VM Data

NIA Closedown Report

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

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Contents

1. Executive Summary

The Virtual Monitoring (VM) Data project, funded by WPD's Network Innovation Allowance, was intended to deliver a virtual monitoring capability across the WPD Low Voltage (LV) network. This was to reduce the need for physical monitoring and to improve knowledge of asset loading against time. This project sought to focus on the ability to harness structured and unstructured data held by ElectraLink,Ltd, combine it with cognitive analytics, and use this to develop a cost-effective virtual monitoring capability across the network. There are three principal ways it was intended to add value:

1. Enhancement of the proof of concept models built under the LCT Detection project, together with other existing toolsets to solve visibility issues on the network, predominantly focusing on lack of visibility of EVs and LCTs.
2. By using this visibility, and existing datasets, a set of consumption profiles were to be developed and used in a mechanism to provide virtual monitoring capabilities.
3. By mapping virtual monitoring at Meter Point Administration Number (MPAN) level to the LV connectivity model, we will enable half-hourly loading profiles on feeders and distribution transformers to be analysed.

This project was structured to progress though a discovery phase and then onto a development phase. A number of key insights regarding customers and substations were developed in the discovery phase to inform challenges the final outputs would need to overcome. These insights provided useful information in their own right.

Across Q1 and Q2 in 2020, Western Power Distribution experienced two major project management impacts on this project. These two impacts related to issues of GDPR and COVID. We have carried out significant due diligence with stakeholders before project progression regarding data sharing, but ultimately evolving knowledge meant that stakeholders had to review their position. In addition to the GDPR impact, the Global Covid pandemic mean that we were not able to progress domestic surveys to inform LCT instances.

This project would have progressed to deliver outputs that would have been implement in BAU in some form had only one of either of the COVID or GDPR impacts landed, but the simultaneous occurrence of both of these outcomes meant that WPD decided it would have been inappropriate to pursue the final project objectives based on the available data.

2. Project Background

The operation of the electricity distribution network is complex and evolving. The increasing number of 'invisible' changes (Electric Vehicles, Embedded Generation, Smart Home, Storage) challenges existing network practices to the extent that the status quo is no longer possible. At present, technology change is outpacing changes in modelling and forecasting of consumer uptake of Distributed Energy Resources (DER) or Electric Vehicle (EV) technology. It is difficult to monitor or understand the change in requirements on the LV network without monitoring EV and DER impacts directly at source (or substation level).

The overall VM project method sought to use IBM's Artificial Intelligence (AI) and cognitive analytics capability to further develop a model developed in the previous "LCT Detection" NIA project[1]. This project sought to use MPAN-level consumption data from Electralink's Energy Market Data Hub (EMDH) plus detailed consumption data (half-hourly intervals or less). The detailed consumption data was to be used to create and refine a set of half hourly customer profiles. These profiles were to be used to extrapolate EMDH consumption data into virtual daily consumption profiles. These consumption profiles could then then be aggregated to achieve a virtual feeder and transformer half hourly loading profile.

[1] The LCT detection project analysed changes in consumption patterns linked to EV/DER proliferation or other factors

3. Scope and Objectives

A summary of the scope and objectives that were achieved are summarized in Table 3-1.

Table 3-1: Status of project objectives

Objective	Status
Discovery: A business analysis phase incorporating design thinking activities and setting out the work plan for subsequent phases.	✓
Execution: Five one month long "sprints" of data analytics activity covering two workstreams were undertaken: Advanced LCT Detection and Profile Modelling.	✓ Two sprints from five were completed
Consolidation: This brought the two workstreams together to produce a final report and model which will enable us to predict load patterns on the LV network	Although only a portion of the project analysis was undertaken, learning was extracted from the two sprints that were completed.

4. Success Criteria

The original success criteria for this project are summarised in table 4-1.

Table 4-1: Status of project success criteria

Success Criteria	Status
An improved version of the LCT Detection model that identifies Low Carbon Technology (LCT) on the LV network.	Future roadmap was informed on the basis of project learning.
Validation of results showing the level of accuracy of the improved LCT Detection model. This will include validation against half-hourly feeder-level readings from our existing LV substation monitoring.	A roadmap to an improved LCT detection model was delivered before the project was suspended.
A set of customer profiles, which will enable the extrapolation of ElectraLink's monthly consumption data to be extrapolated to half hour load profiles on each LV feeder.	Future roadmap was informed on the basis of project learning
Validation of results showing the level of accuracy of the half-hourly feeder loads predicted by the VM data model.	Results could not be validated due to the need to suspend surveys to avoid spreading Covid-19
Delivery of an LCT detection and Virtual Monitoring approach that can be transferred into the business as a BAU approach.	Suspended as a result of the above limitation×
Demonstration that the Virtual Monitoring data outputs can be incorporated into WPD standard tools and systems.	As above

5. Details of the Work Carried Out

This project progressed through four of nine planned activity phases, which are summarised in the following sub sections.

5.1. Discovery Phase

The VM Data project started with a 2 month discovery phase. The purpose of this phase was for the project team to gain a better understanding of the business users and processes in order to ensure that the outputs of the analysis will add business value to WPD. As part of the discovery phase, the project team made a series of visits to WPD sites. For each visit, the team made a short presentation and then spent some time sitting alongside the employees talking about their daily work and how better information may be able to help them. The output from this phase was project knowledge, recorded in a report of standard WPD practices that this project hoped to influence.

5.2. Design Thinking Workshop

Following the discovery phase, the project team undertook a one day "Design Thinking" workshop with attendees from WPD, ElectraLink and IBM. Using this approach, the team were able to:

- Confirm business understanding of the challenges faced by WPD with respect to understanding the load on the LV Network, and the ways in which the planned outputs of the VM Data project could help to address those challenges.
- Generate hypotheses to be tested during the next evaluation phase of the project.
- Identify data sources that could be used for the analytics.

5.3. First analytics sprint

The purpose of this phase was to:

- Identify data sets held by ElectraLink and WPD, or which are openly available, load these into the project data environment and to document the data available.
- Ensure that the project environment is performing at the level that will be required to process the increasing volumes of data expected.
- Develop an understanding of the drivers of household electricity demand and seasonality effects.
- Create mapping from MPAN to distribution substation and primary substation.

Prior to the start of this activity sprint it became apparent that data originally required for validation of the LCT workstream was not available. As a result, this activity sprint had to be refocussed on preparing load profiles rather than use of LCT validation data. The four points above represent this outcome.

5.4. Second analytics sprint

This phase was still encumbered by an absence of the required validation data, as a result, this phase:

- Established the analytics environment and tested it for performance.
- The initial data sets were loaded into the environment and documented.
- The first pieces of analysis were performed, included calculating Average Daily Consumption (ADC) during summer and winter at an MPAN level.

An exercise was conducted to use consumption data from a single substation to investigate how we may be able to use unsupervised machine learning to develop consumption profiles at both a substation and MPAN level. This was in anticipation of more data becoming available to the project. We used consumption data for the distribution substation 873105 Derby. This substation has 155 MPANs connected, 78% of which are domestic. There are no known LCT connected. The first step in the analysis was to create a profile for each day for which we have data for the substation. We showed that using an unsupervised clustering algorithm we could identify different daily patterns of consumption at a single substation that appear related to seasonal differences.

6. Performance Compared to Original Aims, Objectives and Success Criteria

A summary of the project progress is summarised in table 6-1.

Table 6-1: Status of project success criteria

Success Criteria	Performance
An improved version of the LCT Detection model that identifies Low Carbon Technology (LCT) on the LV network.	An improved version of the LCT Detection model that can identify LCT on the LV network with a measurable improvement in accuracy has been created. We have identified additional attributes that can be included in a future version of the LCT detection model should the additional LCT data sets become available.
Validation results showing, with a high level of confidence, the level of accuracy of the improved LCT Detection model. This will include validation against half-hourly feeder-level readings from our existing LV substation monitoring.	Due to the impact of Covid restrictions on the gathering of validation data, the project did not fully progress to meet the full extent of this objective.
A set of customer profiles, which will enable the extrapolation of ElectraLink's monthly consumption data to be extrapolated to half hour load profiles on each LV feeder.	Due to the impact of Covid restrictions on the gathering of validation data, the project did not fully progress to meet the full extent of this objective but work was undertaken which did investigate load profiles.
Validation results showing, with a high level of confidence, the level of accuracy of the half-hourly feeder loads predicted by the VM data model.	Due to the impact of Covid restrictions on the gathering of validation data, the project did not fully progress to meet the full extent of this objective.
Delivery of an LCT detection and Virtual Monitoring approach that can be transferred into the business as a BAU approach.	Due to the impact of Covid restrictions on the gathering of validation data, the project did not fully progress to meet the full extent of this objective.
Incorporation of the Virtual Monitoring data outputs into one of our tools or network management systems. The project will provide load data at feeder level, with improved accuracy, in a format that is compatible with our systems. The data can be integrated into our existing capabilities/applications which are currently being used by planners/control engineers	Due to the impact of Covid restrictions on the gathering of validation data, the project did not fully progress to meet the full extent of this objective.

7. Required Modifications to the Planned Approach during the Course of the Project

In March 2020, Western Power Distribution advised pausing the delivery of the Virtual Monitoring project, due to two key issues relating to GDPR and COVID on planned project methodology.

To successfully progress, this project needed to obtain data from energy suppliers and also a large number of manual inspections by Morrison Utility Services verify the location of LCT via manual inspection. Our initial strategy was to get Smart Meter data from a single supplier. The project engaged with a number of suppliers during project inception and received encouraging feedback that the required data could be shared from a number of suppliers. As the project progressed, it became apparent that their internal GDPR reviews for data sharing was causing them significant concern as HH meter data was classed as personal information.

This project was also dependent upon manual survey of homes to verify whether there had been installation of LCT devices. As a result of the global COVID outbreak we put in measures to ensure that its operations did not help spread the virus, which mean that these manual surveys would could not progress which would undermine validation activities.

This project would have progressed to deliver outputs that would have been implemented in BAU in some form had only one of either of the COVID or GDPR impacts landed, but the simultaneous occurrence of both of these outcomes meant that the project was not able to progress towards the original aims.

8. Project Costs

Table 8-1 summarises project spend. Spending on the Electralink contract includes their subcontractors. It can also be seen that there is significant underspend associated with the pause and subsequent stopping of the project.

Table 8-1: Project Spend

Activity	Budget	Actual
ElectraLink Contract	£2,316,250	£1,060,857
WPD Project Management	£85,372	£42,160
Equipment Costs	£86,000	£86,000
WPD Network services	£11,247	£11,247
TOTAL	£2,498,869	£1,200,264

9. Lessons Learnt for Future Projects

This project undertook a number of analysis sprints that conducted works to inform final process design. This led to the learning points about the WPD network and analytics:

- **<u>Algorithm for profile identification</u>**
  During the project some analysis work was undertaken to assess different clustering algorithms and establish which are the most suitable for the purpose of identifying discrete profiles from half hourly consumption. This compared a number of different algorithms and it was concluded that the Hierarchical method gives the best results when clusters are scored objectively.
- **<u>Seasonal and Weekday/Weekend Profiles</u>**
  Analysis was undertaken to determine whether the distinction between weekday and weekend is an important factor in defining the profile shape. The conclusion was made that there needs to be a distinct set of profiles to allow for weekends and that a "one profile for all time" does not give acceptable outcomes.
- **<u>Propensity to change supplier</u>**
  As part of this data analysis, an MPAN's propensity to change supplier was defined. This metric is an additional attribute which was intended to inform subsequent analysis in both the LCT detection and consumption profile workstreams. This metric was calculated for 70% of WPD MPAN's. It was also discovered that there is no evidence that customers with LCT are more likely to switch suppliers.
- **<u>Correlation between LCT ownership and Energy Supplier</u>**
  To identify attributes that would be useful in the LCT detection model and analysis was undertaken to test whether there was a correlation between LCT ownership and certain energy suppliers. It was concluded that customers of the 'Big 6' suppliers are generally less likely to have LCT. The exception to this is Scottish Power for both EV and PV, and SSE for PV only.
- **<u>Relationship between Energy performance certificate data attributes and ADC</u>**
  Analysis was undertaken to identify attributes that indicate different patterns of energy consumption as a means to inform subsequent consumption profile work. A number of factors were found to be related to different ADC summer: winter ratios, which included
  - Main heating energy efficiency,
  - Hot water energy efficiency,
  - Presence of mains gas
- **<u>Relationship between building fabric and energy consumption or LCT installation.</u>**
  - Properties with LCT are more likely to be houses, particularly detached houses for EV
  - Bungalows are more likely to have PV than the population as a whole
  - The number of rooms does not influence the pattern of energy usage, but it does influence the absolute level of energy consumption.
- **<u>Substation properties</u>**
  The number of rooms is highly correlated to the amount of energy consumed, but not to the difference between summer and winter consumption.

- **Substation estate**

  To determine the extent to which a better understanding of domestic consumption patterns can aid in understanding the load at the distribution substation, analysis was undertaken to set out likely sensitivity parameters for domestic demand on distribution substations. This developed new learning insor as it was was found that:

  - 25% of substations supply only domestic MPANs and for 50% of the substations >90% of the connected MPANs are domestic MPANs. It was also observed that 20% of substations supply only commercial MPANs
  - 95% of distribution substations have no known EV connected
  - 72% of distribution substations have no known PV connected
  - Almost 50% of Distribution substations have no smart meters

10. The Outcomes of the Project

In addition to the learning captured in section 9, this project established:

- There is value to being able to predict substation profiles from customer HH data
- The analytics environment that was required to deliver the required outputs
- A number of datasets as identified in the discovery phase, including
    - Anonymised or pseudo-anonymised HH MPAN data
    - Energy Performance Certificate
    - LCT presence
    - Substation demographics

11. Data Access Details

Project resources can be accessed at www.westernpower.co.uk/Innovation/projects/virtual-moniotring-data-vm-data

12. Foreground IPR

A record of the learning developed is recorded within the suite of reports that can be found on the project website. www.westernpower.co.uk/Innovation/projects/virtual-moniotring-data-vm-data

13. Planned Implementation

The learning described in section 9 will be incorporated into future WPD projects and decision making.

14. Other Comments

Not applicable

15. Contact

Further details on this project can be made available from the following points of contact:

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Glossary

Abbreviation	Term
ADC	Average Daily Consumption
DER	Distributed Energy Resources
DNO	Distribution Network Operators
DSO	Distribution System Operator
DTS	Data Transfer Service
EAC	Estimated Annual Consumption
EMDH	Energy Market Data Hub
EPC	Energy Performance Certificate
EV	Electric Vehicles
GDPR	General Data Protection Regulation
HH	Half Hourly Meter
HV	High Voltage
LCT	Low Carbon Technology
LV	Low Voltage
MPAN	Meter Point Administration Number
PV	Photovoltaic
RIIO	Revenue=Incentives + Innovation + Outputs
VM	Virtual Monitoring
WPD	Western Power Distribution

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