NIA ENWL025

Online Assessment of Neutral Conductor Integrity

Progress Report

31 July 2023

VERSION HISTORY

Version	Date	Author	Status	Comments
V0.1	26/07/2023	Geraldine Paterson	Draft	

REVIEW

Name	Role	Date
Ben Ingham	Innovation Technical Manager	27/07/23
Andy Howard	Innovation Programme Manager	27/07/23

APPROVAL

Name	Role	Date
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GLOSSARY

Term	Description
BAU	Business as Usual
LV	Low Voltage

1 PROJECT FUNDAMENTALS

Title	Interface
Project reference	NIA_ENWL025
Funding licensee(s)	Electricity North West Limited
Project start date	April 2021
Project duration	1 year 11 months
Nominated project contact(s)	innovation@enwl.co.uk

2 PROJECT SCOPE

The project will be split into two phases:

Phase 1: a desktop study to understand the different Low Voltage cable types, failure mechanisms for the neutral conductor and types of data required, including use of Smart Meter data, to enable detection.

**Stage Gate – at the end of phase 1 a decision will be made as to whether the method is viable, and the project can continue to phase 2

Phase 2: develop and test a detection algorithm in a real network environment with a view to incorporating the algorithm in fault identification and location processes, including consideration of changes to existing business processes.

3 OBJECTIVES

To develop a tool that DNO's can use to analyse LV monitoring data to enable the early detection of neutral degradation on the LV networks.

4 SUCCESS CRITERIA

Phase 1: Desktop study and data collection/interfacing:

WP1 – Identification of the physical traces neutral degradation produces at various parts of the network.

WP2 – Identify existing sources or potential sources of data that can be used to facilitate WP1.

Phase 2: Detection algorithm in real network environment:

WP3 – Develop the infrastructure needed to gather the data from the sources identified in WP2.

WP4 – Creation of algorithms to detect neutral degradation based on the data sources identified in phase 1.

WP5 – Use algorithm to identify real world networks with defective neutral conditions developing.

WP6 – Verify the algorithm by investigating and, if necessary, repairing the defective networks and demonstrating that subsequent data now demonstrates an intact neutral. This work package will determine the benefits of the algorithm to all UK DNO's.

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

Our project partner, Kelvatek undertook a desktop modelling exercise to investigate how parameters such as voltage, current, harmonics, unbalance, and step changes are affected by an increase in the series resistance of the neutral conductor between the supply and customer loads.

Data from historical occurrences of neutral failures on ENWL's network and insights from ENWL staff were used to ensure the accuracy and reliability of the findings. To further confirm and consolidate the findings, verification exercises were carried out on the Kelvatek test network. This step involved checking the network in normal running conditions and then adding in a series resistance and observing the effect.

By expanding the investigations beyond the desktop modelling exercise and integrating the insights from historical data, ENWL staff, and verification exercises, we have gained an understanding of the phenomenon and its implications throughout the network. Furthermore, analysis of voltage and current waveforms provide valuable insights into detection and identification.

Leveraging the outputs from previous projects the development of a suitable model was accelerated. Kelvatek used the Maple mathematics modelling and simulation package to create models to represent:

- the network source impedance,
- the LV board (where measurements are likely to be taken from),
- network resistance,
- the ability to adjust series neutral resistances,
- the ability to simulate load upstream and downstream of the compromised neutral,
- the ability to simulate voltage readings from customers smart meters.

The modelling and simulation work has shown that it is possible to detect a series resistance increase in the neutral from the measurements taken at the LV board or customer's smart meters, even if the series resistance is in the order of one ohm. Early detection and flagging of this change would allow the feeder to be flagged for closer inspection.

Our project partner then identified existing sources or potential sources of data to facilitate the development of the algorithm.

Data is currently available from three-phase LV monitors which have been programmed to collect the data following a positive step trigger i.e. an increase in load. Despite this limitation, the significant amount of switching on the LV network still allows sufficient data to be gathered.

As we explore transitioning the solution to a Business-As-Usual (BAU) scenario, the potential benefits of a negative step trigger should be evaluated.

In contrast, data from monitors which use three single-phase devices would require a series of pre-processing steps to convert the data into a useable format. However, since the majority of these devices are typically used for fault management and only temporarily deployed at specific substations, we will not analyse their data for this project. This may be revisited for BAU purposes in the future.

We have also started to review what is possible with smart meters by identifying suitable information the meter can be configured to record. To enable this, we set up a feeder with smart meters and configured them to provide data which we will assess over the remainder of the project to see if it can be used in the assessment of the neutral condition.

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

There was additional work involved in the simulation and testing phase to fully the optimise the approach being trialled which has resulted in a delay in the overall delivery of the project. As a result, the project has been extended and is now due to complete by December 2023.

The outputs from Phase 1 have demonstrated that the proposed methodology is viable, the project has now passed the Stage Gate and Phase 2 is currently being delivered.

7 LESSONS LEARNED FOR FUTURE PROJECTS

There are no lessons learned to report at this stage.

8 THE OUTCOME OF THE PROJECT

Not applicable.

9 DATA ACCESS

The data gathered, so far, as part of this project is applicable to specific ENWL assets and is of limited value to external stakeholders. The data could be made available on request in line with our innovation data sharing policy which can be found on our website.

10 FOREGROUND IPR

None

11 PLANNED IMPLEMENTATION

Not applicable.

12 OTHER COMMENTS

Not applicable.