Case study
4. Conclusions

Introduction

- EU energy policy target by 2020:
  - ✓ 20% increase energy efficiency

Introduction

- EU energy policy target by 2020:
  - ✓ 20% increase energy efficiency

- Electricity sector is crucial:
  - ✓ Distribution losses across Europe :1.35-7.67% (of the power injected)
  - ✓ LV distribution systems have the majority of losses

Introduction

- EU energy policy target by 2020:
  - ✓ 20% increase energy efficiency
- Electricity sector is crucial:
  - ✓ Distribution losses across Europe :1.35-7.67% (of the power injected)
  - ✓ LV distribution systems have the majority of losses
- Regulatory incentives for DSOs
  - ✓ Motivation for identify and reduce energy losses

CEEE2018

Introduction

- Losses estimation in LV Smart Grids is affected by uncertainty
  a) Presence of non-metered customers
  b) Existence of non-technical losses (energy theft)
  c) Topology network uncertainty (connections)

CEEE2018

Introduction

- Losses estimation in LV Smart Grids is affected by uncertainty
  a) Presence of non-metered customers
  b) Existence of non-technical losses (energy theft)
  c) Topology network uncertainty (connections)

- Solution proposed for losses estimation:

Feeder classification method in groups of maximum losses based on topological and operational properties and represent them in a loss map

Contents

Methodology

- Classification approach is adopted by appliying **Linear Discriminant Analysis (LDA)**

CEEE2018

Methodology

- Classification approach is adopted by appliying **Linear Discriminant Analysis (LDA)**
- Find a **linear combination** of **features** that separate two or more classes

Methodology

- Classification approach is adopted by appliying **Linear Discriminant Analysis (LDA)**
- Find a **linear combination** of **features** that separate two or more classes
- Classes have to be known “a priori”

Methodology

- Classification approach is adopted by appliying **Linear Discriminant Analysis (LDA)**
- Find a **linear combination** of **features** that separate two or more classes
- Classes have to be known “a priori”

Classes -> Levels of maximum losses:
(1%, 2%, 3%, 4%)

Features-> Customized Coordinates: $[X_F \ , \ Y_F]$

CEEE2018

Methodology

- **Classification parameters:**

1. Key parameter of the feeders

CEEE2018

Methodology

- **Classification parameters:**

1. Key parameter of the feeders

(1) Relative lateral branch length *i*

$$L_{D,i} = \frac{l_i}{L_S} = \frac{\sum_k^{N_k} l_{i,k}}{L_S} \qquad (1)$$

CEEE2018

Methodology

- **Classification parameters:**

1. Key parameter of the feeders

(1) Relative lateral branch length *i*

$$L_{D,i} = \frac{l_i}{L_S} = \frac{\sum_k^{N_k} l_{i,k}}{L_S} \qquad (1)$$

(2) Relative lateral branch position *i*

$$K_{D,i} = \frac{k_i}{L_S} \qquad (2)$$

CEEE2018

Methodology

- **Classification parameters:**

1. Key parameter of the feeders

(3) Weight of the lateral branch *i*

$$W_{D,i} = \frac{p_i}{P_T} = \frac{\sum_{k=1}^{N_D} p_{i,k}}{P_T} \qquad (3)$$

CEEE2018

Methodology

- **Classification parameters:**

1. Key parameter of the feeders

$$\boldsymbol{r_{1,i} = L_{D,i} \cdot W_{D,i}} \qquad (4)$$

$$\boldsymbol{r_{2,i} = K_{D,i}} \qquad (5)$$

Methodology

- **Classification parameters:**

2. Coordinates of the feeder

$$X_F = \frac{\sum_{k=1}^{N_D} r_{1,k}}{N_D} \qquad (6)$$

$$Y_F = \frac{\sum_{k=1}^{N_D} r_{2,k}}{N_D} \qquad (7)$$

Methodology

- **Obtaining the loss map**

1. Training set of feeders (max. losses known)
2. Calculate classification parameters (features)
3. Apply LDA to obtain the loss map

CEEE2018

Methodology

- **Obtaining the loss map**

1. Training set of feeders (max. losses known)
2. Calculate classification parameters (features)
3. Apply LDA to obtain the loss map

- **Losses Estimation**

1. Calculate classification parameters (features)
2. Represent each feeder in the loss map: assign a max. power losses class

Contents

1. Introduction
2. Methodology
3. Case study
4. Conclusions

CEEE2018

Case Study

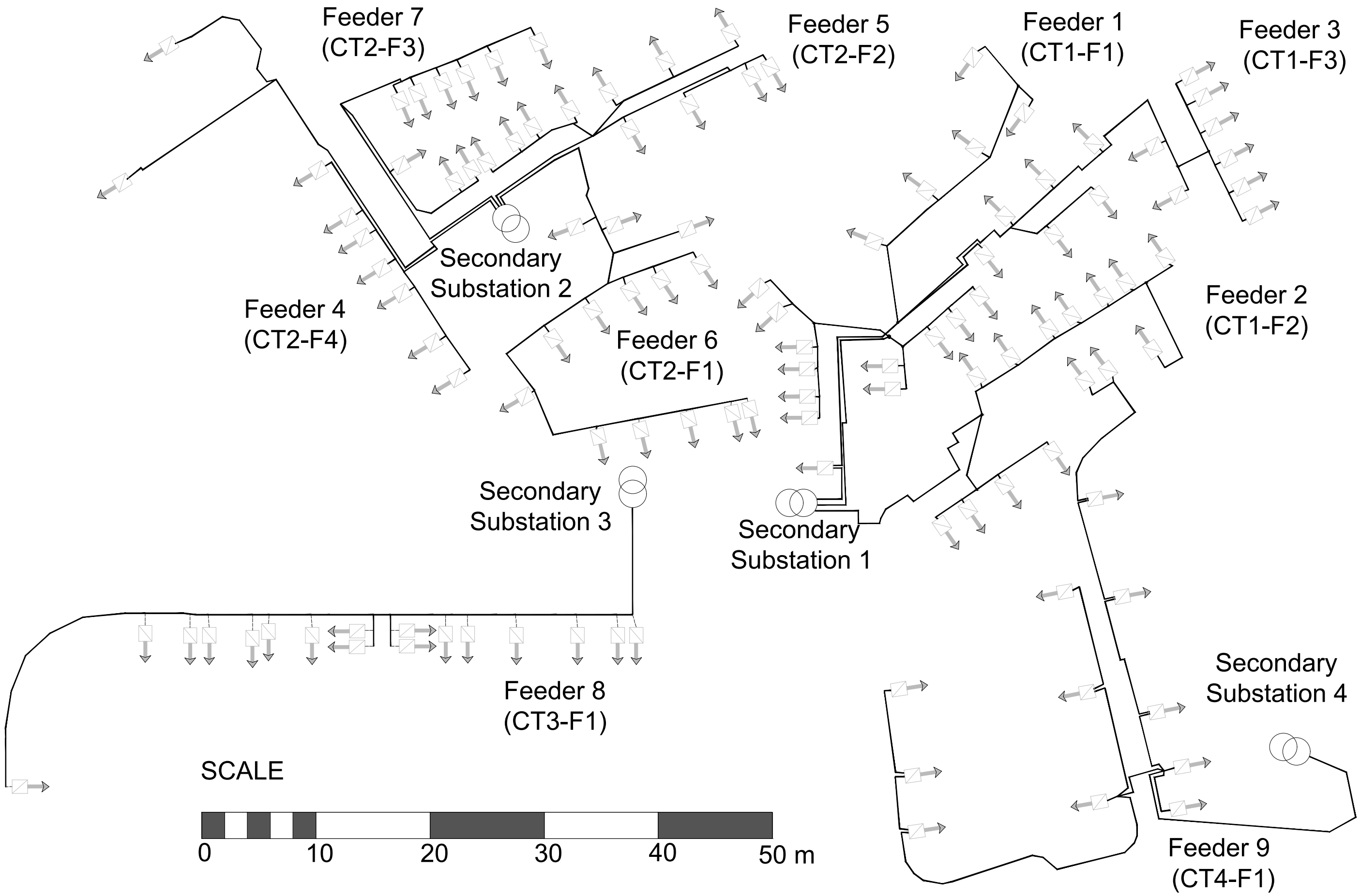
- Demonstration project **OSIRIS** (Spain)
  - Utility Gas Natural Fenosa (Naturgy)
  - 31000 clients (residential and commercial)
  - 155 MW power contracted
  - 750 LV Feeder
  - 95% of clients with less than 15kW

Case Study

- Demonstration project **OSIRIS** (Spain)
  - ➢Utility Gas Natural Fenosa (Naturgy)
  - ➢31000 clients (residential and commercial)
  - ➢155 MW power contracted
  - ➢750 LV Feeder
  - ➢95% of clients with less than 15kW
- “Synthetic” training set
  - ✓Topology builder heuristic algorithm (1000 feeders)
  - ✓Montecarlo simulation for load demand
  - ✓Based on OSIRIS networks

Case Study

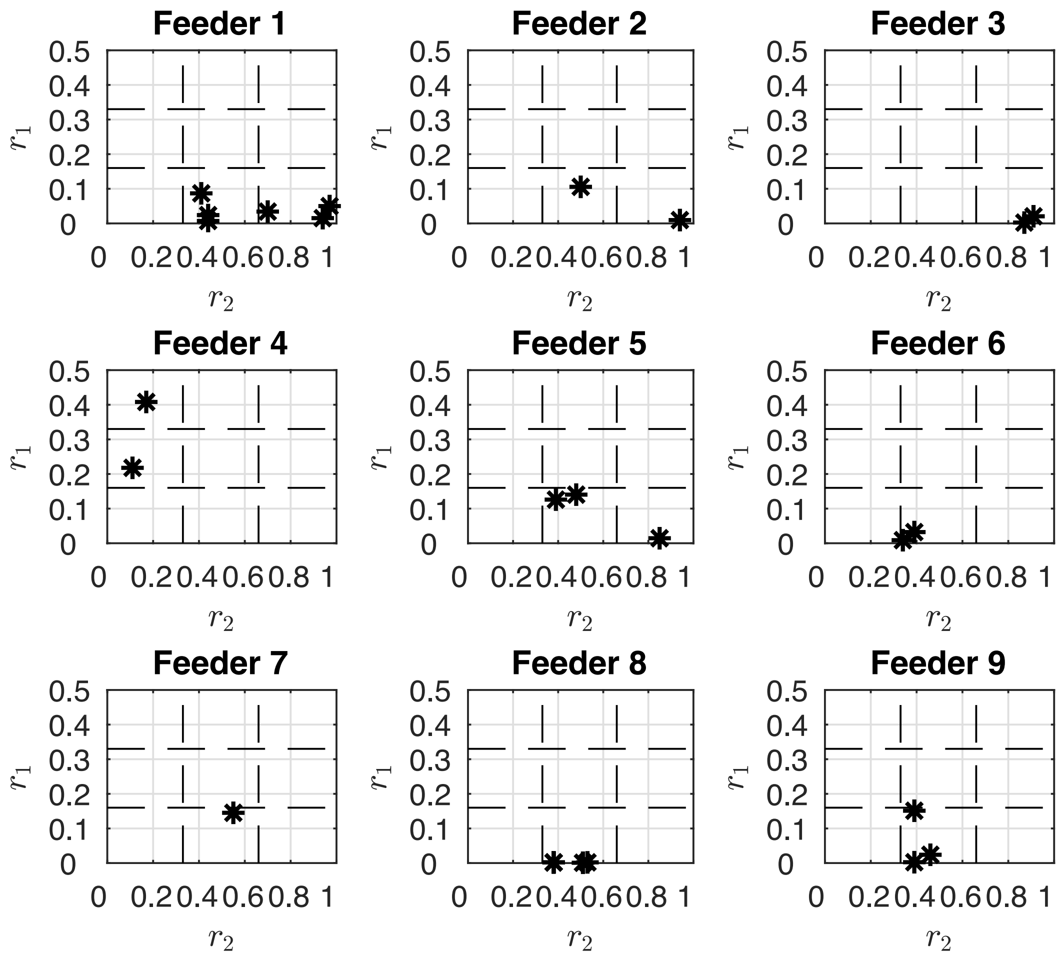
- Validation feeders



CEEE2018

Case Study

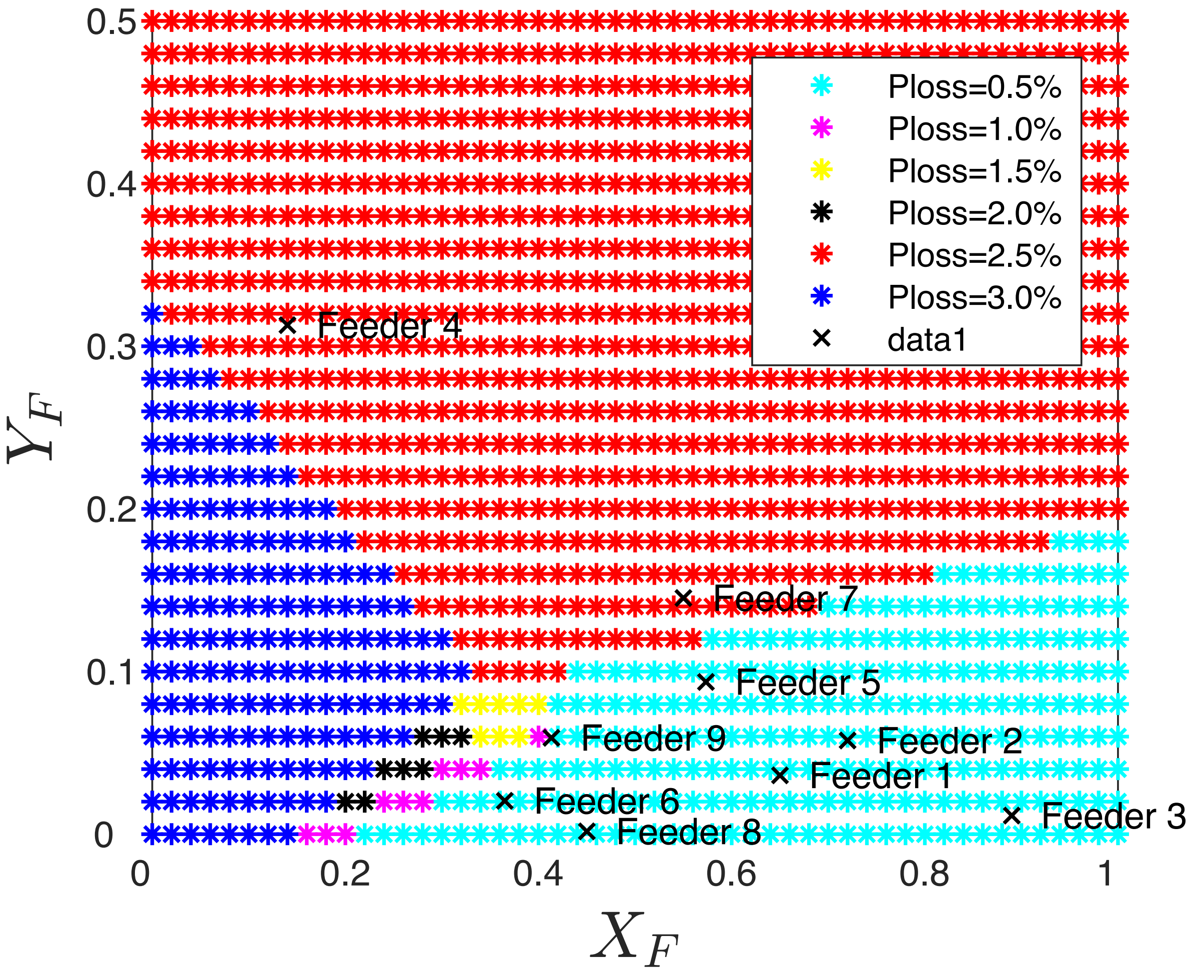
- Calculate classification parameters



CEEE2018

Case Study

- Representation in the loss map



Contents

Conclusions

- Method exploits similiraty of LV feeders
- Good-enough losses estimation for enerfy efficiency decision-making purposes
- Renewable-based Distributed Generation expansion plans

Thank you very much
for your attention

ICEEE2018