Electricity North West & Kelvatek

Low voltage monitoring case study

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Introduction

Electricity North West's 'Connect and Manage' research in ED1 has shown how monitoring and analysis of the network can enable significant additional load capacity to be released using existing assets that customers have already paid for.

Increasing low voltage (LV) visibility to allow for proactive management of the network has grown in importance with the challenges presented by decarbonisation, climate change and increasing consumer reliance on energy for heat, transport, and home working. Electricity North West's 'Connect and Manage' approach has demonstrated that fitting three phase and neutral monitoring allows an accurate measure of demand on LV substations, allowing the effective management of feeder loading to enable the release of previously unavailable network capacity.

By the end of ED1, Kelvatek's PRESense advanced low voltage (LV) monitor will be installed at 5,000 of Electricity North West's most populous ground mounted substations supplying around 1.1 million customers. They will additionally have access to consumption data from smart meters for up to 70% of domestic customers.

Through the ED2 period, tactical installation of PRESense will continue on LV circuits to help deliver savings to customers through the continuation of the 'Connect and Manage' programme, measuring the risk profile of circuits, their capacity, and their ability to connect and balance load optimally.

Additional capacity will be released during ED2 from existing assets facilitating the adoption of more low carbon technologies (LCTs). This greater visibility of the LV and HV networks will enable Electricity North West to model networks more accurately, and more efficiently target new capacity provided through flexibility services or new assets.

Targeted monitoring for deferment of reinforcement & network resilience

Before deployment could take place, Kelvatek worked in partnership with Electricity North West to develop an optimised deployment plan. Unlike many DNOs, deferment of reinforcement alone was not the only consideration. The fundamental link between higher levels of load, unpredictable power flows and network resilience is often overlooked. Therefore, Electricity North West wanted to consider the impact of a number of factors including customer density per feeder (a strong indicator of potential load growth) and the impact of asset age combined with historical fault data.

Kelvatek constructed an optimised deployment plan based on these factors utilising cutting edge machine learning models to determine where to deploy LV monitors that could simultaneously provide network health visibility, enable deferment of reinforcement, and provide an index of cable asset health and therefore ensure LV network resilience through the ED2 period. A key part of this deployment model was to ensure that value for money was being provided to consumers through the deployment of these advanced monitors, since the smart metering deployment would eventually deliver some of the requirements pertaining to deferment of network reinforcement.

Most LV monitors are specified to only provide load profile information which enables decisions to be made relating to deferment of network reinforcement. The resolution of data that this type of monitor provides is suitable for only this primary use case.

The most significant cost involved in LV monitoring is the commission and installation work. To provide optimal value for money to consumers over the lifetime of an LV monitor it must be flexible and have capabilities that solve not only today's problems but those we will face in the future. The scenario that Electricity North West wished to avoid was a high lifetime cost of LV monitoring for the consumer where many simple devices were installed which would need to be subsequently replaced by more capable units deigned to manage asset health, reliability, and a host of technical issues such as harmonics. Failure to include these future needs in the sensor design would effectively leave thousands of stranded assets on the network and increase costs for customers in the longer run.

By using a monitor with advanced edge intelligence capabilities Electricity North West can assess newly monitored assets with high frequency, detailed wave form capture allowing the tracking of asset condition and the impact this has on localised network resilience. A higher and more accurate determination of thermal capacity is also possible which can lead to the release of up to a fifth more capacity on LV feeders.

Electricity North West LV monitoring strategy

PRESense is a powerful hardware and software platform, it utilises best-in-class current sensor probes, contains no moving parts, and can be reprogrammed remotely to fulfil several different functions. The unit is designed to be fit and forget for its lifetime meaning PRESense can perform all functionality at a substation with minimal maintenance. The functionality it provides will not be superseded by smart metering and it can be reconfigured to adapt to new challenges that the network operators may face.

Deployment

Electricity North West contracted Kelvatek to undertake the full install and commissioning process for PRESense. Of particular importance was ensuring the unit was easy to install, and that the feeder labelling system was well understood to match the correct channels on the PRESense to the correct substation feeder ways.
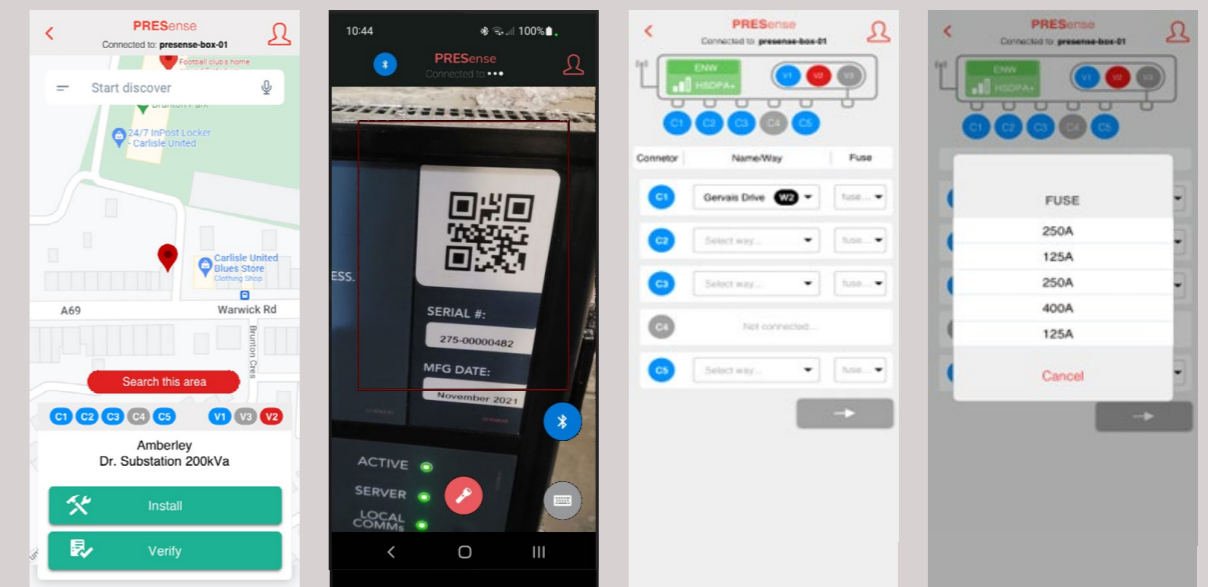
PRESense installation mobile application

Kelvatek's field services team is now carrying out the installation of thousands of PRESense devices with completion of the project due before the beginning of ED2.

The installation process is aided by an installation application and QR code scanner which automatically associated the location of the substation utilising GIS coordinates. Pictures of the installation can also be taken and uploaded automatically.

Edge intelligence

Due to its powerful hardware and software platform, PRESense can run artificial intelligence and machine learning models at the 'edge' of the network, in effect learning 'normal' operating conditions in its localised area and flagging up anomalies. Historically more than 50% of new LCT connections are not flagged to Electricity North West through an established industry process, the edge intelligence capabilities of PRESense allow Electricity North West to mitigate this risk by employing localised anomaly detection to pick up changing load activity on the network.

The edge intelligence approach allows for the collection of high resolution, high interval data and for it to be processed on the unit itself. The results of the analysis can then be communicated to Electricity North West teams across the business, enabling data use cases to be deployed at scale but at a reduced cost for data communication.

Empowering the workforce

PRESense isn't just an LV monitor, it enables access to a whole host of data use cases which have started to empower the Electricity North West workforce with actionable information, that ultimately provides a superior level of service to their customers. The various benefits PRESense is already providing to Electricity North West include:

- Speeding up connections saving on-site visits
- Aiding in power quality investigations, avoiding specialist equipment fitting and site visits
- Customer contact centres utilising the information collected to provide relevant history of the feeder to customers, setting more accurate expectations for connections or restoration after an interruption to supply
- Operational staff utilising the enhanced fault location technology to reduce the number of site visits needed and understand the type and severity of faults.
- Increased understanding of the impact of phase imbalance and load growth
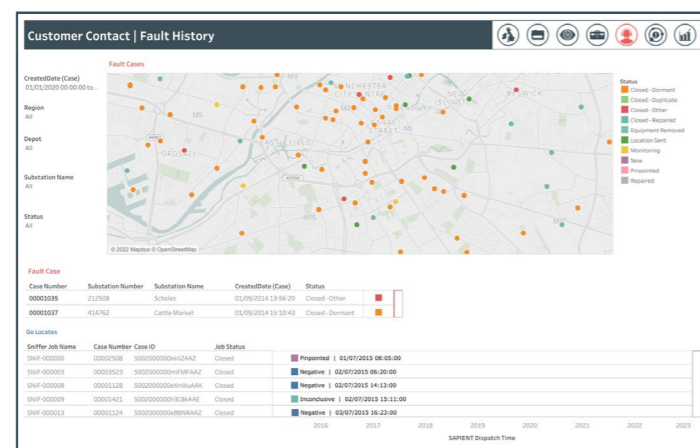

Fault history per feeder

Key applications for advanced LV monitoring

Cable health

Cable health is derived from a host of different factors that Kelvatek's PRESense unit has been specifically designed to detect using a variety of advanced measurement triggers and data tags that have been deployed after years of studying the degradation of cables.

There are two distinct approaches that Kelvatek can support with PRESense for cable health.

The first is the use of a dashboard showing health indices to aid in funding decisions. Data is taken from monitored sites and combined with asset information to provide a clear picture of long-term cable health that aligns with the regulatory landscape.
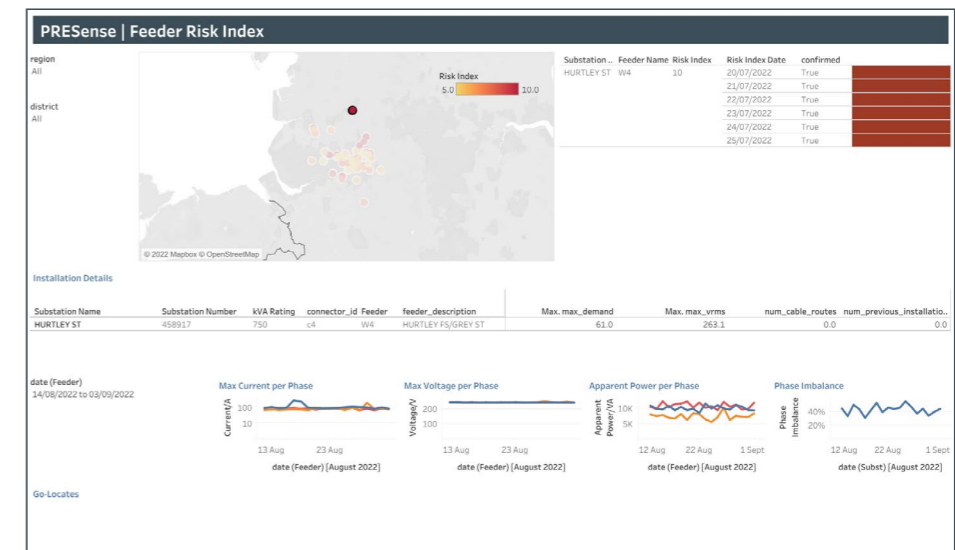
High level risk ranking

The other is a more detailed 'intelligence at the edge' approach which takes extremely high frequency and high-resolution measurements, using advanced triggering algorithms to collect specific patterns of data. This is held and processed on the unit, at the edge of the network in order to reduce the amount of data transmission that would be needed to communicate this back to central servers. This is then summarised periodically and where issues with cable health are highlighted, the full or subset of data collected can be communicated back to provide actionable insights.
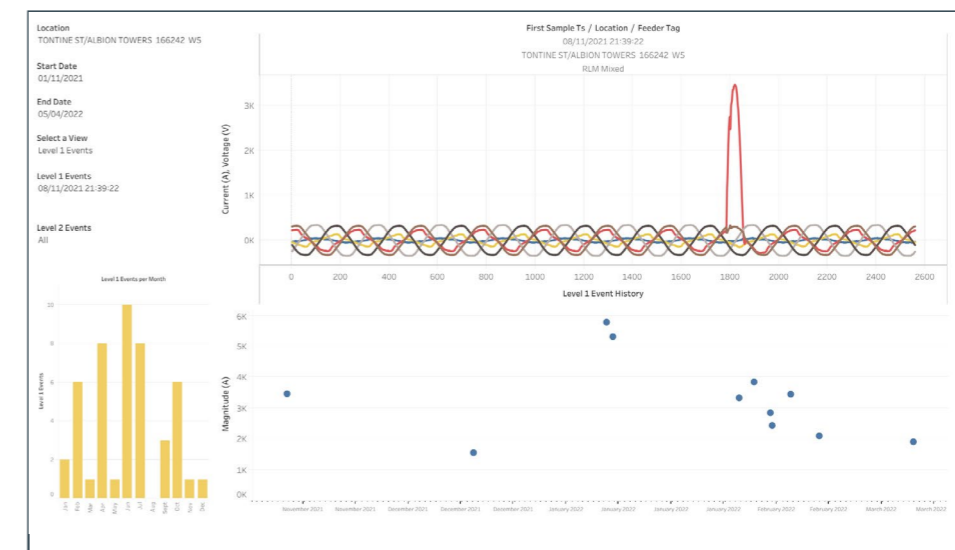

Edge intelligence asset anomaly events summary

Enabling the pathway to net zero

PRESense provides several data use cases that directly supports load reinforcement deferment, connections, and phase imbalance.

Phase imbalance and connections

Electricity North West now have the information from both their low voltage fault management devices and LV monitors to aid in managing their connections processes to assess load conditions on localised areas of the network and gain insight into issues such as voltage and current imbalance on feeders. This helps Electricity North West plan for the future, to get the investment case right for a safer and more resilient network.
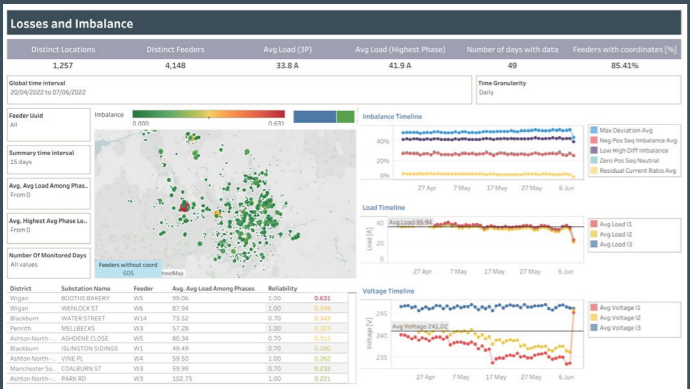
Dashboards showing ranking of worst imbalance on feeders for current and voltage

Imbalance feeder ranking dashboard

Hourly ranking of imbalance per feeder, creating a feeder 'print' with seasonal day and holiday day variations

This collection of dashboards highlights events on feeders, including load timelines per phase, residual vs average current, hour by hour, weekly, seasonal, and workday summaries.

All this information and the way it has been visualised allow engineers to make quicker decisions, minimises site visits to install quicker connections and ultimately provide better customer service to consumers.

Key takeaways

- Electricity North West's strategy to deploy a monitor that delivers multiple benefits ensures value for money for consumers over the lifetime of the device.

- Using advanced monitoring technology allows Electricity North West to start moving towards a holistic model of network management considering asset health and loading and their potential impact on connections, investment strategy and customer service.

- This level of network visibility will allow Electricity North West to work in a way which allows them to be more proactive, planning work ahead of time, avoiding costly reactive interventions while providing improved customer service.

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