

## NIA Project Registration and PEA Document

### Date of Submission

Dec 2015

### Project Reference

NIA\_SSEPD\_0021

## Project Registration

### Project Title

Thermal imaging Observation techniques for Underground CAble Networks (TOUCAN)

### Project Reference

NIA\_SSEPD\_0021

### Project Licensee(s)

Scottish & Southern Electricity Networks

### Project Start

January 2016

### Project Duration

1 year and 9 months

### Nominated Project Contact(s)

SSEN Future Networks Team

### Project Budget

£311,100.00

## Summary

Thermal imaging equipment has traditionally been specialised and very expensive but thermal sensing technology has advanced to the point where it is relatively inexpensive to manufacture and is more readily available. This has resulted in a number of comparatively inexpensive devices becoming available on the open market, including some very low cost devices which attach to a smart phone or tablet. Within the context of rapid location of underground cable faults trials and investigations with a range of imaging devices and solutions will be carried out and, if successful, recommendations made for equipping repair operatives and depot staff. A training programme for safe and efficient use of the equipment will be designed and delivered.

### Nominated Contact Email Address(es)

fnp.pmo@sse.com>

## Problem Being Solved

Rapid and accurate pinpointing of underground cable faults is a key factor in minimising supply interruption time and repair costs. Methods exist for locating underground cable faults with varying degrees of precision but ways of improving accuracy and confidence are constantly being sought. One method used by SSEPD is a device supplied by Kelvatek known as a Bidoyng auto-recloser, which can detect when certain types of low voltage cable faults occur. This device alerts a monitoring centre and gives an approximate indication of distance to the fault, but there is a varying accuracy tolerance which could be +/- 10m or more. The fault location is pinpointed by depot staff taking readings with a "cable sniffer" device before committing to excavation. This device requires a bore hole to be drilled to a depth of 150mm and a sensor inserted. The sensor is capable of detecting the presence of certain gases which

are emitted when a cable overheats significantly, e.g. when insulation material is burnt or melts. Usually at least 5 sniffer bore holes are required, sometimes more. In some scenarios, for example where there are multiple cable branches or 'feeders', there could be several attempts to identify the cable section on which the fault has occurred, often resulting in several bore sites and groups of cable sniffer tests. This adds cost and delay to pinpointing the precise repair site and subsequently the time taken to restore supply to the consumer. The effectiveness of cable sniffing is greatly reduced from 2 to 3 hours after the fault event due to gas dispersion/absorption, so response time is important. Time lost in "sniffing" the wrong cable segment could mean that the opportunity to pinpoint is lost. For some underground cable faults a surge generator (or 'cable thumper') can be used to help locate the fault. This device sends a high energy pulse into the cable in order to momentarily intensify the fault. While moderate cable 'thumping' may be acceptable there is a risk that sustained or frequent stressing can cause further cable damage.

## Method(s)

This project investigates a technical method using thermal imaging solutions as complementary tools in the context of locating underground cable faults in the power distribution network. When a cable fault occurs the repair operative uses conventional methods to locate the fault and pinpoint the excavation site. However, in a scenario where there is not enough precision, thermal imaging techniques will be employed to help locate the fault and confirm the primary excavation site.

For some types of faults thermal imaging devices could be rapidly deployed upon arrival on site in order to detect a heat signature on the ground before using conventional methods. The project will determine under which conditions this could be beneficial. For example, an operative could rapidly deploy thermal imaging techniques and walk the cable route immediately upon arrival on site. If this method locates a fault from a residual heat signature it will reduce the number of bore holes for cable sniffers or reduce the amount of stress induced by cable thumping. The method could also eliminate false clues from the potential fault location data.

The aim is to reduce both the time and costs involved in restoring power to consumers in the event of an outage caused by an underground cable fault and, in addition, to promote the proactive investigation of potential faults before they occur.

Market analysis will be performed in order to identify a range of devices and study performance, functionality and cost. A literature review will be followed by an exercise of building a short list of devices, both high specification and low cost, for acquisition and evaluation in cable fault detection scenarios. A common test methodology will be established and field trials conducted by depot staff in order to evaluate and compare device performance. The benefits of using such devices to help locate cable faults will therefore be established.

Consultation work will be undertaken by Kelvatek (Lisburn) to try to replicate and/or simulate underground fault conditions in order to speed up some trials, but field trials in real world scenarios and under different environmental conditions will be extremely valuable. Measurements will be recorded and statistics compiled in order to determine and rank the required measurement parameters for locating underground cable faults in different scenarios. Tests will be carried out in different environmental and weather conditions and for different types of ground surface (e.g. pavement, tarmac etc.).

## Scope

Thermal imaging equipment has traditionally been specialised and very expensive but thermal sensing technology has advanced to the point where it is relatively inexpensive to manufacture and is more readily available. This has resulted in a number of comparatively inexpensive devices becoming available on the open market, including some very low cost devices which attach to a smart phone or tablet. Within the context of rapid location of underground cable faults trials and investigations with a range of imaging devices and solutions will be carried out and, if successful, recommendations made for equipping repair operatives and depot staff. A training programme for safe and efficient use of the equipment will be designed and delivered.

## Objective(s)

- Produce a literature review of available products
- Select and acquire product examples for testing based on cost and performance criteria
- Establish common equipment testing and results recording methods
- Evaluate equipment performance in simulated fault scenarios
- Issue equipment to field operatives for evaluation in real fault scenarios
- Acquire data and develop tools for performing a detailed cost benefits analysis
- Document all results, conclusions and recommendations
- Evaluate project outcomes for possible adoption by BAU

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

The project will be successful upon the achievement of the following results and conclusions after assessing devices as complementary tools:

- 1) A range of thermal imaging devices are successfully evaluated as to their ability to locate or assist in locating underground cable faults and in which conditions;
- 2) Practical comparisons are made between the performance of low cost devices with that of higher specification equipment;
- 3) Substantiated recommendations are made on whether or not there are benefits in equipping field operatives with thermal imaging cameras, and low cost devices in particular.

### **Project Partners and External Funding**

n/a

### **Potential for New Learning**

n/a

### **Scale of Project**

Operations staff from 4 Southern Electric Power Distribution (SEPD) regions will conduct trials using several types of thermal camera when attending cable fault scenarios. This will occur over a full year in order to collect enough statistics over four weather seasons. Kelvatek will also conduct trials in a simulated environment. This multi-team broad field approach is essential for assessing camera performance for a range of faults on different cable types, different ground materials and different environmental conditions. The best performing cameras will be shortlisted and will potentially be field trialled in other SSEPD regions.

### **Technology Readiness at Start**

TRL7 Inactive Commissioning

### **Technology Readiness at End**

TRL9 Operations

### **Geographical Area**

The project will be undertaken within the SEPD and SHEPD network areas with involvement of Kelvatek's fault simulation and test area in Lisburn (N.I.).

### **Revenue Allowed for the RIIO Settlement**

None

### **Indicative Total NIA Project Expenditure**

Total NIA expenditure = £311,100 of which 90% (£279,990) is allowable NIA Expenditure.

## Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

### Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

#### How the Project has the potential to facilitate the energy system transition:

n/a

#### How the Project has potential to benefit consumer in vulnerable situations:

n/a

### Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

#### Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

The project is justified on the grounds that the method process (using thermal cameras as a complementary tool) could reduce the average time spent in locating underground cable faults and therefore enable the field teams to locate and repair significantly more cable faults relative to the current base method (using sniffers only) and time period efficiencies. If adopted it will result in a cost saving to the DNO which can be passed on to customers. Currently around 100 faults (flagged by Bidoyng) per month are identified but only an average of around 25 are actually located. It is thought that the method process will be able to locate an average of at least 8 additional cable faults per month (with the potential to increase). Financial benefits analysis from the Bidoyng programme shows that the average saving from locating and repairing a single cable fault is approximately £12.3k so it makes financial sense to locate as many faults as quickly as possible. In order to break even the method process will need to locate an average of about 3 additional cable faults per month.

This project builds on the Bidoyng LV automation programme. Base savings estimated at £10.4 million are forecast between October 2017 and the end of that programme in March 2019. Using thermal cameras the (Method) savings during that same period (when the technology is estimated to be BaU ready) are estimated at £12.7 million. This produces savings of £2.3 million over that time period.

#### Please provide a calculation of the expected benefits the Solution

The method cost for this project totals £81,324 which accounts for the procurement of a wide range of IR cameras as well as training staff to use the cameras. It is estimated that these cameras will be able to make a saving of £544,104 over the course of the project. This equates to a total saving of £462,780.

#### Please provide an estimate of how replicable the Method is across GB

Developed methods will be based on off the shelf solutions and will be fully transferable to all DNOs who want to acquire them. The method would have the potential to be deployed by all field teams working on underground cable fault repair or condition monitoring.

#### Please provide an outline of the costs of rolling out the Method across GB.

The goal is to establish a methodology which is easy to use, can be deployed rapidly and has minimal equipment costs. Worst case equipment costs will be around £11,500 per unit if high specification thermal imaging equipment is required. If the project proves that a low cost thermal imaging solution is fit for purpose (such as a smartphone accessory/app based solution) then roll out costs will be much lower, possibly in the order of £300 - £400 per unit. To equip the field teams of SSEPD approximately 64 units are needed for

BaU rollout. In addition there would be training costs of approximately £500 per operative. The actual costs GB wide would depend upon the extent of take up by each DNO and the number of operatives to be equipped and trained.

### Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

- A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).
- A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)
- A specific novel operational practice directly related to the operation of the Network Licensees system
- A specific novel commercial arrangement

RIIO-2 Projects

- A specific piece of new equipment (including monitoring, control and communications systems and software)
- A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven
- A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)
- A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology
- A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution
- A specific novel commercial arrangement

### Specific Requirements 4 / 2a

**Please explain how the learning that will be generated could be used by the relevant Network Licensees**

n/a

**Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)**

n/a

- Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

**Is the default IPR position being applied?**

- Yes

## Project Eligibility Assessment Part 2

### Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

**Please demonstrate below that no unnecessary duplication will occur as a result of the Project.**

n/a

**If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.**

n/a

## **Additional Governance And Document Upload**

**Please identify why the project is innovative and has not been tried before**

n/a

**Relevant Foreground IPR**

n/a

**Data Access Details**

n/a

**Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities**

n/a

**Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project**

n/a

**This project has been approved by a senior member of staff**

Yes