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Road to ZEN

Zero Emission Neighbourhoods

Bruno Galhardo (bgalhardo@eneida.io)

CHALLENGES OF THE LOW VOLTAGE GRID

TRADITIONAL GRID

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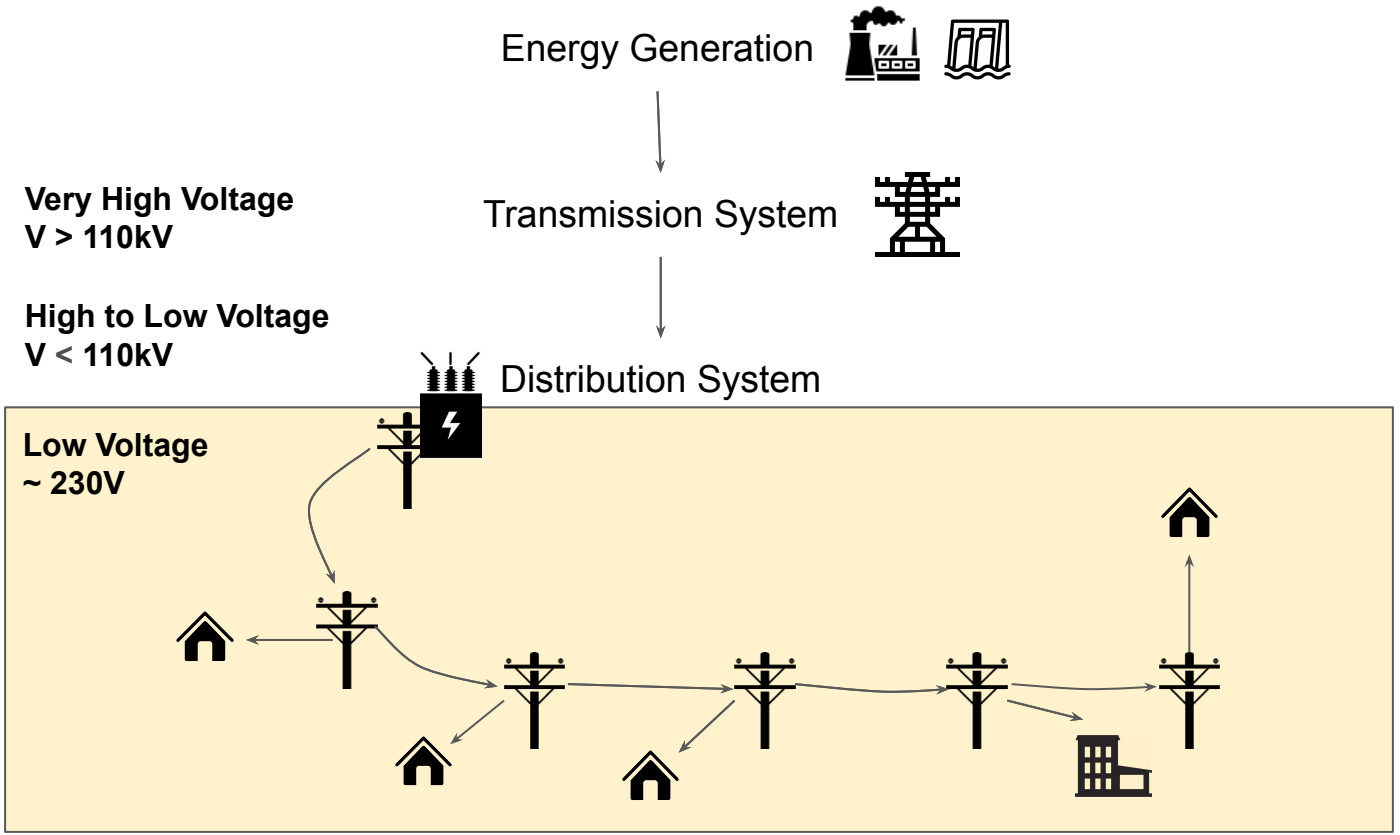
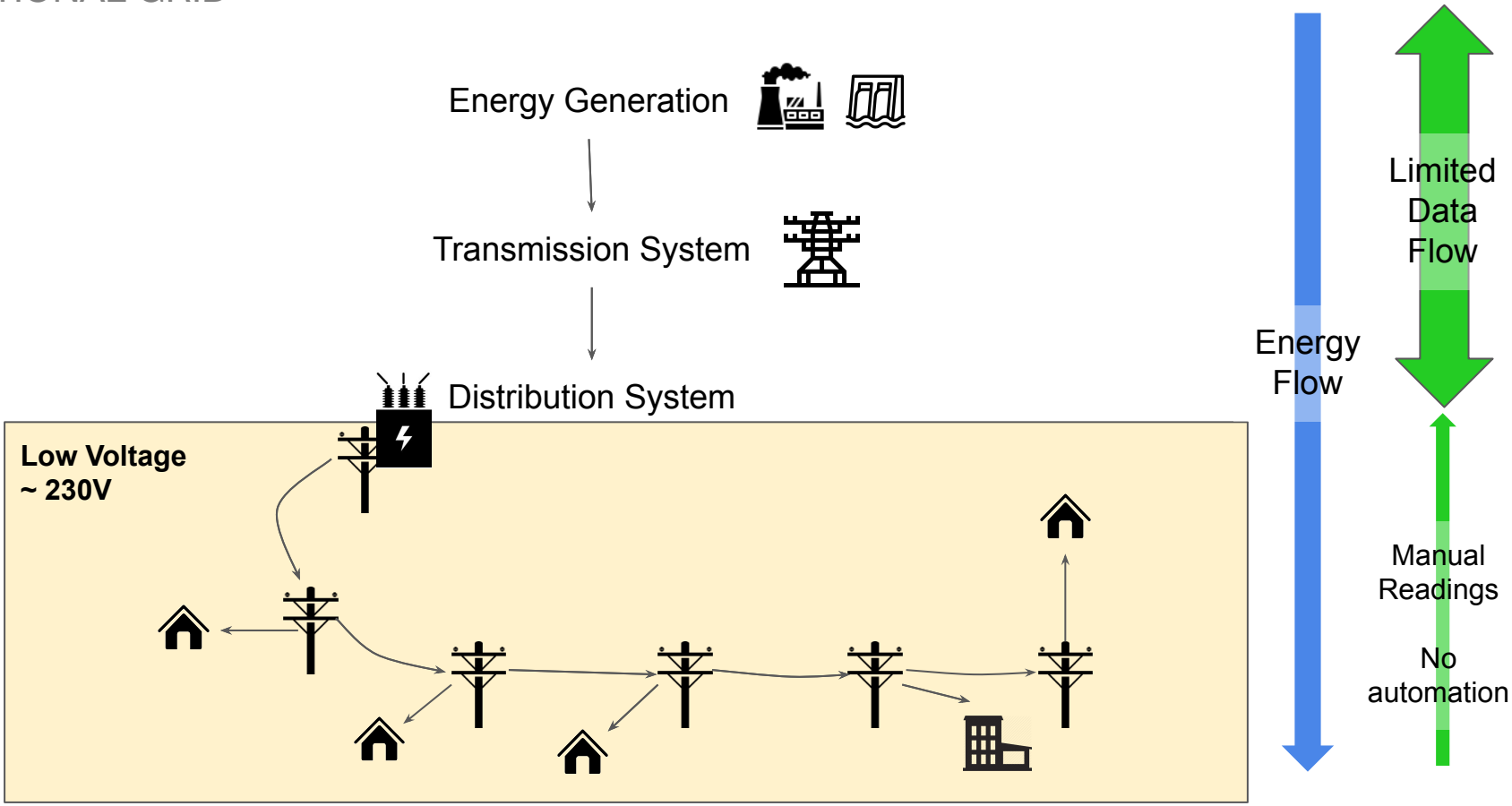


CHALLENGES OF THE LOW VOLTAGE GRID

TRADITIONAL GRID

ENEIDA.IO



CHALLENGES OF THE LOW VOLTAGE GRID

TRADITIONAL GRID

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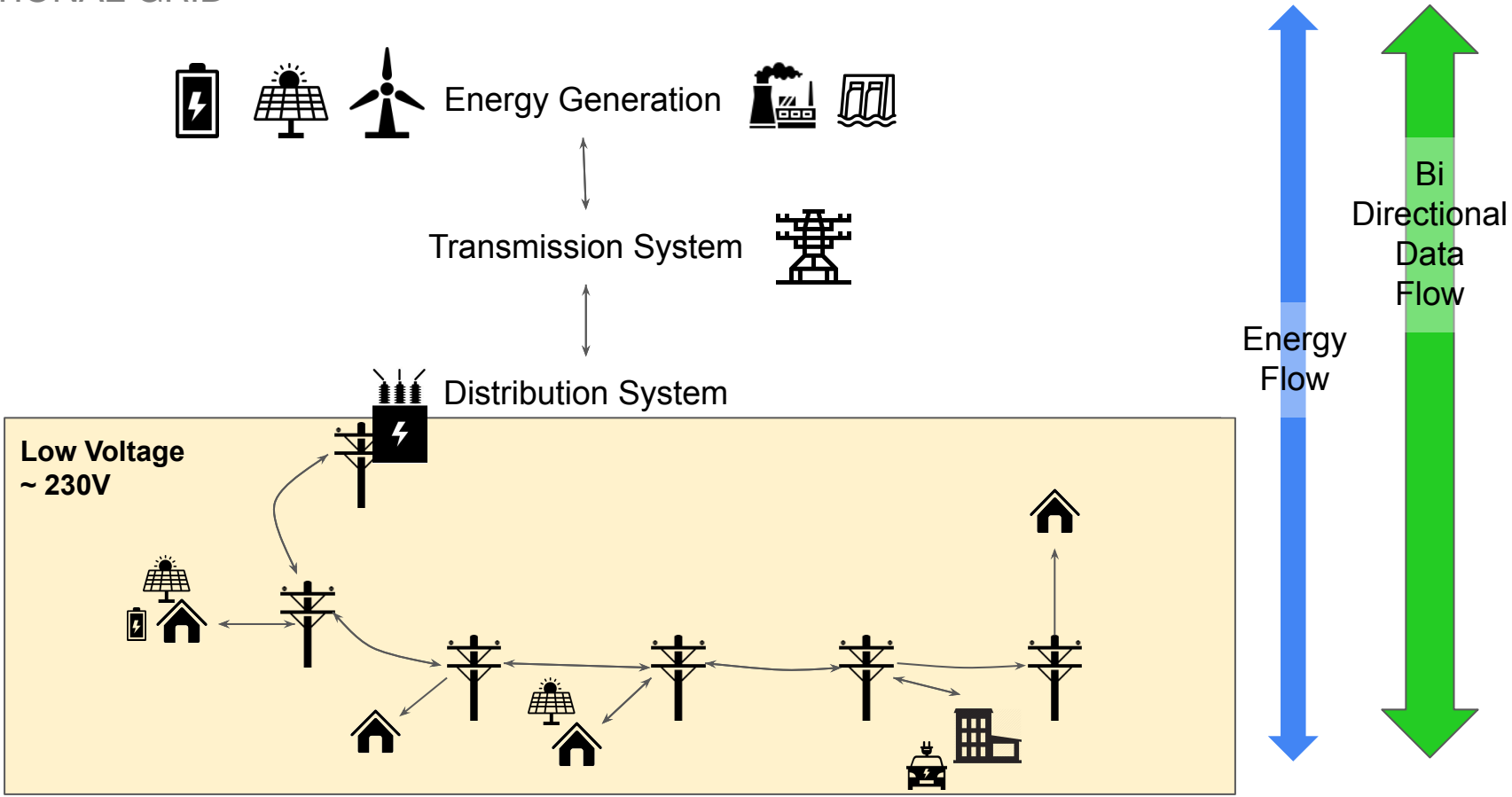

CHALLENGES OF THE LOW VOLTAGE GRID

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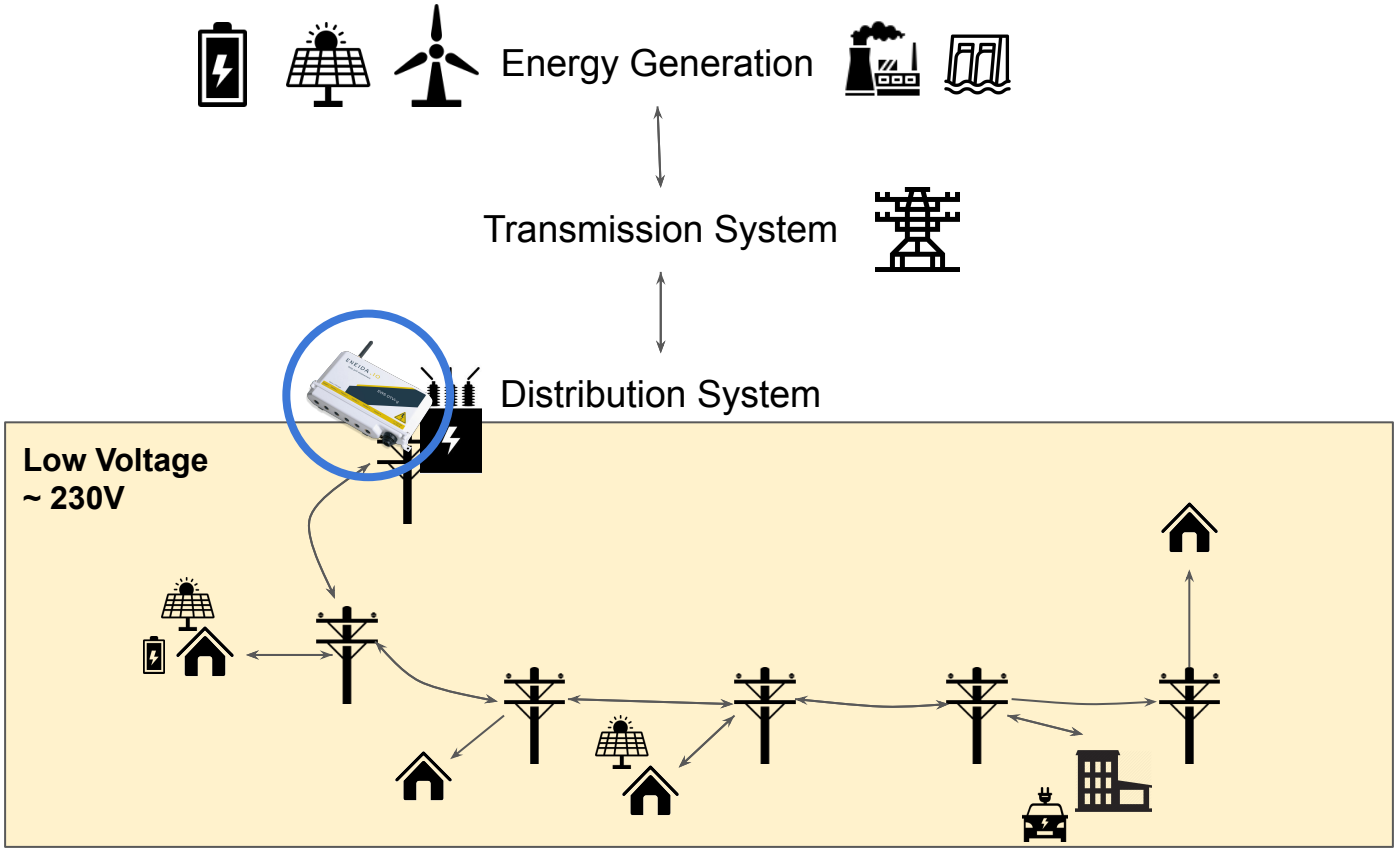
TRADITIONAL GRID



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SINCE 2012

GOAL: Monitor and optimize Low Voltage Grids

SOLUTION

VISIBILITY, CONTROL E INTELLIGENCE OF THE LOW VOLTAGE GRID

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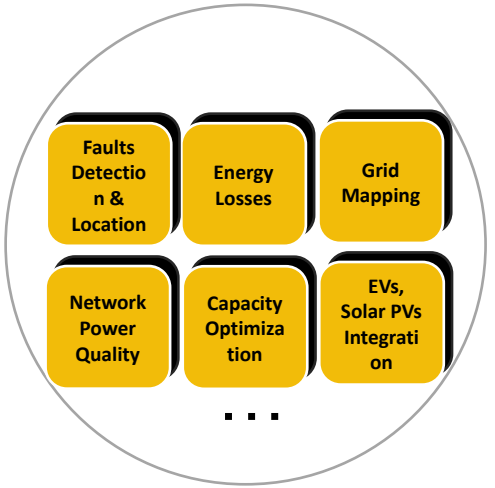
eneida DeepGrid®
EdgeSense

eneida DeepGrid®
Discovery



eneida DeepGrid®
Analytics Apps

SOLUTION

VISIBILITY, CONTROL E INTELLIGENCE OF THE LOW VOLTAGE GRID

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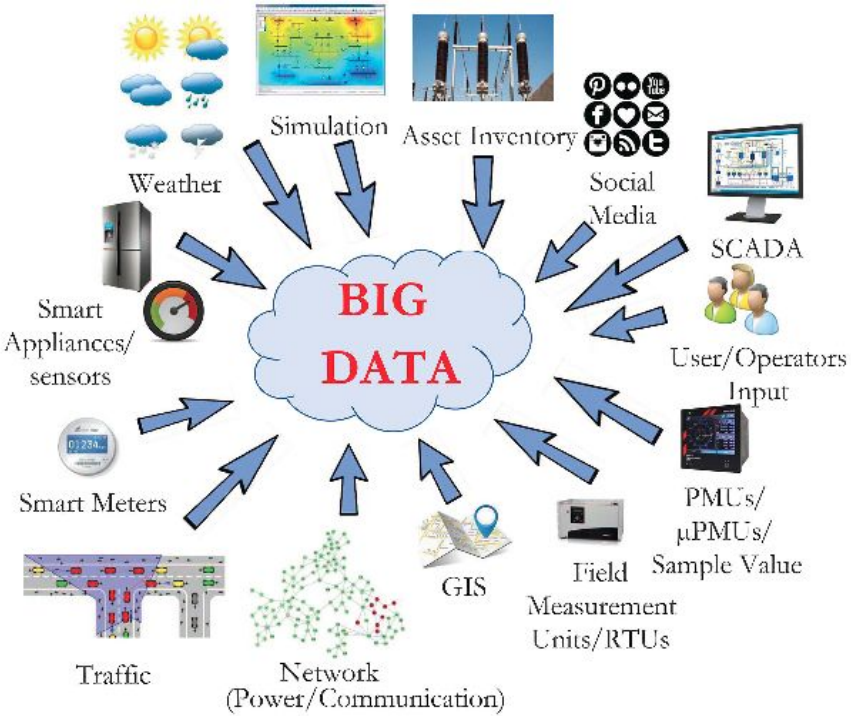

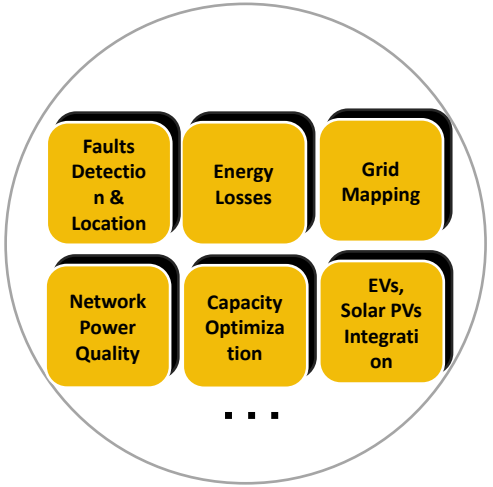

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Analytics Apps

Meter Mapping

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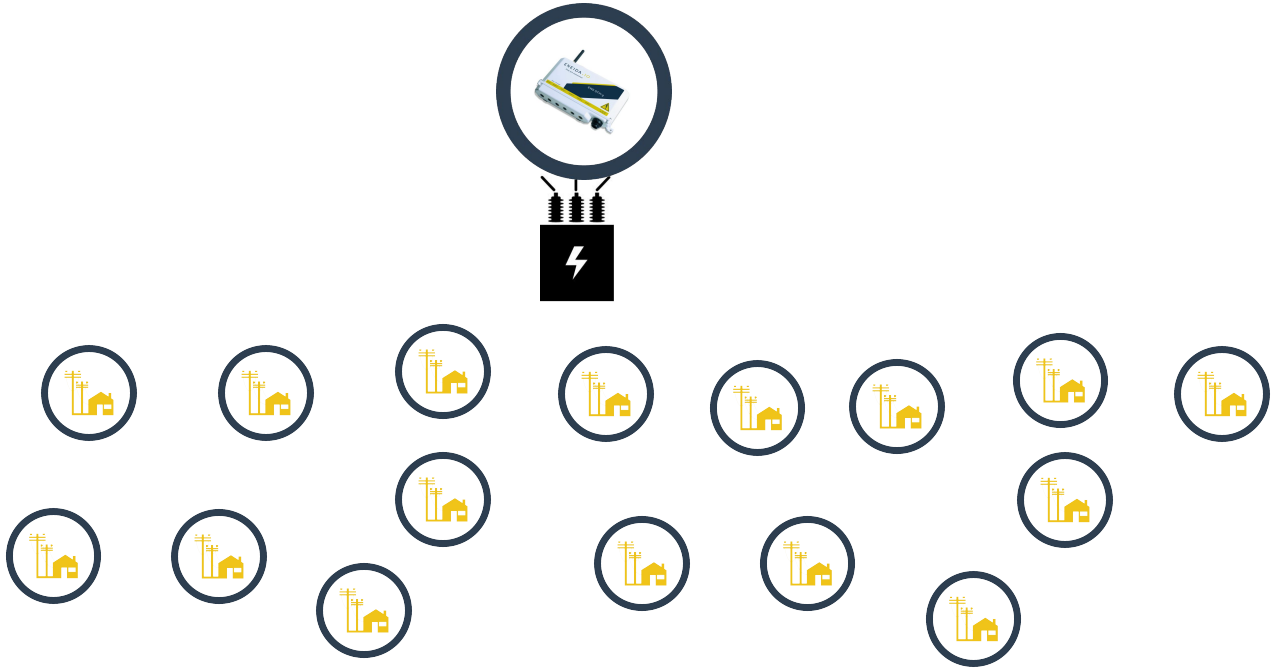
Deep grid assessment

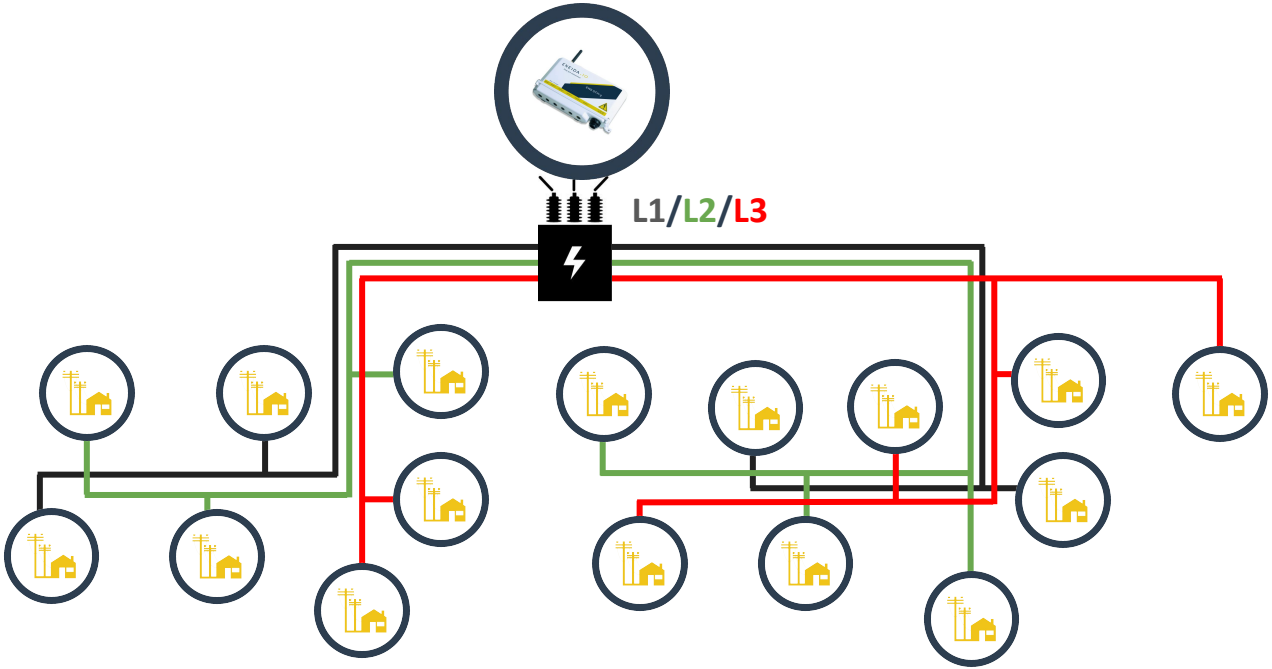
The Problem

Phase/Circuit at each location is unknown



The Problem

Phase/Circuit at each location is unknown



The Problem

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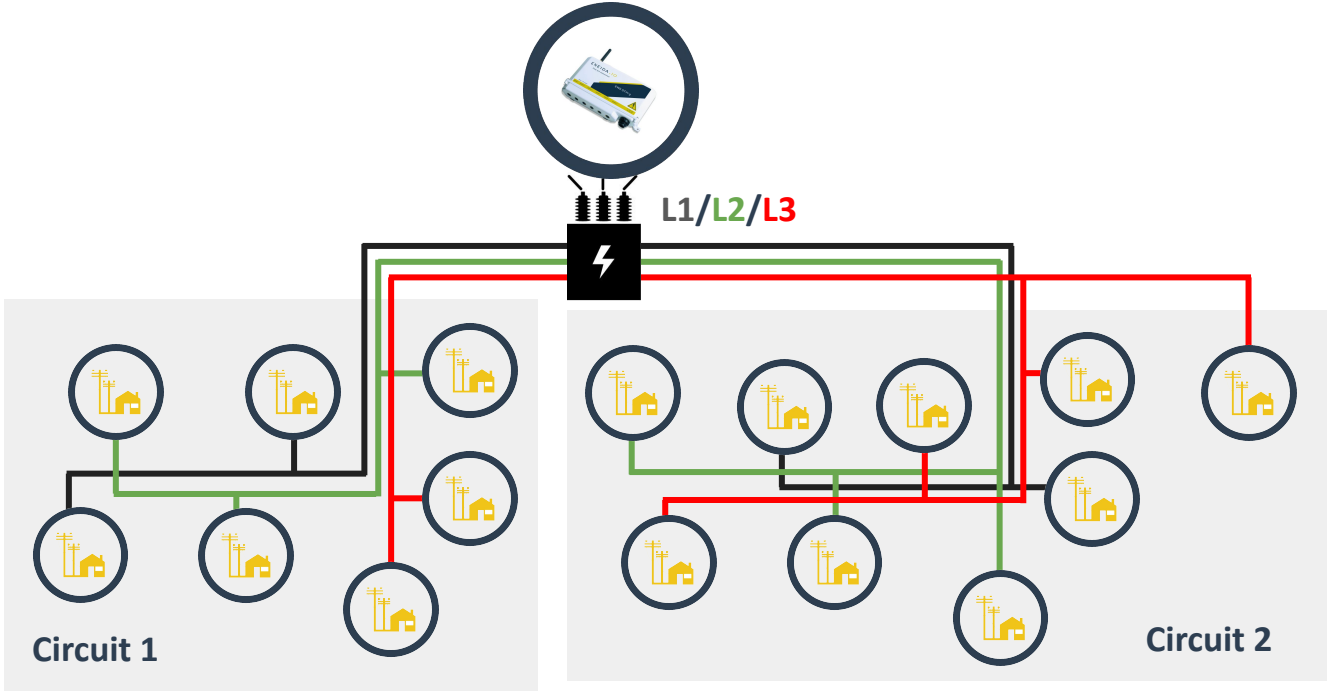
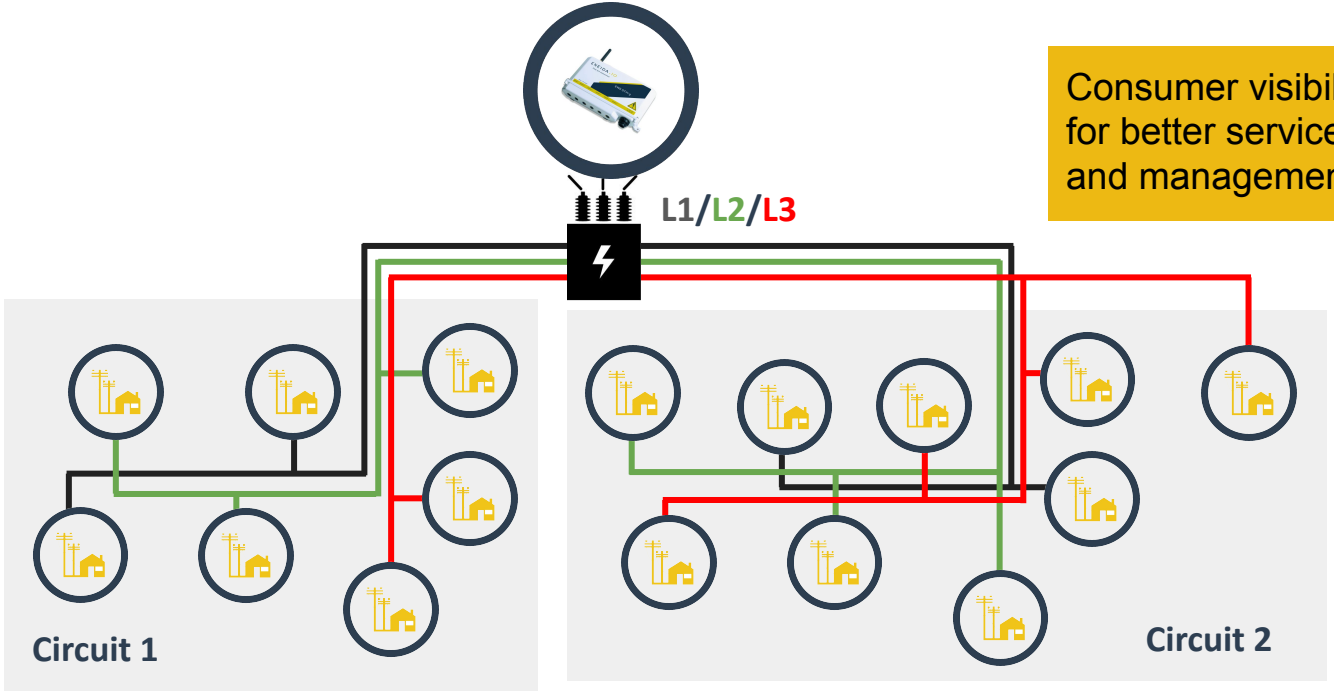


The Problem

Phase/Circuit at each location is unknown



Consumer visibility allows for better service planning and management

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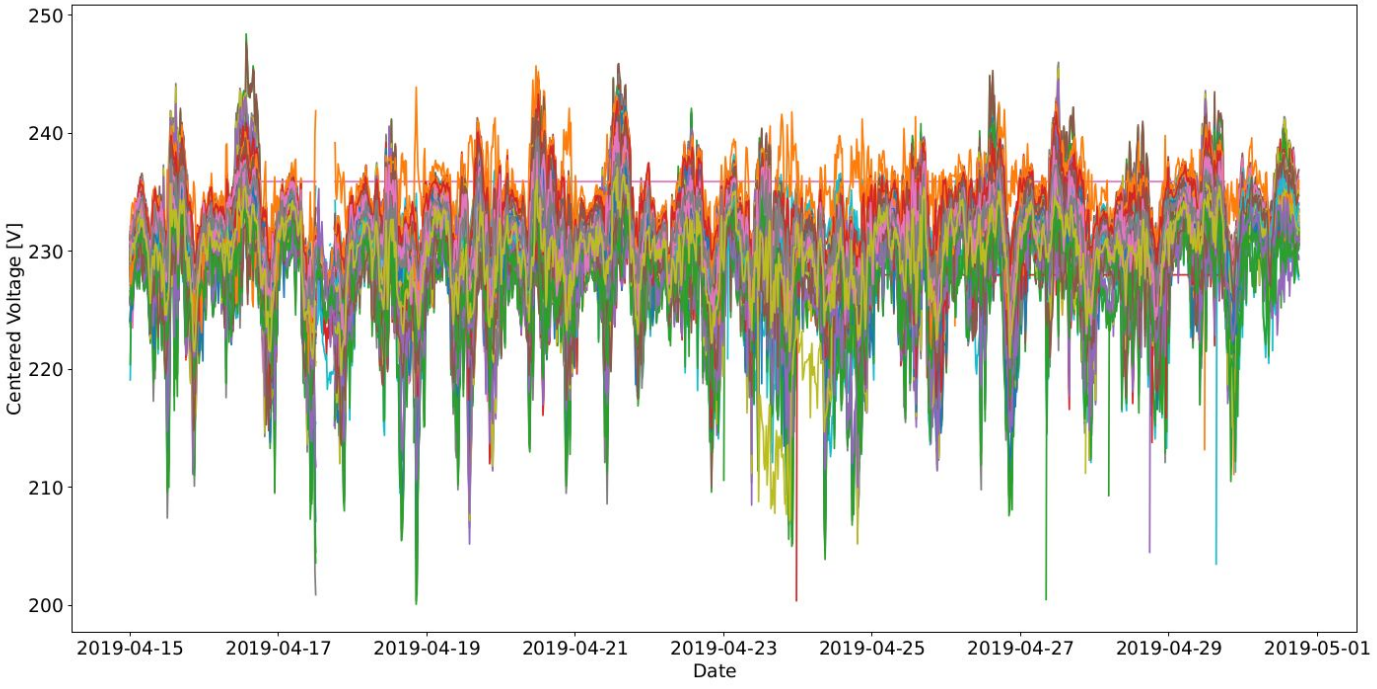
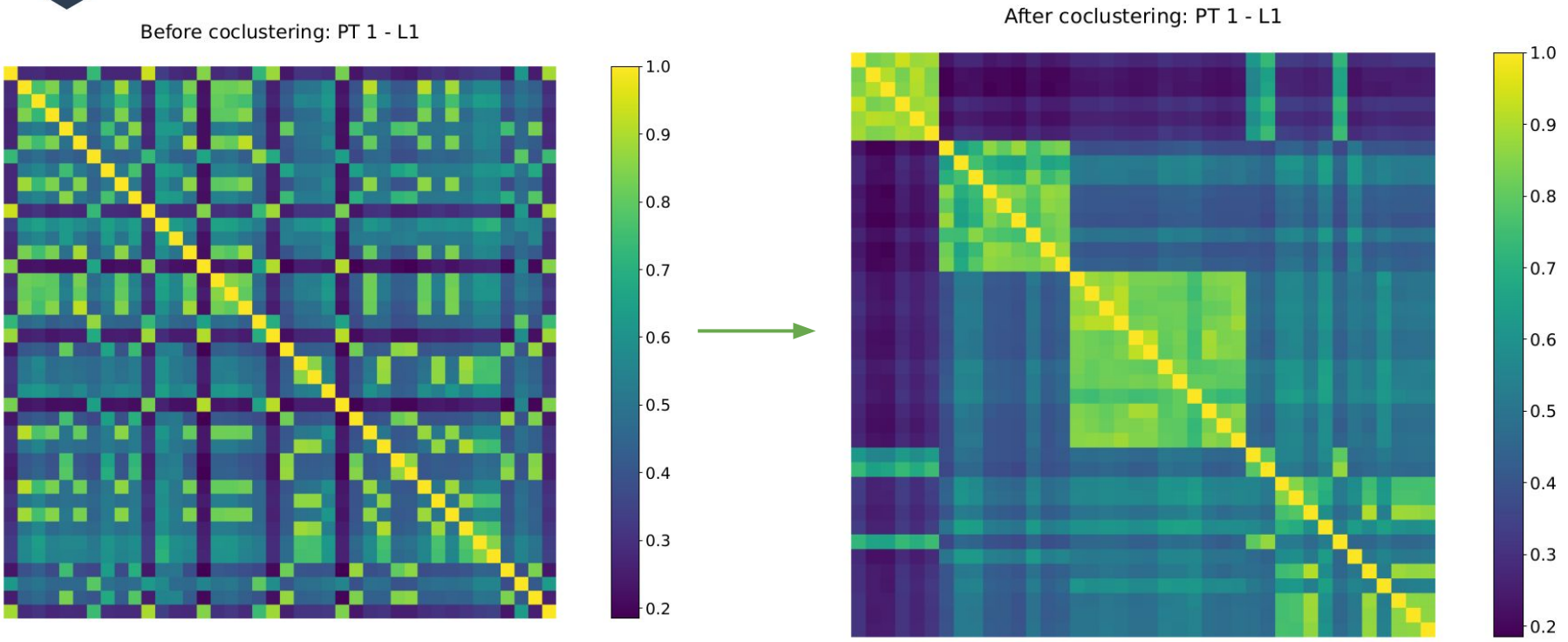
The Problem



Household **meters** in the same neighborhood measure very **similar Voltages**

Co-Clustering: Circuit Attribution



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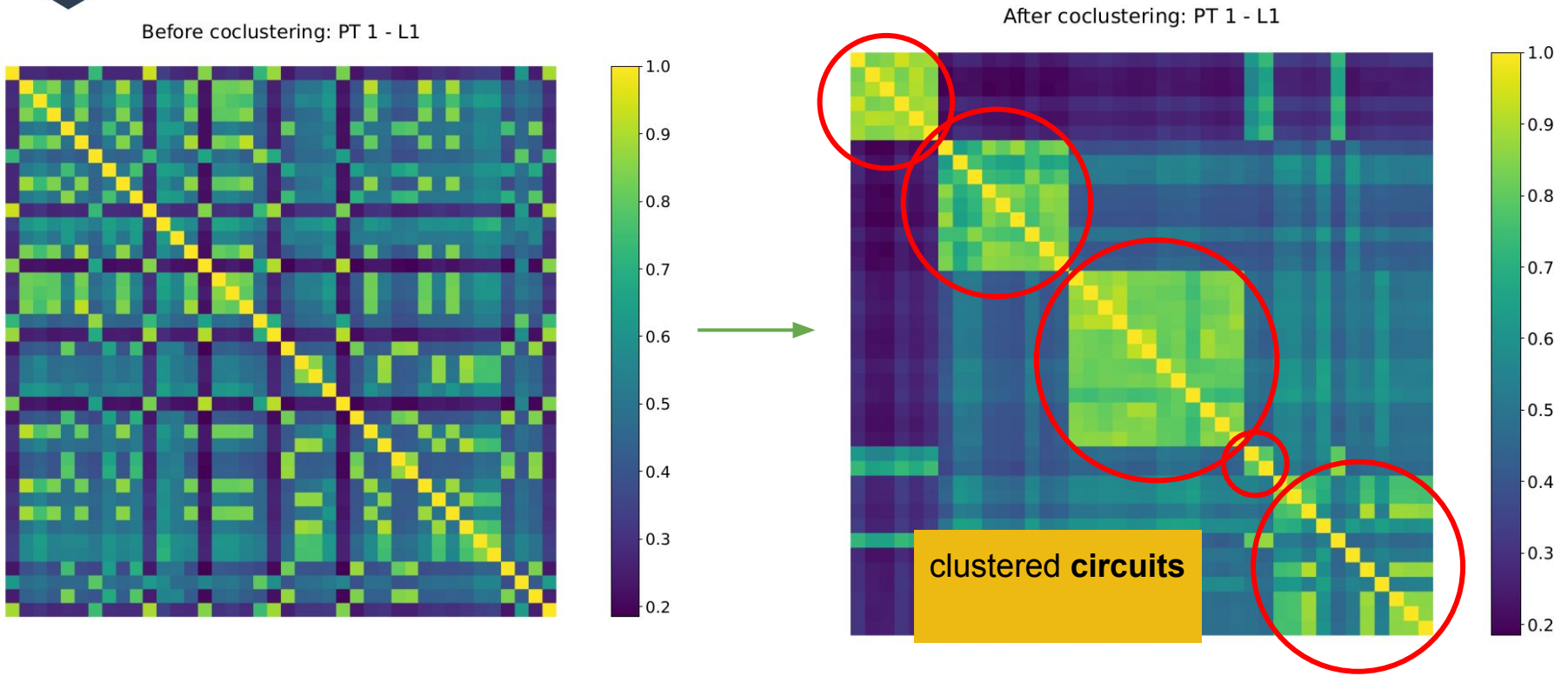
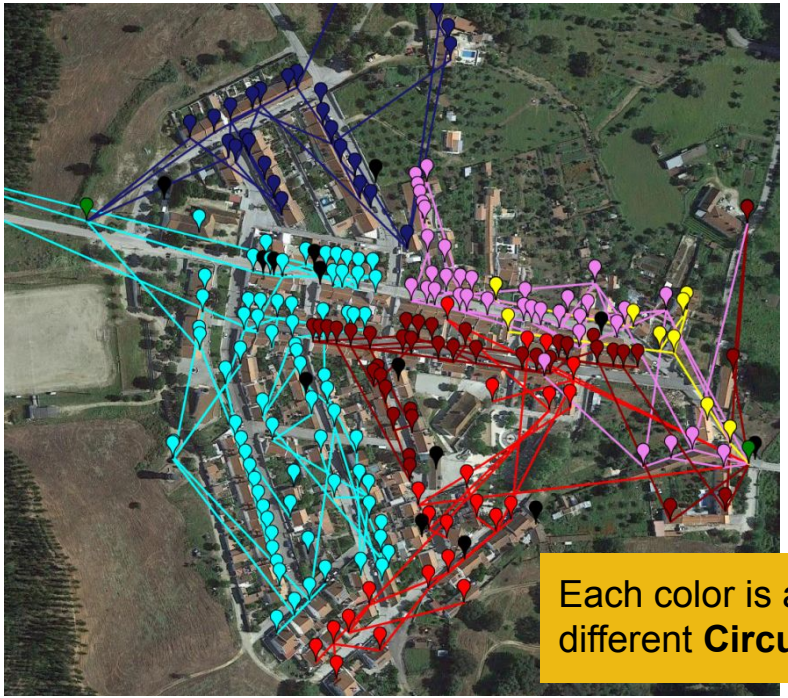
Co-Clustering: Circuit Attribution



Circuit assignment



Each color is a different **Circuit**

Series Forecast

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Deep grid assessment

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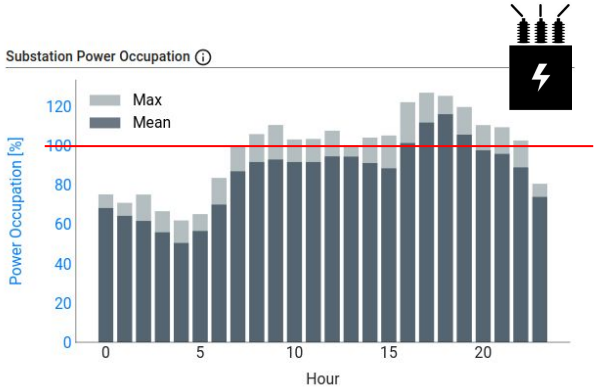
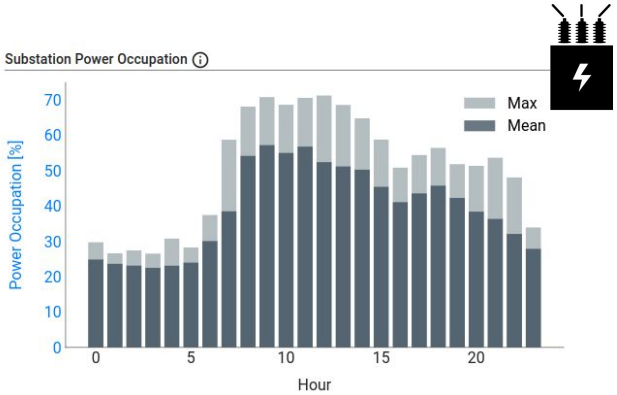
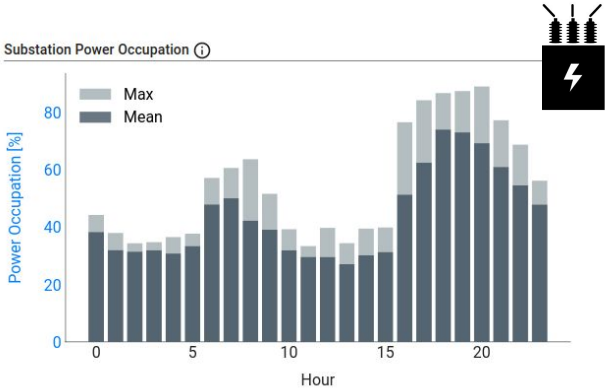
The Problem







The operator wants to know when a given **transformer** will not meet the demand

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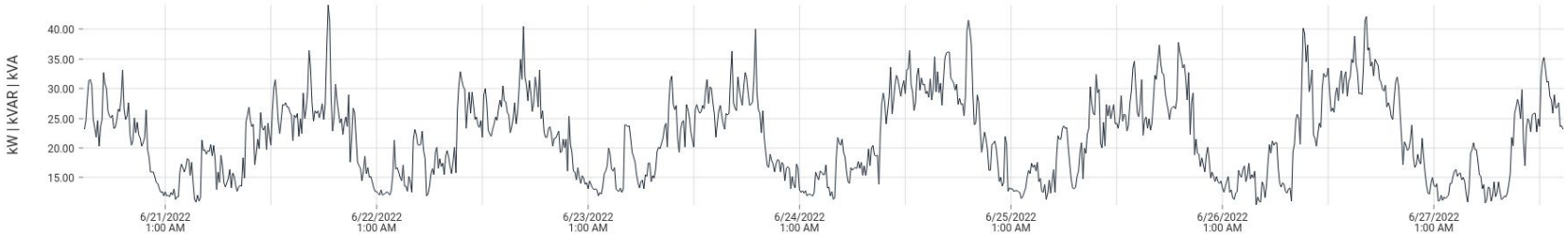
The Problem



Series Forecast

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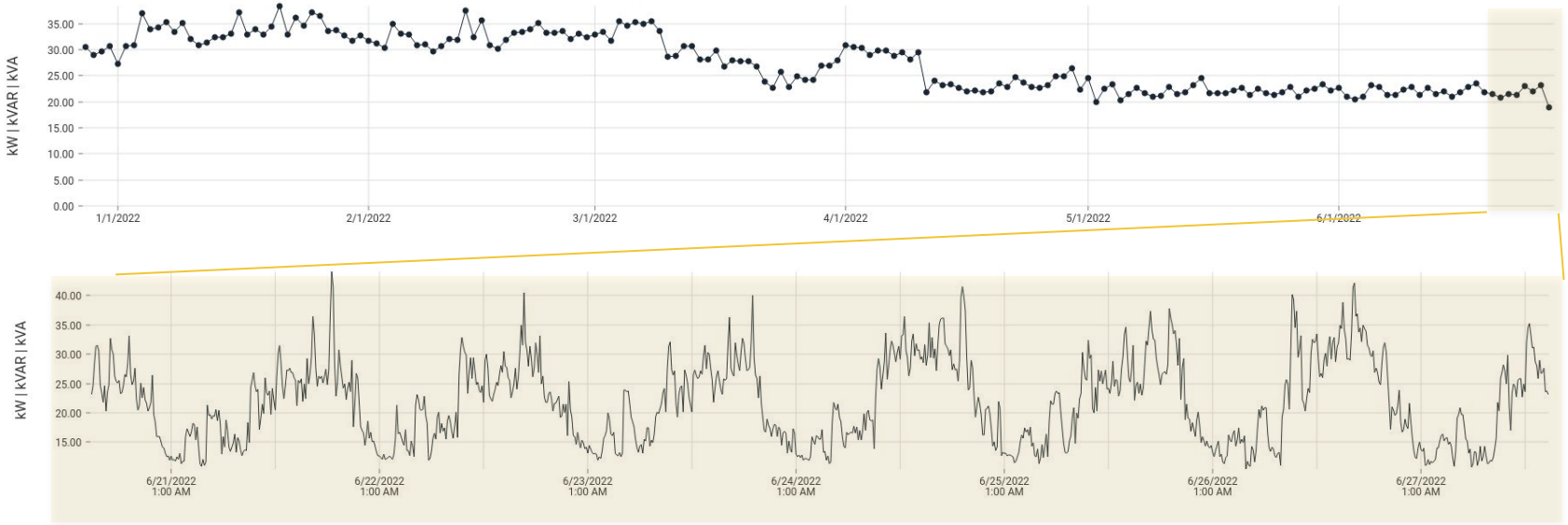
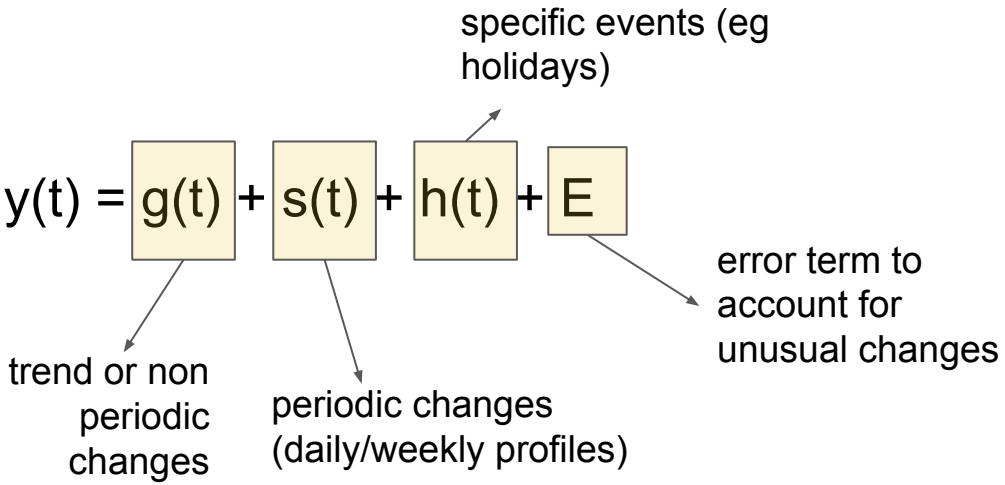
The Problem



?

Method


specific events (eg holidays)
y(t) = g(t) + s(t) + h(t) + E
error term to account for unusual changes
trend or non periodic changes
periodic changes (daily/weekly profiles)

Series Forecast

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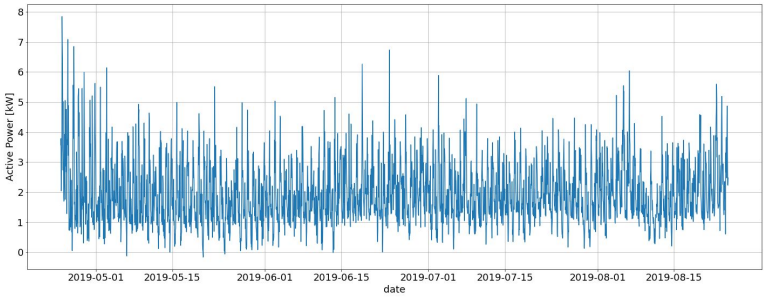
Method

$$y(t) = g(t) + s(t) + h(t) + E$$



trend

events

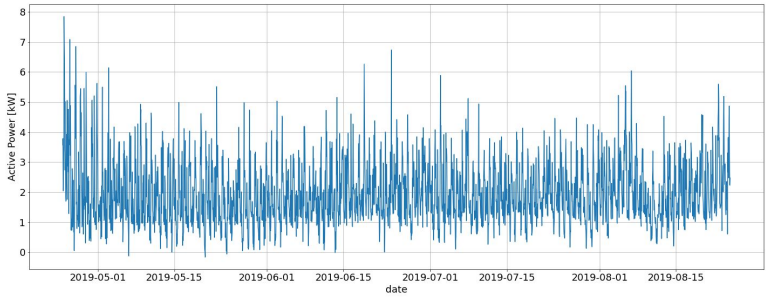
periodic series

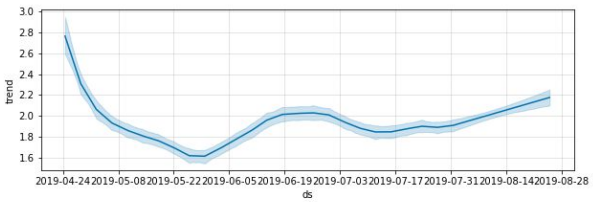
Series Forecast

ENEIDA.IO

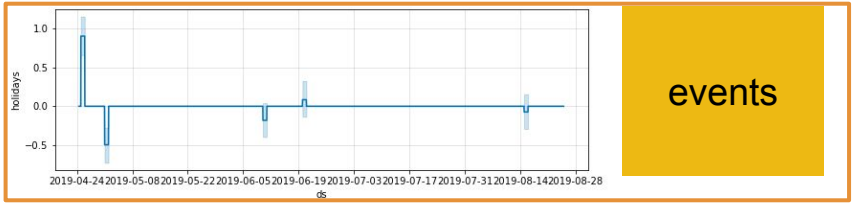
Method

$$y(t) = g(t) + s(t) + h(t) + E$$

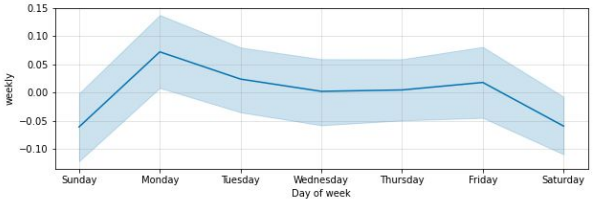


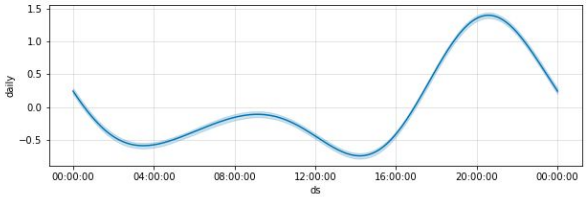


trend



events





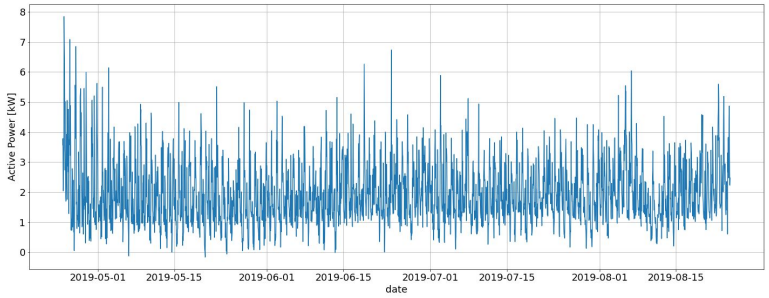
periodic series

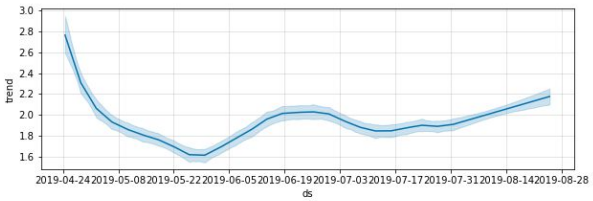
Series Forecast

ENEIDA.IO

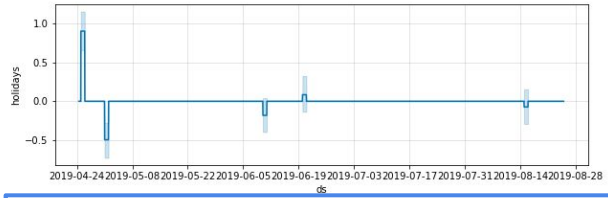
Method

$$y(t) = g(t) + s(t) + h(t) + E$$

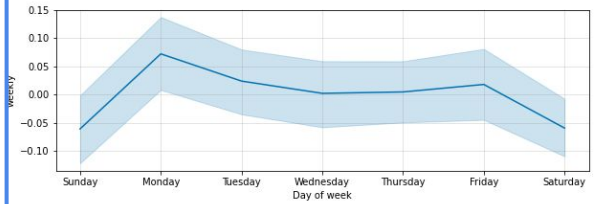


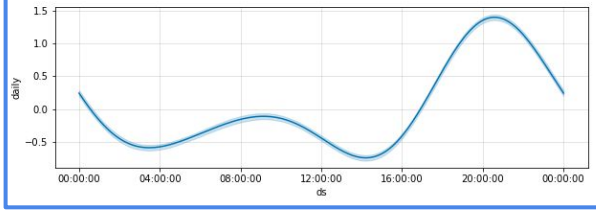


trend



events





periodic series

Series Forecast

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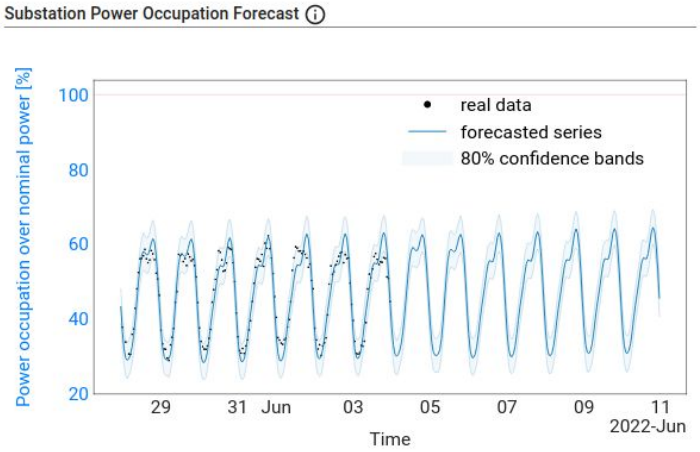
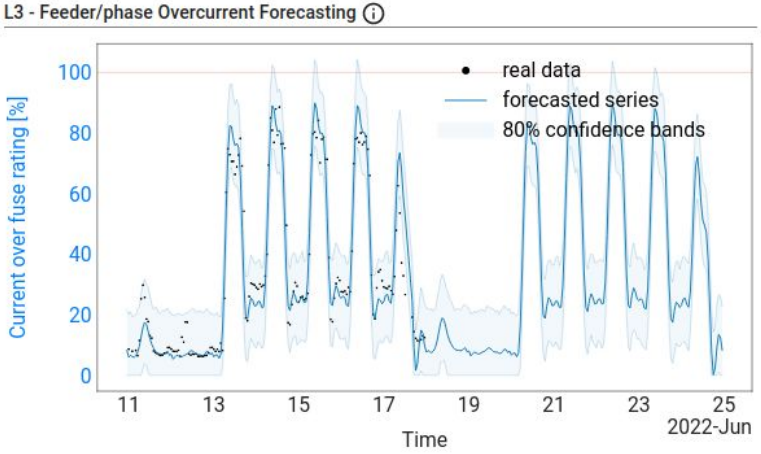
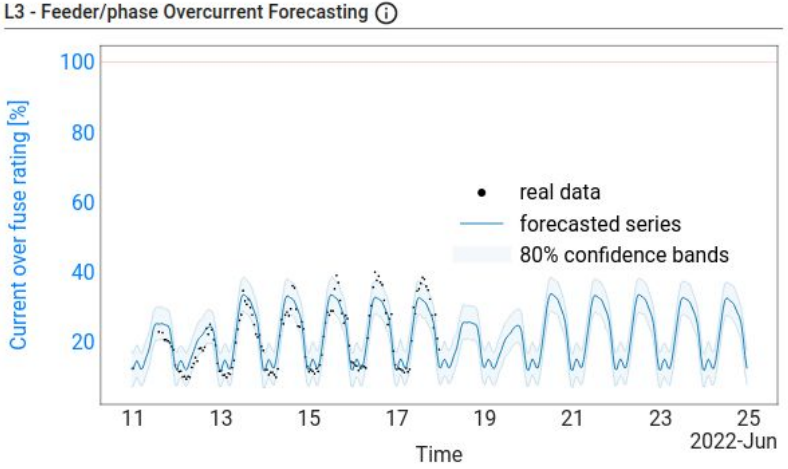
Result







Injection Decoupling

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Deep grid assessment

Injection Decoupling

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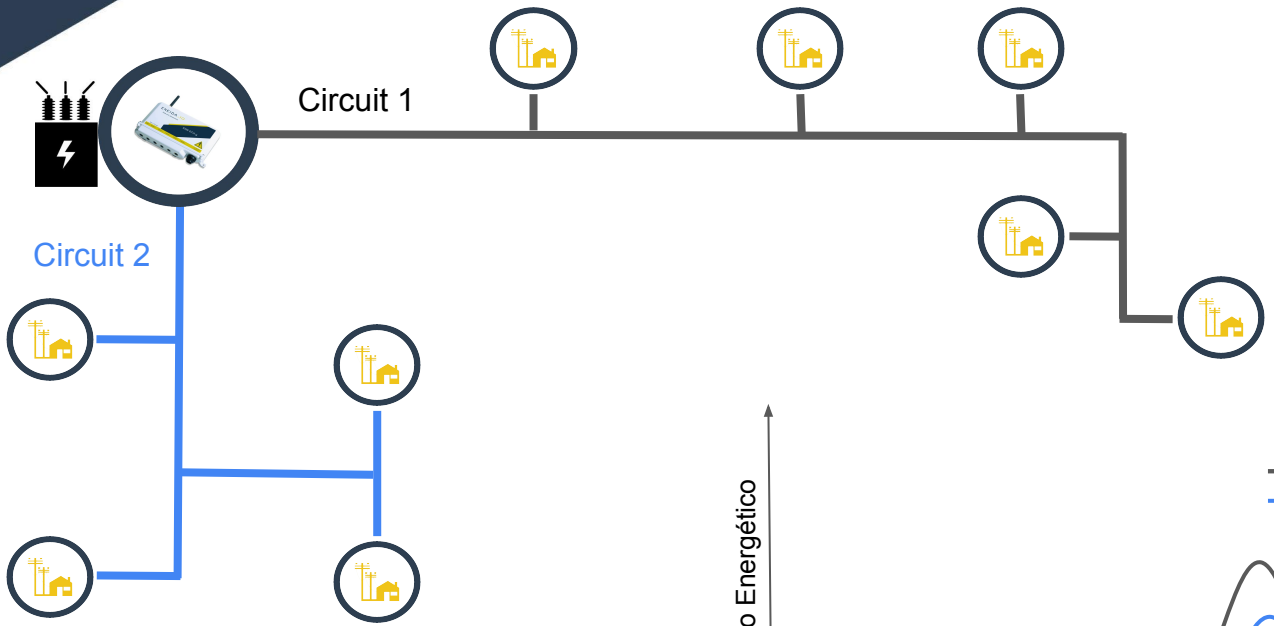
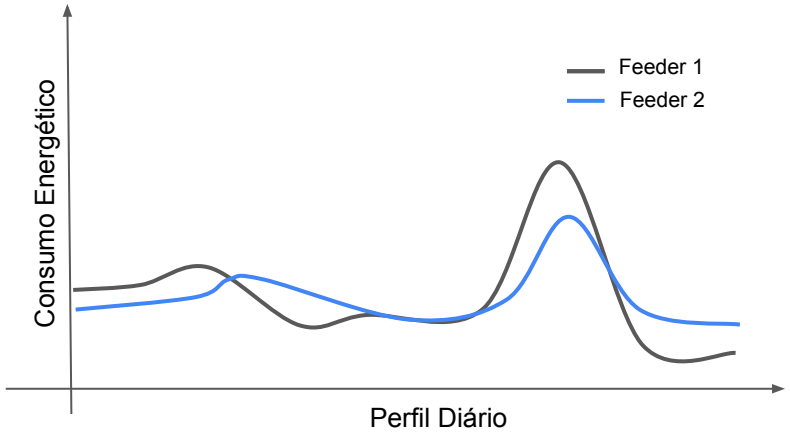
The Problem





Injection Decoupling

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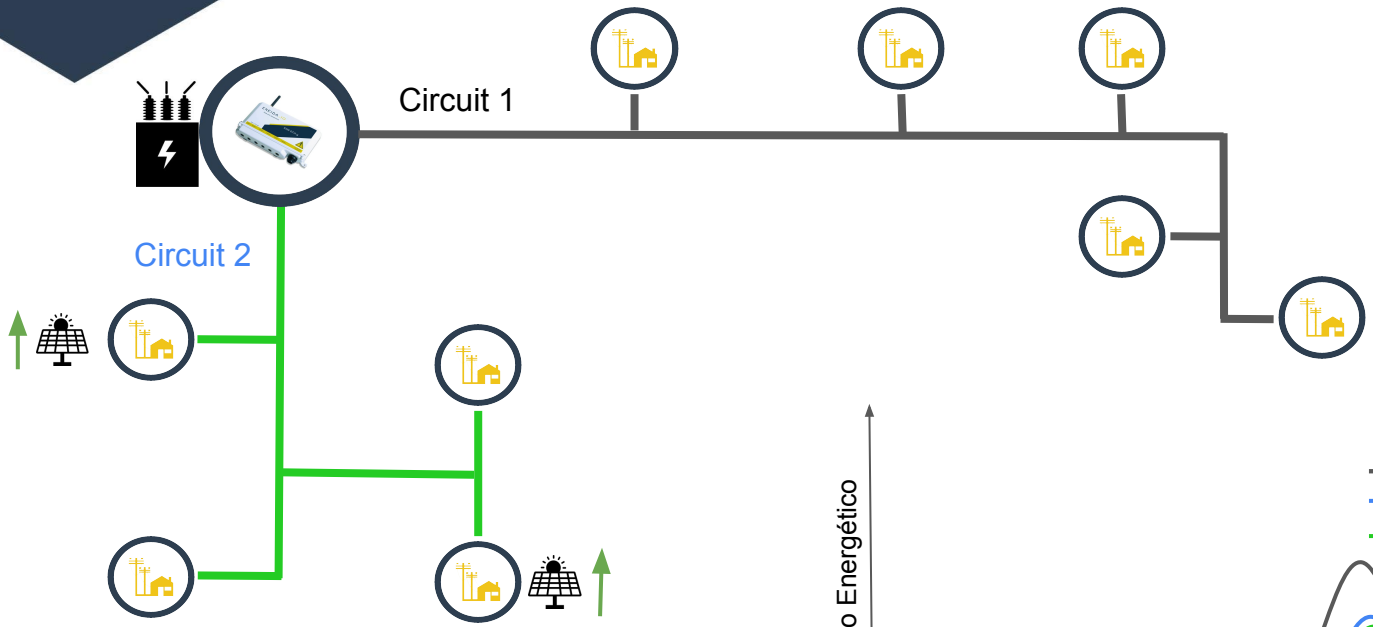
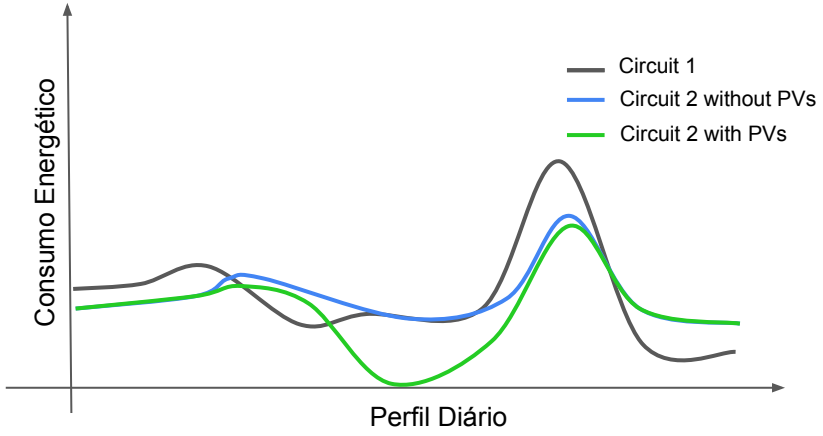
The Problem





- PV usage impacts what we perceive as the total consumption since a **transformer** with **low consumption in sunny days can be overloaded in cloudy days**.
- It also has voltage impacts in the neighborhood.

Injection Decoupling

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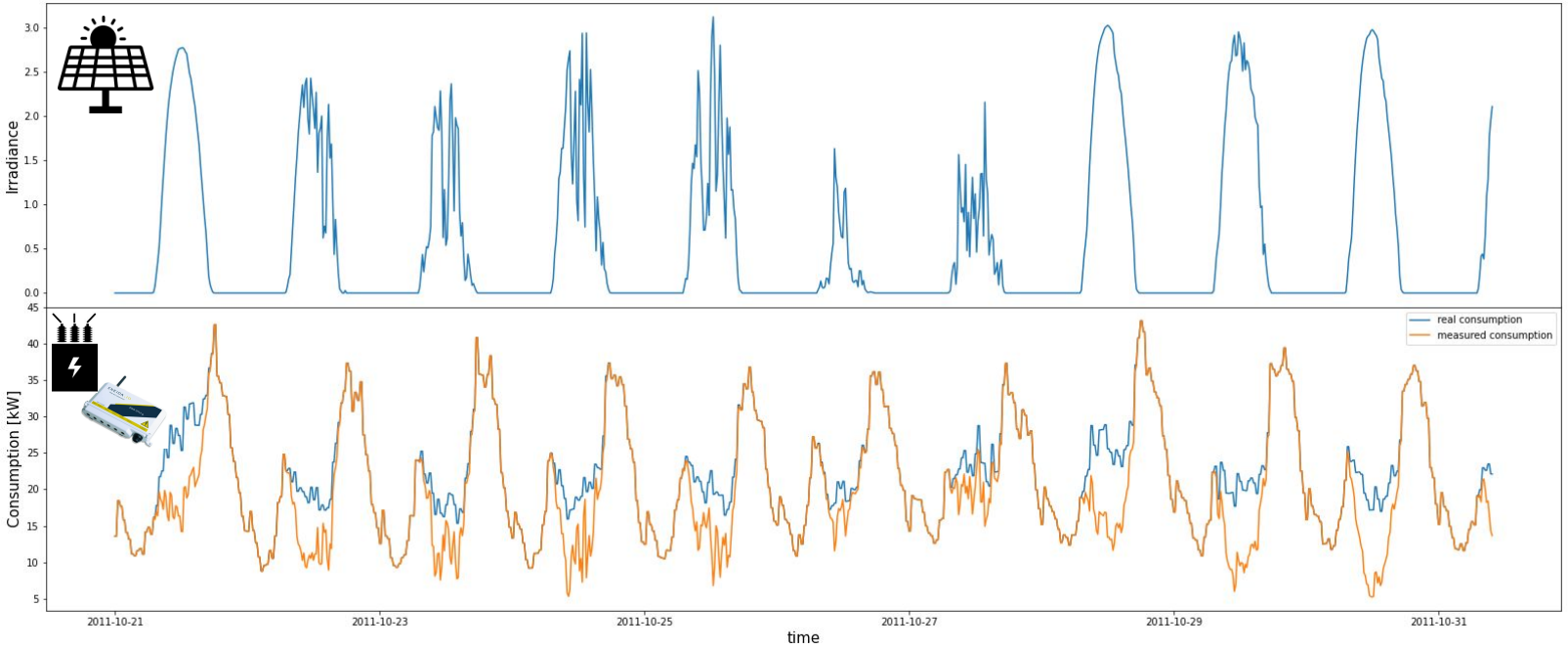
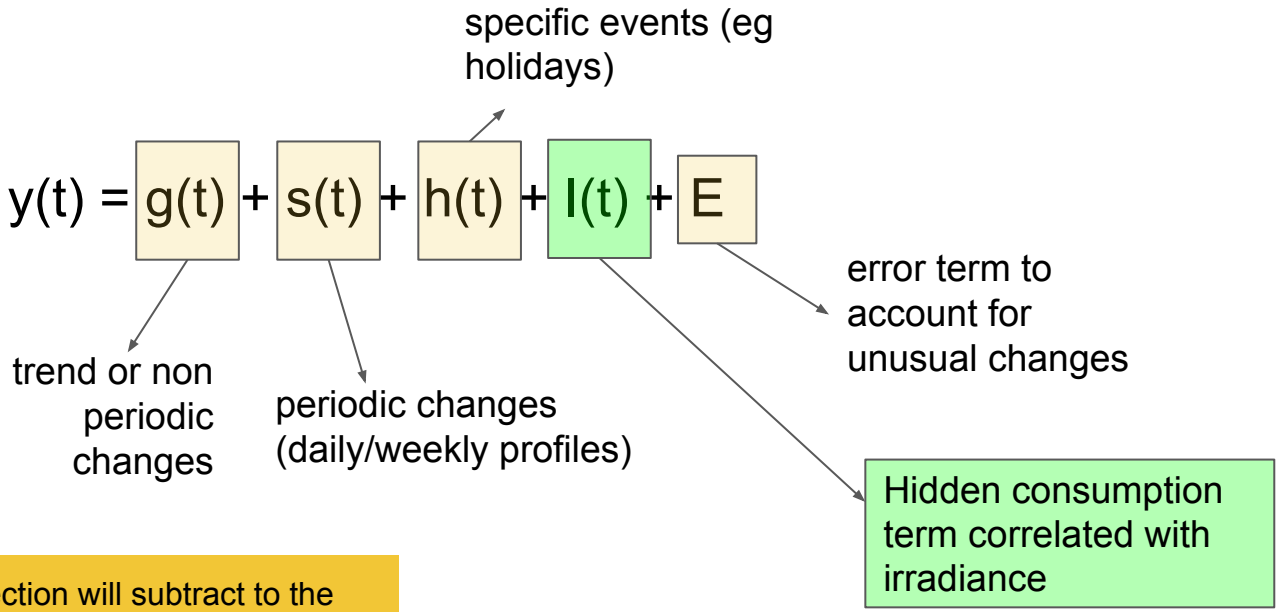
The Problem



We are interested in the **real** (bottom blue) **consumption** so that we can know the **transformer** peak demand

Method



The component from PV injection will subtract to the consumption series (consumers will use own produced energy) and will be invisible for outside measurement

Injection Decoupling

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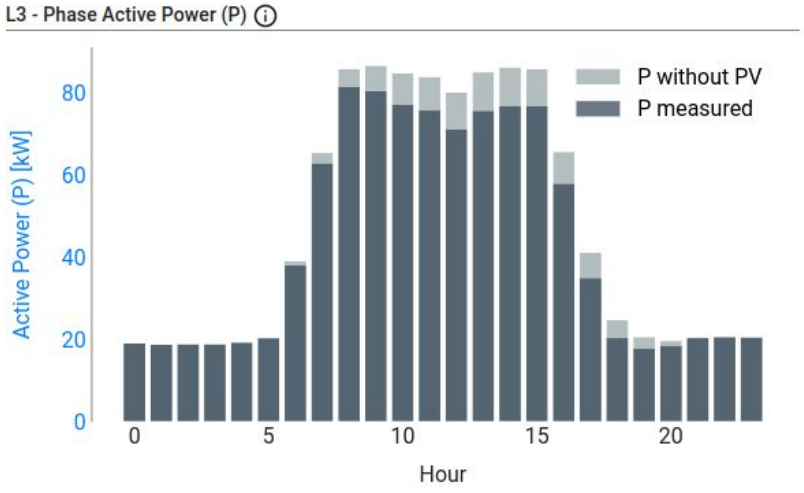
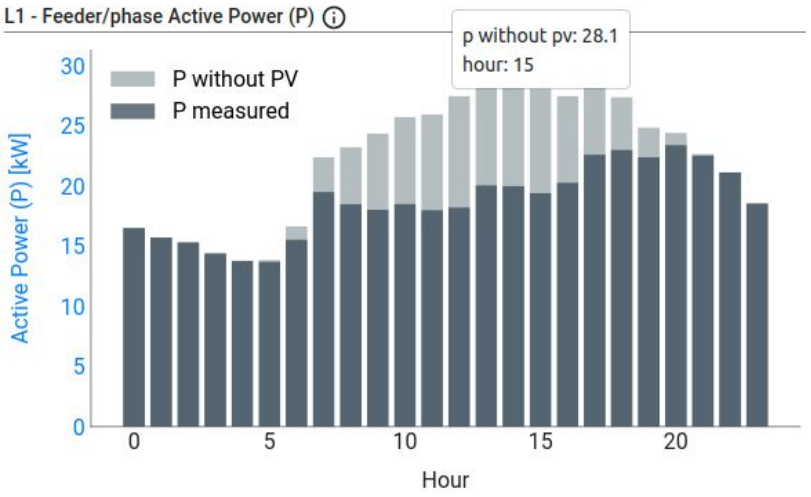
Result





Photovoltaic Panels: imaging approach

ENEIDA.IO

Deep grid assessment

Photovoltaic Panels: Imaging approach

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The Problem

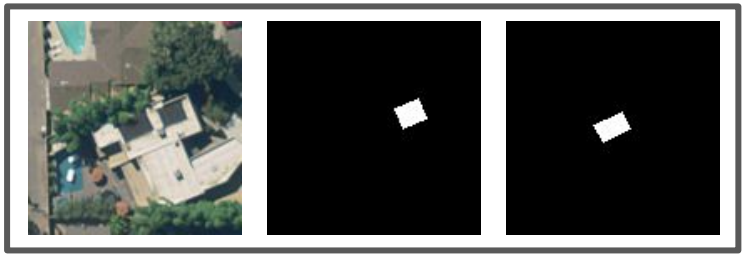
- instead of looking to the consumption series to find hidden consumption from injection we look at satellite imagery to find the PVs directly
- The amount of injection (hidden consumption) in the grid will be proportional to the PV area

Photovoltaic Panels: Imaging approach

ENEIDA.IO

Method

TRAINING:



(MANY!) → RCNN → PV MODEL

PREDICTION:

PV MODEL → Confidence in identification is **above threshold?**

- **YES** → Save Location and Area
- **NO** → Send for Manual Classification

Photovoltaic Panels: Imaging approach

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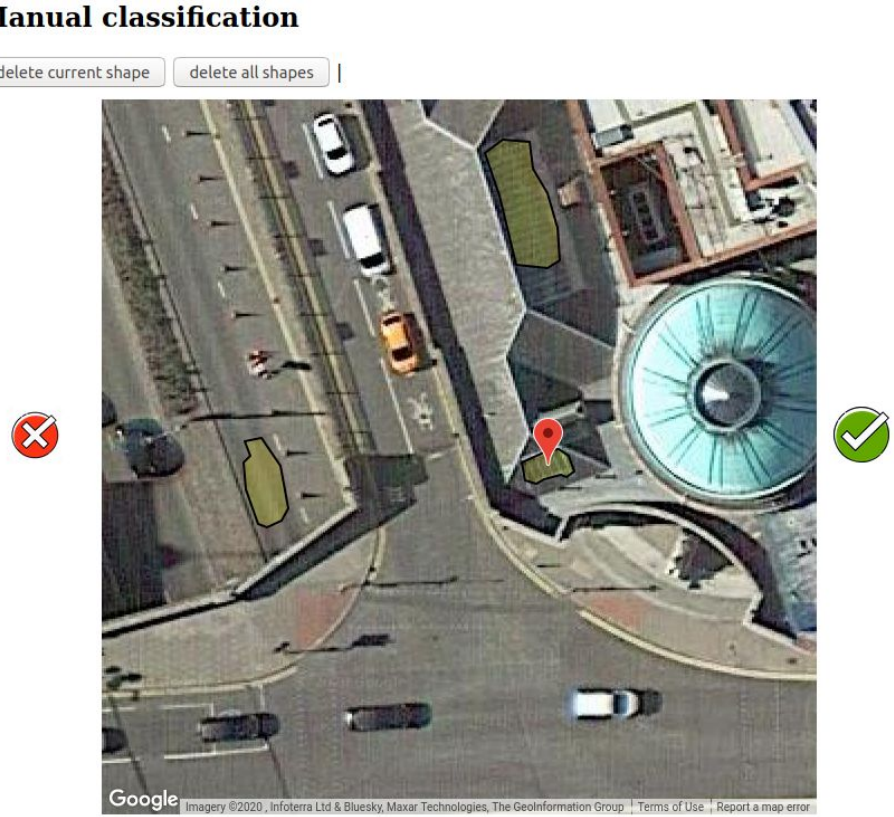
Manual Classification

User can **validate** identified PVs, **remove** wrong ids and **delineate** missing PVs.

Valid PV locations will be added to endpoint and images added to training database.



Photovoltaic Panels: Imaging approach

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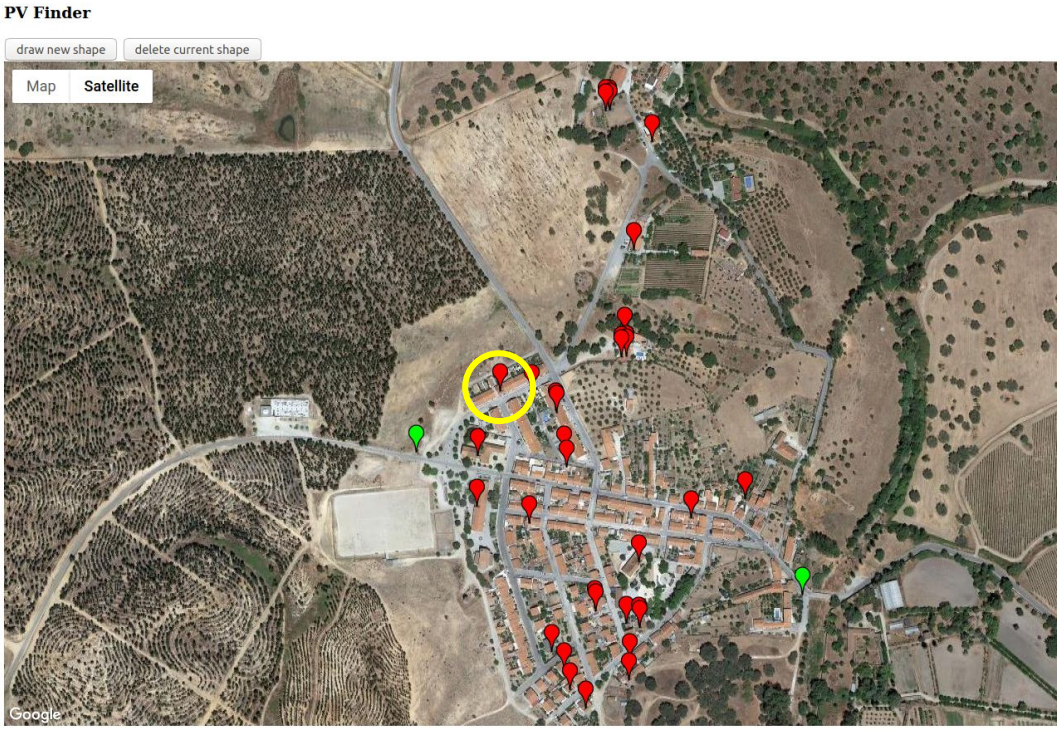
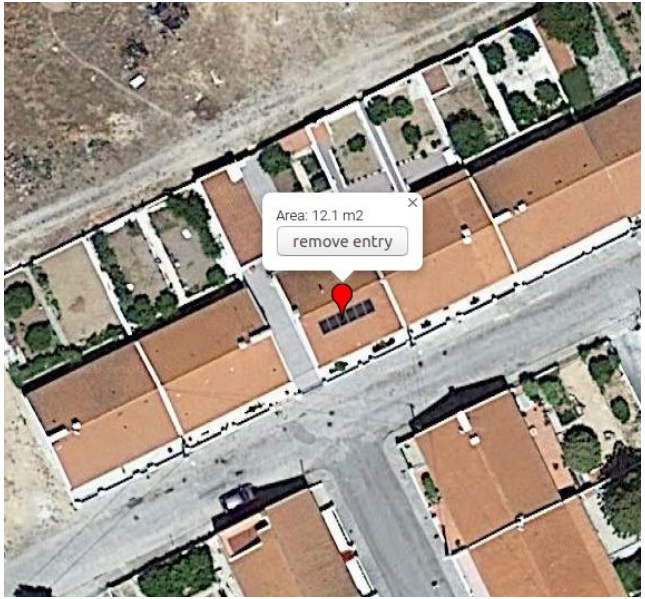
Results





CONCLUSION

MORE LV GRID CHALLENGES

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In the near future the outputs of these apps (and others) will be used to act directly on the grid. For example:

High Consumption + High presence of EVs → Will require the operator to limit EV chargings in peak demand times

Low Consumption + High PV injection → Will require the operator to limit injection in the grid and prevent voltage violations

Other applications being developed inhouse:

- Fault detection and location
- Prediction of faults before they happen
- Energy theft detection and location
- EV charging detection and location

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Zero Emission
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