cigre | PARIS 2022

Study Committee B3
Substations and electrical installations

ESB NETWORKS

Paper 639

# Online Monitoring and Data Analytics Enabling LV Network Investment Optimisation for a Low Carbon Future in Ireland

Jack Herring*   John Fitzgerald   Emma Silke   Hugh Cunningham   Francois Pienaar   Clem Power   Dan Catanase

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Motivation

- Irish Government Climate Action Plan targets include **950,000 Electric Vehicles** and **600,000 heat pumps** by 2030.
- This will significantly challenge the ability of the LV Network to accommodate the increased domestic load.
- This paper describes steps taken to move to a proactive LV Network reinforcement strategy


Number of BEVs and PHEVs Registered in Ireland since 2015
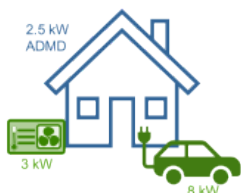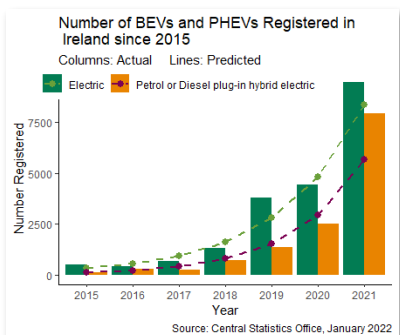
- Without proactive action increased customer load and consumption will lead to issues of thermal overloading and undervoltage.

MV/LV Transformer Loading is Unknown

- Load of MV/LV Transformers is not known and must be estimated based on kWh consumption.

$$MaxLoad_{est} = \frac{kWh_{dg12,peak}}{339 \cdot 24 \cdot 0.5 \cdot 0.9} + \frac{kWh_{dg12,day}}{339 \cdot 15 \cdot 0.5 \cdot 0.9} + \frac{kWh_{DG56,peak}}{339 \cdot 24 \cdot 0.5 \cdot 0.9} + \frac{kWh_{DG56,day}}{339 \cdot 15 \cdot 0.5 \cdot 0.9}$$

Distribution of Estimated Load of All Units [% of Rated Load from Eq. (1)]
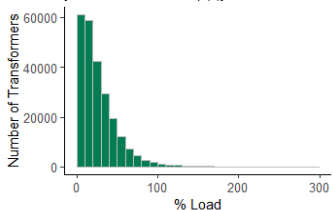
MV/LV Transformer Monitoring

- 1000 Current and Temperature Monitors installed
- Used to validate and improve Load Estimation

Analysis Results

Detailed on the following slides.

- Validation of Load Estimation
- Improved Load Estimation by regression
- After Diversity Maximum Demand (ADMD) estimation
- Low Carbon Technology (LCT) Transformer Case Study
- Load Factor Analysis

Number of Monitored 3 Phase Transformers by Maximum Load Reached (% of Rated Load), n = 770
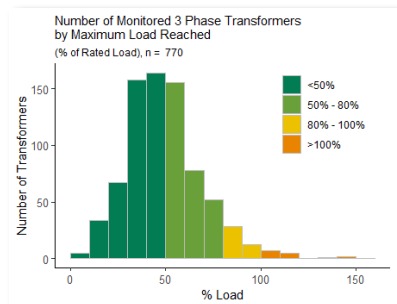
Conclusion

- This work facilitates the move to proactive reinforcement of LV Network to accommodate increased domestic LCT in Ireland.

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Monitor Deployment

Selection of Locations

- 1000 locations were selected to monitor in 2021

- The selection of locations was based on known LCT adoption and high customer consumption (kWh)


Percent of Households with Home Charger Grant

Monitor Hardware

VT VISUALIZE

- Log current and temperature every minute

- Every hour communicate median and maximum to cloud database hosted by vendor (VT)

- More communications = lower battery life. Currently 5-10 years with this configuration

- Out of box connected to cloud platform. Easily attached with magnets and minimal commissioning necessary

Installations

- 1000 monitors succesfully installed in 2021
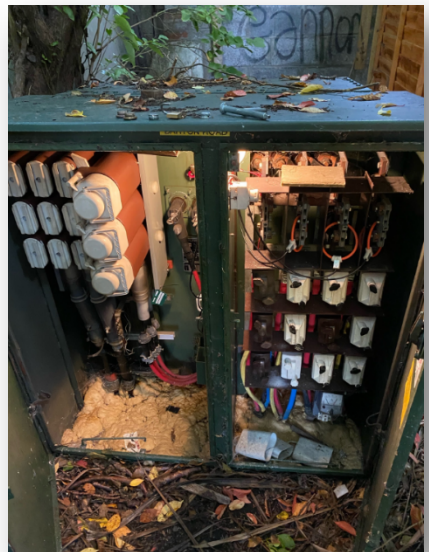
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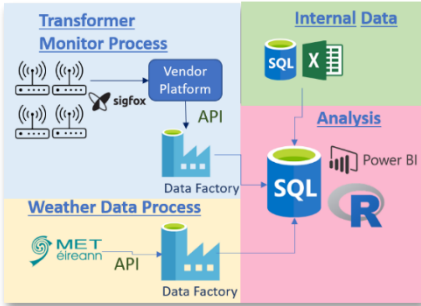
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Data Analytics

Cloud Based Data Engineering

- Cloud infrastructure implemented to facilitate analysis
- Monitor data, asset register, consumption data, socioeconomic data and weather data combined in SQL database
- Allows analysis of near real time data

Business Intelligence Dashboards

- Analytics Dashboards built on live database to empower business users in making more informed decisions related to network reinforcement
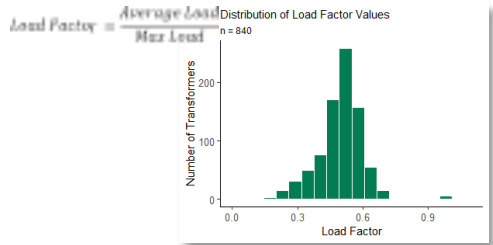

ADMD Analysis

- After Diversity Maximum Demand (ADMD) analysed in comparison to design assumption of 2.5 kW per customer
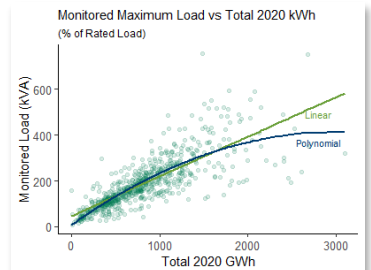- Mean ADMD is approximately 1 kW per house
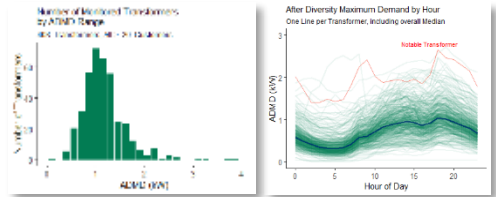
Load Factor Analysis

- Load factor calculated for each transformer
- Mean load factor calculated as 0.5.

$$Load\ Factor = \frac{Average\ Load}{Max\ Load}$$

Prediction of Loading of Unmonitored Transformers

- Monitored data used to train regression models to predict maximum load based on customer consumption data

$$Load_{Polynomial} = 7.7 + (0.27) * GWh_{Total} - 0.00015 * (GWh_{Total})^2$$