Date of Submission

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Annual Project Progress Report Document

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Project Title

Overhead Line Vibration Monitoring System

Project Reference

NA_SSEPD_0020

Funding Licensee(s)

Scottish Hydro Electric Power Distribution and Southern Electric Power Distribution

Project Start Date

November 2015

Project Duration

48 Months

Nominated Project Contact(s)

Joe McNeil

Year

2019

Scope

Under IFI project 2014_08 Monitoring of Conductors and Poles, a prototype sensor system, comprising of line mounted sensors, and a communications system was developed to operate on overhead lines up to 11kV. This project will take that work further to produce a production ready system. The newly developed sensors will be encased within environmental protective cases, and are powered by solar panel, which trickle charges a backup battery within the case. They will then be installed on overhead lines in several areas of the distribution network and left for an extended period of time to determine the suitability for use. In terms of effect on the installed infrastructure, ability to withstand weather events, and ability to maintain power on during the winter months will also be assessed.

Connections to the SCADA system will be made and tested.

Objective(s)

The project will:
1) Prove whether the production prototypes will survive winter months when mounted on live overhead lines•
2) Determine whether there is any sign of degradation to the wires where the sensors are mounted•
3) Will indicate whether there is any sign of vegetation encroachment onto the overhead line network•
4) Prove whether, or not, the sensors can communicate quickly and effectively with the SCADA system•
5) Provide an indication that non-vegetation objects have collided with an overhead line or pole. Examples would be poles moving due to soft ground and line collisions by raised farm trailers or forestry vehicles;
6) Determine the viability of deploying the sensor system as an alternative to replacing sections of overhead line with underground cabling.

Success Criteria

The project will be a success if:
1) It can be confirmed whether or not the system is able to detect the collision between the overhead wires and trees, branches and/or farm, forestry, or construction vehicles, on live lines.
2) Confirm whether or not the sensors and communication system can withstand the effects of the weather on the system.
3) Confirmed whether or not the mounting of the sensors will have a deleterious effect on the overhead lines.
4) Determine if and when the sensor system is a viable alternative to replacing an overhead line with underground cabling.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

This year the overhead line monitoring system has been installed on the 11kV network, at Perth Training School, with a data connection directly into the SSEN SCADA system. Additionally, it has also been possible to generate email notifications of events that have triggered the alarms. Assessment of the system is ongoing to determine its level of reliability in the field.

Below is a summary to date of the project's progress.

1) **Prove whether the production proto-type produced will survive winter months when mounted on live overhead lines;**

This was successfully achieved in previous years, as a trial was carried out at a remote training site using a de-energised section of overhead line, during December 2017 and January 2018. This proved the ability of the system to cope with extremes of Scottish weather.
The latest equipment was installed in December 2018. Although the winter has been milder than expected, the units have withstood the elements and maintained their data connections.

2) **Determine whether there is any sign of degradation to the wires where the sensors are mounted;**

This objective was successfully met in previous years, following the trial at the remote training site. During the trial, the conductor was examined, and no signs of degradation were observed.

3) **Indicate whether there is any sign of vegetation encroachment onto the overhead line network;**

This year with the installation of the overhead line monitoring system there is a much better understanding of how the notification information is being viewed within SCADA. Onboard the overhead line monitoring system and also the pole mounted unit there are 5 different notification events that can be triggered, they are as follows;

- A change in angle, slope, lean or inclination
- A displacement event where the location of the equipment changes
- A sudden acceleration event
- Dip in battery voltage, a warning that the device may not communicate; and
- Communication failure

The field devices have been set up to send a message if the associated notification event parameter is broken, remaining silent when the normal conditions are experienced. However, in strong winds or if the line drops to the ground the overhead line monitoring system will indicate which notification event has been triggered. The overhead line monitoring system only confirms which notification event has occurred, but it does not send any information that would help deduce what had occurred in the field.

With a greater understanding of the information that was being returned it was decided to trial the equipment at the Perth Training School where it is possible for the poles to be struck or the overhead line conductor to be dropped. At the training school it is possible to force a number of simulated events which is

beneficial as the reliability of the overhead line monitoring system can rigorously be tested and it should be possible to build a pattern of notification events that tally with known field occurrences.
It is very unlikely that the overhead line monitoring system will be able to accurately confirm vegetation encroachment on an overhead circuit, as only 1 notification parameter may be triggered at best.

4) Prove whether, or not, the sensors can communicate quickly and effectively with the SCADA System;
This year it has been possible to demonstrate the sensors communicating directly into the SSEN SCADA system. Additionally, it's also been possible to set up email notifications of the overhead line monitoring notification triggers, which enables instant viewing of the field event both internally and externally.

5) Provide an indication that non-vegetation objects have collided with an overhead line or pole, examples would be pole moving due to soft ground, line collisions by raised farm trailers or forestry vehicles;
With the trialling of the overhead line monitoring system at the Perth Training School, it has been possible to simulate poles falling and overhead conductor sagging excessively, for instance, to view the event notification. The overhead line monitoring system can positively trigger when extreme events occur, but as the notification does not contain any information it's not possible to tell the difference between events.
There has been success in the overhead line monitor triggering, however several devices would possibly need to be installed on the same section of line each set with different notification parameters otherwise the internal logic of the devices would have to be altered so that a low, medium and high notification event can be sent.

6) Determine the viability of deploying the sensor system as an alternative to replacing sections of overhead line with underground cabling;
There are positive concepts with the overhead line monitoring system, such as
- The analytics is undertaken in the field
- The devices are silent until a parameter is broken in the field
- There is a regular connection check undertaken to ensure all the elements are well and able to report
- The system appears to be reliable, based on the analysis carried out so far

However, there are several draw backs that really challenge the viability and cost efficiency. Mainly, the chosen method of data communications, which minimises the sending power requirements thereby necessitating a repeating module every 80-100m. There is a need to visit every pole in the circuit to place a repeater module, this is costly and time consuming. The need for a repeater module makes it challenging as more often than not there is a 200-400m 'no pole' zone around urban substations as the overhead line circuits have been undergrounded leading into the substations.
Evaluation of the overhead line monitoring system will continue, with the emphasis placed on identifying how best the learning can be used.

Details of how the Project is investigating/solving the issue described in the NIA Project Registration Pro-forma. Details of how the Project is performing/performed relative to its aims, objectives and success criteria.

Required Modifications to the Planned Approach During the Course of the Project

This year an extension was required to the project timescale as challenges had been encountered in sourcing an appropriate location for the trial. Perth training school was identified as the best location as the equipment under testing can be energised and events like a conductor drop can be simulated to see how the equipment responds.

The Network Licensee should state any changes to its planned methodology and describe why the planned approach proved to be inappropriate.

Lessons Learnt for Future Projects

The learning that has been obtained this year is as follows;

- It's been possible to generate an email notification both to SSEN and to the external equipment manufacturer to notify of a movement event. Being able to set this up has saved time checking weekly to find out which, if any, units have sent notifications. On receiving an email notification, it's then possible to investigate the activities that had been carried out at the training centre.
- The field units notify when a movement parameter has been broken, the units are only set-up with one parameter therefore it is difficult if not impossible to determine what has occurred in the field. While the concept is made simple by having set parameters, it also means that it will only determine a single event. To be able to draw more meaningful conclusions as to why the device has notified, several parameters need to be set for one movement.

Recommendations on how the learning from the Project could be exploited further. This may include recommendations on what form of trialling will be required to move the Method to the next TRL. The Network Licensee should also state if the Project discovered significant problems with the trialled Methods. The Network Licensee should comment on the likelihood that the Method will be deployed on a large scale in future. The Network Licensee should discuss the effectiveness of any Research, Development or Demonstration undertaken.

The Outcomes of the Project

N/A

When available, comprehensive details of the Project's outcomes are to be reported. Where quantitative data is available to describe these outcomes, it should be included in the report. Wherever possible, the performance improvement attributable to the Project should be described. If the TRL of the Method has changed as a result of the Project, this should be reported. The Network Licensee should highlight any opportunities for future Projects to develop learning further.

Data Access Details

No network or consumption data has been gathered during the project. Data sharing requests can be made in accordance with SSEN NIC and NIA Data Sharing Procedure; { HYPERLINK "https://www.ssen.co.uk/InnovationLibrary/Distribution/" \h }

Foreground IPR

No foreground IPR has been created during this project

A description of any foreground IPR that have been developed by the project and how this will be owned.