NIA ENWL009

Cable Health Assessment - LV

Closedown Report

A Network Innovation Allowance Project

30 July 2021

VERSION HISTORY

Version	Date	Author	Status	Comments
V1.0		B Ingham		

REVIEW

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APPROVAL

Name	Role	Signature & date
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GLOSSARY

Term	Definition
BAU	Business as usual
CBRM	Condition based risk management
IPR	Intellectual property rights
LV	Low voltage
PCB	Printed Circuit Board
R&D	Research and development

1 EXECUTIVE SUMMARY

This project has generated a significant amount of learning around the condition monitoring and fault detection fields, which will benefit a number of other projects. This learning, whilst not leading to a device as originally envisaged, also helped to refine the design of the PRESense unit which is currently being installed across the ENW network.

2 PROJECT FUNDAMENTALS

Title	Cable Health Assessment – Low Voltage
Project reference	NIA_ENWL009
Funding licensee(s)	Electricity North West Limited
Project start date	November 2015
Project duration	5 years 9 months
Nominated project contact(s)	Ben Ingham (innovation@enwl.co.uk)

2 PROJECT BACKGROUND

Low Voltage cables represent a significant proportion of the Electricity North West asset base, yet there is little availability of data to permit asset condition assessment and hence risk to the company. Electricity North West uses the Condition Based Risk Management system to assess the condition of many of our assets. This is based on an assessment of the likely condition from the age, environment, and duty of an asset and then modifies this through the use of various data sets to provide an estimate of the probability of failure. In order for an asset to be assessed in this manner there needs to be a collection of appropriate input data which reflects the asset's current condition and the trend in any change to that condition over the medium long term.

In the case of solidly insulated cables in general and low voltage cables specifically, data is not presently widely available. Existing methods require the destructive testing of the cable, generally though cable sampling, and analysis of the cable's components to determine if a level of degradation can be determined. This results in disruption to customers and is often costly owing the necessary excavation of footways and roads. This project sought to develop an alternative to this destructive testing in the form of a device which could collect measurement from in service cables over a long period and use this data to determine the condition of the asset.

3 PROJECT SCOPE

This project will develop the technology, data processing, support services, business as usual (BAU) operating model and condition based risk management (CBRM) asset health modelling required allowing low voltage (LV) cable condition data to be included in the condition based risk model giving network operators the ability to assign health indices to its low voltage cables and associated networks.

4 OBJECTIVES

- Develop low cost technology which can be used to define the condition of the low voltage network
- Develop BAU support services to allow wide-scale deployment
- Develop the data processing and modelling necessary to allow inclusion in the CBRM framework
- Installation of hardware at a number of distribution substations (expected to be 500)
- Run a live trial of the new models and associated support services
- Produce all the necessary documentation (specifications and models) to allow adoption by other network operators.

5 SUCCESS CRITERIA

- Production of hardware and backend data processing technologies
- Production of the relevant processes and models to allow LV cable condition to be included in the CBRM framework
- Development of a BAU operating model to allow wide-scale deployment
- Production of the CBRM methodology, specifications and codes of practice to permit replication.

7 PERFORMANCE COMPARED TO THE ORIGINAL PROJECT AIMS, OBJECTIVES AND SUCCESS CRITERIA

The project was initially focused on the requirements of the hardware necessary to capture the condition of the cables. Our Project partner, Kelvatek, conducted testing to assess what degradation may look like and how it could be measured. Device software was developed to deliver basic functionality and operated successfully.

System software and fault detection/triggering algorithms concepts have been developed and agreed. These components were refined as more data becomes available from field trials on LV networks.

Since July 2018 180 units have been installed with all reporting back to the Kelvatek server. Analysis is ongoing to identify the operational trigger values for the previously developed algorithms. Initially these devices used a time-based trigger to take readings in order to obtain the ‘noise’ for each cable, which could then be filtered out in order to detect any sounds associated with degradation of the asset. As these trials progressed it became clear that the high frequency sampling was not producing the anticipated benefits. In addition the costs of the units had increased to a point where they were no longer viable for development into a BaU product.

8 THE OUTCOME OF THE PROJECT

This has been a very valuable project that has provided learning and outcomes that influence several other projects in the asset health and fault prediction fields. One of the key goals of the project was to identify substations that had faults developing and to provide information that will help give a CBRM score. At the outset of the project, the intent was to design and install monitoring system at LV substations that had a very high bandwidth monitoring system, so as not to miss any vital data that could lead to scoring or fault identification very early in the process.

For the high bandwidth monitoring, a > 100 MHz sampling system was utilised. As well as a signal injection system to take advantage of impulse response analysis. However, this decision to include high bandwidth in the monitoring system had several repercussions:

- Each unit was much more expensive to manufacture, assemble and test – with a high number of units initially failing the testing stage, and having to be re-worked extensively, further increasing cost and time for many of the units.
- Limitations related to the decision of monitoring transformer tails only for current – this aggregated data meant that a substation with failing cable assets could easily be identified, but not individual feeders without further intervention. This is ok from a CBRM analysis for investment purposes, but not practical for individual feeder management.

When the benefits of high bandwidth sampling were reviewed the benefit of it over decent ~ 200 kHz sampling that was synchronised was marginal.

Learning outcomes from the project included:

- Deployment experience of fitting monitoring for current and voltage in substations, showing that advanced triggering and monitoring could be successfully deployed,
- Tested the comms infrastructure by generating very large amounts of data.
- Limitations of only monitoring aggregate transformer tail data
- Requirements for PRESense device, regarding the sampling and individual feeder elements
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PRESense has taken these requirements forward and provided an advanced LV monitoring platform with high performance in the LCT identification, asset and fault management and power quality areas. With a wide deployment of PRESense monitors, it is envisaged that the data coming from them will provide a basis for building of a CBRM model for LV cable assets.

9 REQUIRED MODIFICATIONS TO THE PLANNED APPROACH DURING THE COURSE OF THE PROJECT

There was no change to the planned approach made on this project

10 PROJECT COSTS

Item	Category	Estimated costs (£k)	Final costs £k (rounded)	Variance
1	Project Management	34,150	217,384	-179,166
2	Research & Development	2,715,850	2,715,850	0
	Total	**2,750,000**	**2,933,234**	**-179166**

The project management costs were higher than anticipated over the course of the project. As the design was adjusted over the course of the project to lead to the project being extended by 34 months. In addition, closer liaison between Electricity North West and the project partners was required as work was undertaken to overcome the technical challenges.

11 LESSONS LEARNT FOR FUTURE PROJECTS

Based on the challenges faced during the project additional time spent prototyping the devices to fully understand the complexities of design choices may have highlighted some of the issues at an earlier stage.

This project has shown the benefits of trials, even where the original plan does not quite come to fruition, the learning generated on this project has benefitted several other projects. This does, however, need to be balanced against the need to provide value for money for customers. This can be a difficult balance to strike, in this instance it is believed that it was struck.

12 PLANNED IMPLEMENTATION, RECOMMENDATIONS OR NEXT STEPS

The project as envisaged will not be implemented as the solution was found to be not viable as originally proposed. The learning from the project will be taken and applied to other projects to help improve their performance. This has also refined the performance of the commercially available PRESense device, which Electricity North West are currently rolling out on the network.

13 DATA ACCESS & QUALITY DETAILS

Electricity North West's innovation data sharing policy can be found on our website.

There has been no data collected over the course of this project.

14 FOREGROUND IPR

The project looked to develop additional knowledge of cable degradation using LV cable test facilities at Kelvatek and was to be used to ultimately develop a monitoring device with sufficient bandwidth to detect and measure cable condition. Kelvatek own the IPR for the specification for the sensor and trial units which can be fitted to the busbar without the need for a shutdown.

15 FACILITATE REPLICATION

Not appliable

16 STANDARDS DOCUMENTS

Not applicable

17 OTHER COMMENTS