Network Innovation Allowance

Summary Report

1 April 2017 to 31 March 2018

Scottish and Southern Electricity Networks

Scottish Hydro Electric Power Distribution
Southern Electric Power Distribution

FOREWORD

This report is a summary of the progress that has been achieved by Scottish Hydro Electric Power Distribution (SHEPD) and Southern Electric Power Distribution (SEPD) in NIA projects during the period between April 2017 and March 2018. SHEPD and SEPD are both part of Scottish and Southern Electricity Networks (SSEN) and they own and operate the distribution networks in the North of Scotland and the South of England respectively. Since the onset of RIIO-ED1 in April 2015, Distribution NIA has been funding smaller technical, commercial and operational innovation projects with potential to deliver benefits to Distribution Licensees and their customers.

In line with SSEN's core value to provide the energy people need in a reliable and sustainable way, we have set targeted innovation objectives in our Innovation Strategy submitted as part of the RIIO-ED1 plan. In recent times, we have seen a rise in the adoption of low carbon technologies such as Electric Vehicles and Heat Pumps. There is also a steadily rising penetration of distributed energy resources (DER) such as renewable generation sources and other non-conventional assets like large scale batteries, all connected at distribution level. To better manage the seamless integration of these disparate systems, the GB electricity market is reforming with the transition towards a Distribution System Operator (DSO) model which will transform the way Distribution Network Operators (DNOs) operate. All these developments have introduced new challenges which need to be addressed to ensure that there is minimal disruption to the service that our customers have come to expect from us. We also continue to be informed by the collaborative industrial effort led by ENA to develop an industry-wide joint innovation strategy.

In the year to 31st March 2018, we had a portfolio of twenty-one live NIA projects at various stages in their lifecycles. Sixteen of those projects were led by SSEN with the remainder being led by our collaboration partners. Due to our experience of the GB Electricity market changes since the onset of RIIO-ED1, and our tracking of the shifting priorities imposed by those changes, the composition of our portfolio of distribution NIA projects has started to reflect the changes. We therefore now have a small number of projects which focus on understanding the adverse impact and/or opportunities that may be unlocked by our transition to DSO.

Within SEPD and SHEPD, one of the measures of innovation success is to take project learning and translate this into business as usual. To confirm that, we have successfully completed the rollout of outputs from one of our projects to our teams in both network licence areas of SSEN. We also have recently completed projects that are in the process of seeking approval for wider roll out within our business. Meanwhile, we continue to lookout for learning generated by other network licensees for any opportunities to fast-follow whenever feasible. We also continuously engage with our stakeholders and collaborate with other interested parties in the energy supply chain so that our innovation efforts can deliver the best possible value to our customers.

Stewart A Reid
Head of DSO and Innovation
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1 NIA Project Portfolio

For the year ending 31 March 2018, there were 21 projects funded under SEPD and SHEPD Network Innovation Allowance (NIA). 16 of the projects were led by us and the remainder by our collaboration partners. Three of the NIA projects that were live at the beginning of the financial year have since completed whilst 4 new projects have been registered.

A crucial aspect of the ongoing SSEN NIA project portfolio is that it takes into consideration the 20 top innovations identified as part of the RIIO-ED1 Innovation Strategy. Where the projects do not map directly to the top 20 core innovations, each project still maps onto at least one of the RIIO-ED1 primary outputs.

Table 1 below shows all the RIIO-ED1 primary outputs, the top 20 core innovations and the relevant registered NIA projects associated with each. These targets guide the entire Innovation programme for SSEN including those not funded under NIA. Further details of how other projects are mapping onto our core innovations are covered in the update to the published Innovation Strategy. The link to the update is provided here [Innovation Strategy Update]

RIIO-ED1 PRIMARY OUTPUT	CORE INNOVATIONS FOR RIIO-ED1	RELEVANT NIA PROJECTS	COMMENTS
Connections	Active network management – generator constraint management	• NIA_SSEN_0031 Risk Assessment and Modelling of Smart nEtwork Solutions (RAMSES)	
	Demand side management – thermal energy storage	• NIA_SSEPD_011 ACCESS – Local Constraint Management	
	Local smart EV charging infrastructure	• NIA_SSEPD_0026 Management of Plug-in-Vehicle Uptake on Distribution Networks	

RIIO-ED1 PRIMARY OUTPUT	CORE INNOVATIONS FOR RIIO-ED1	RELEVANT NIA PROJECTS	COMMENTS
Customer service	Advanced distribution automation – network reconfiguration	• NIA_SSEPD_009 Automated Loop Restoration	
		• NIA_SSEPD_003 Network Damage Reporter, • NIA_SSEPD_007 Field Team Support Tool, • NIA_SSEPD_010 Mobile Generator Re-sync at 11kV and 33kV, • NIA_SSEPD_0021 Thermal Imaging Observation Techniques for Underground Cable Networks (TOUCAN) • NIA_SSEPD_0023 Fault Passage Indicators for SEF • NIA_SSEN_0032 Phase Identification Unit to Assist in Underground Fault Location	No core innovation is associated with these projects. However, these projects support the associated RIIO-ED1 primary output.
Environment		• NIA_SSEPD_0025 Applied Integrated Vegetation Management (IVM),	No core innovation is associated with these projects. However, these projects support the associated RIIO-ED1 primary output.
Reliability		• NIA_SSEPD_029 11kV power electronics providing reactive compensation for voltage control • NIA_SSEN_0033 ACSS Conductor Study	No core innovation is associated with this project. However, this project supports the associated RIIO-ED1 primary output.
	LV network modelling	• NIA_SSEN_0030 Whole-System Growth Scenario Modelling	
	LV network monitoring	• NIA_SSEPD_0027 Low Cost LV Substation Monitoring,	
Safety	Conductor sag and vibration monitoring	• NIA_SSEPD_0020 Overhead Line Monitoring	
	Live line tree felling		
Social Obligations	None at present		

Table 1: Mapping top 20 core innovations to registered NIA projects

2 Summary of Progress

2.1 NIA_SSEPD_0003 Network Damage Reporter

Start Date: April 2015

Duration: 38 months

Description:
The scope of the project is to produce a smartphone application for Android and Apple tablets and smart phones that will allow third parties such as members of the public and the emergency services to easily provide us with reports of damage to our networks.

Expected Benefits:

- Develop new procedures and processes to make use of the data submitted by users, such that the fault report submitted is integrated into the company fault management system
- Develop a publicity strategy to publicise the availability of the application
- Evaluate the viability of fault reporting using smartphones

Progress:
The project is nearing completion. The application has now been produced and has replaced the existing Power Track app available for both Android and iOS. The application is now downloadable for free in all major app stores and can be used to report faults with photos, descriptions and location information. The level of interest by the public is still under evaluation but a high level of interest was shown in initial discussions with emergency services. It is expected that the level of benefits achievable from using the app will become apparent after some faults and periods of stormy weather. The images below show the integration of the application with the back-end as well as the information presented to customer contact centre personnel.

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Fig 1: Interaction between mobile devices and the DNO service centre desktop

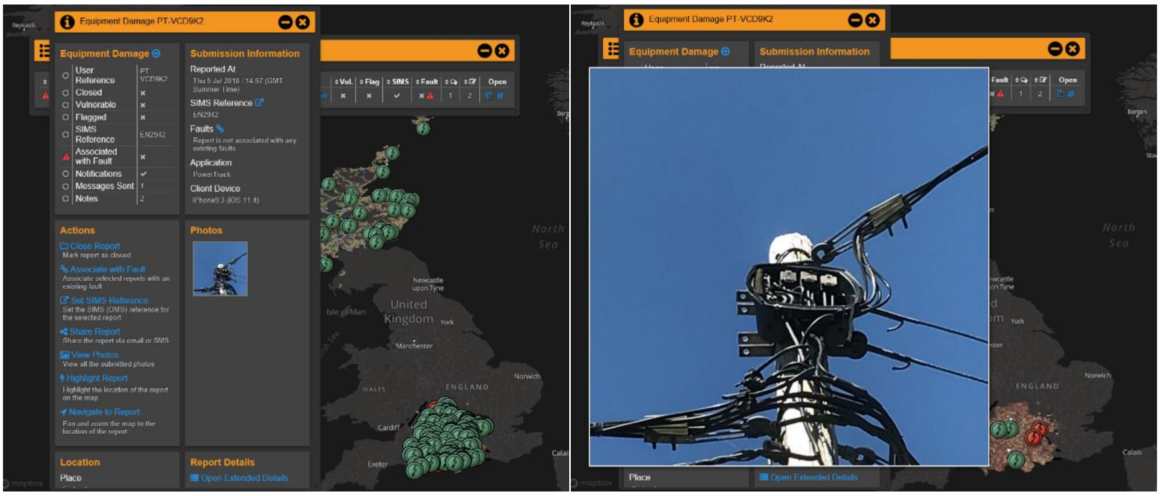

Fig 2: User interface showing a fault report as it appears on the DNO service centre desktop

2.2 NIA_SSEPD_0007 Field Team Support Tool

Start Date: April 2015

Duration: 39 months

Description:
This is a continuation of an IFI project looking at providing field staff with a tablet device that can hold the necessary field documentation, can be updated in real time, and provides a visual display of the power network, overlaid on to a geographic map, or through augmented reality techniques, on live images displayed on screen. This project will further develop the tablet device so that it can be used to report task progress and issues back to supervisors and managers, and to ask for advice and further documentation if necessary.

Expected Benefits:

- Improvements in efficiencies of everyday working thereby cutting down costs
- Improvement in level of customer service through increased productivity and speed of resolution of faults to decrease time off supply

Progress:
The project is nearing completion. The objective to demonstrate that data can be transferred between the tablet and the server in a standardised and secure format that is immune to external interference has been successfully met with data transfers maintaining integrity using data encryption. In terms of the scalability of the system, over 6000 reports have been handled by the servers without problems in organising and searching of the data.

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The most notable benefit of the project has been its application in the Air Break Switch Disconnector (ABSD) project where over 2000 ABSDs were inspected. Feedback from the field staff who used the tool has provided input into the scope of Maximo, the new Asset Management tool being rolled out in SSEN. For efficient connections, there are ongoing efforts to understand if connection staff may be able to benefit from a modified form of the tool. In addition, the application's background mapping system has been used for the Network Damage Reporter and is being evaluated for use in a business as usual activity to monitor and predict lightning strikes on the network. The images below capture some of the applications which may benefit from elements of the field team support tool (FTST).

Fig 3: Potential use of the FTST for connection quotations with annotation of cable routes

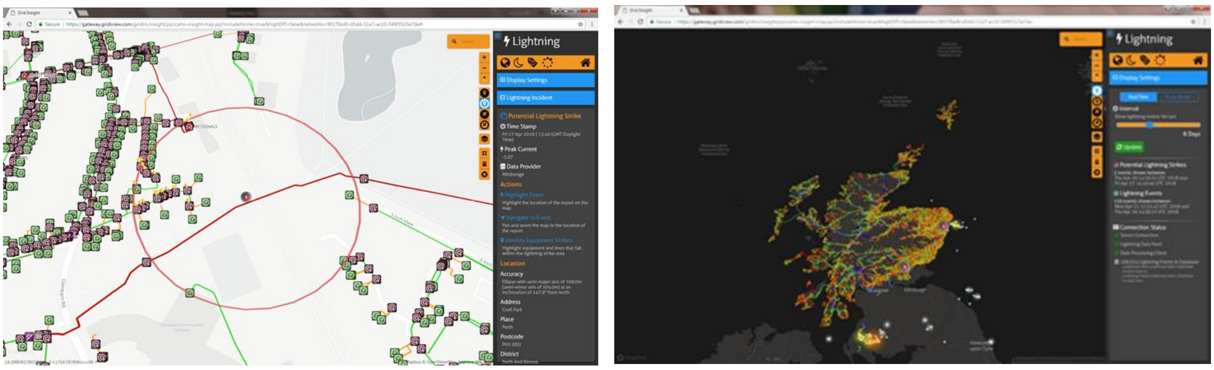

Fig 4: Images from the lightning tracker interface using the mapping system behind the FTST

2.3 NIA_SSEPD_0009 Automated Loop Restoration

Start Date: June 2015

Duration: 45 months

Description:
This is an automation scheme for reducing customer interruptions and customer minutes lost (CI/CMLs) by automatically restoring supply to sections of the network initially affected by a fault but not actually having a fault. This project makes use of loop reconnection which does not rely on communication links to transfer data to enable automatic restoration of supplies. Seven pole mounted circuit breakers will be installed on two sections of 11kV overhead line networks on the Kintyre Peninsula to create an overall scheme of eight sections.

Expected Benefits:
The method in this project is expected to reduce CI and CMLs.

Progress:
Equipment for this project has been procured and work has been ongoing to integrate communications between this equipment and the SHEPD control systems. The learning to date shows that there has been significant time spent on integrating the switchgear being used in the trial with the Distribution Management System (DMS). This has also been compounded by capacity issues with the communication link. The full trial system was not installed due to the foregoing issues and internal policy reviews on working processes. A recent development in the implementation of automated restoration system based on conventional hardware and the existing DMS has made further development of this project redundant. Decommissioning is now in progress before the project is brought to an early close.

2.4 NIA_SSEPD_0011 ACCESS – Local Constraint Management

Start Date: July 2015

Duration: 31 months

Description:
The project involves the creation of a technical and commercial framework to allow generators to manage generation and demand within a pre-determined network area. Specifically, this is intended to link local controllable demand, such as heating systems, with intermittent local generation. This is in response to policy drivers put in place to facilitate locally owned community generators to be used to supply local customers in an attempt to address fuel poverty in rural areas.

Expected Benefits:
The new local demand side management will have the potential to avoid or defer network reinforcement to allow connection of new renewable generation. This is also anticipated to allow increased utilisation of existing assets and reduction of network losses.

Progress:

The project is now complete. DNO requirements for local demand side response have been defined and understood with lessons learnt concerning the definition of a set point. A functional specification was also produced at the project inception and has been followed since. Communications with heating elements in over 80 participating dwellings has been proven. The generator load shedding and disconnection schemes in the event of control loop failure have been proven. Further details of this project are covered in Section 3 of this report.

2.5 NIA_SSEPD_0020 Overhead Line Monitoring System

Start Date: November 2015

Duration: 38 months

Description:
This project develops the initial IFI project (2014_08) to produce a production ready line mounted sensor and communication system to mitigate susceptibility of rural overhead lines to damage by wind debris, inadvertent collision by farm and forestry vehicles, kites etc. 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

Expected Benefits:
There will be potential cost savings through:

- Reduction in costs due to damage from vegetation
- Reduction in costs due to not undergrounding in high risk areas

There will also be better safety performance through reduction in the risk of safety incidents due to wires drooping close to the ground due to pole movement or collisions with the wires by vehicles.

Progress:
The project is progressing but a modification was initially required to deal with the effects of heat generated by the conductor on the sensor. This resulted in re-design of the sensors. Most of the objectives have been achieved. However, a further change request was made for extra time to identify suitable trial circuits and gain authorisation to install the test system on the overhead lines.

2.6 NIA_SSEPD_0021 Thermal Imaging Observation Techniques for Underground Cable Networks (TOUCAN)

Start Date: January 2016

Duration: 20 months

Description:
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. 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. Within the context of rapid location of underground cable faults trials, an investigation with a range of imaging devices and solutions will be carried out and, if successful, recommendations made for equipping repair operatives and depot staff.

Expected Benefits:
There are potential significant cost savings through reduced time spent locating cable faults and reduced outage times.

Progress:
This project has now successfully completed. The outputs of the project have already been rolled out to the rest of SSEN. Benefits from the project continue to be tracked and there have been knowledge dissemination activities to extend the learning to peer DNOs.

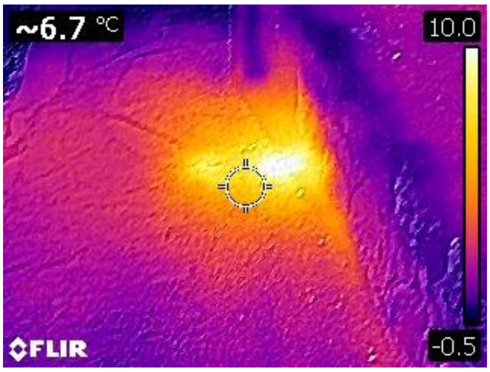

Fig 5. Fault location image from FLIR E5 camera

2.7 NIA_SSEPD_0023 Fault Passage Indicators for Sensitive Earth Faults

Start Date: December 2015

Duration: 27 months

Description:
The aim of this project is to establish the magnitude of reduction in Customer Minutes Lost (CMLs) achievable by locating sensitive earth faults (SEF) with a revised fault passage indicator (FPI) supplied by Bowden Brothers and modified to be sensitive to currents as low as 4A through tests at the Power Network Demonstration Centre (PNDC), field trials and a post-trial evaluation.

Expected Benefits:
- Improved customer service through reduction in CMLs
- Reduced costs due to reduction in CMLs

Progress:
The project has now completed. The project has successfully evaluated an FPI with SEF detection capability which subsequently led to the development of a new FPI version with the combined functions of normal fault detection and SEF detection. Based on analysis of data from the field trials, the project has reached a conclusion that this is a viable way of reducing CI/CMLs on relevant circuits. So far, the technology has received positive reviews from internal stakeholders hence a business case paper has been produced for review by the stakeholders responsible for investment decisions.

2.8 NIA_SSEPD_0025 Applied Integrated Vegetation Management (IVM)

Start Date: January 2016

Duration: 87 months

Description:
The project addresses the problem of trees in the vicinity of overhead electricity lines and also ensuring that regulatory standards are met. One of the potential solutions is the use of machine mulchers to clear all vegetation but this is costly and is not desirable from either an ecological or landscape point of view. This project proposes the use of integrated vegetation management (IVM). This is the practice of promoting desirable, stable, low-growing plant communities that will resist the invasion by tall-growing through the use of appropriate, environmentally sound, and cost-effective control methods.

Expected Benefits:
- Financial savings through reduction in use of cost-intensive mulching methods
- Environmental benefits due to reduced disruption to protected wildlife species

Progress:
The project is progressing as planned. The completed literature review indicates that IVM can result in significant cost reductions, and improvement in biodiversity of both plant and animal species. The project has now extended in scope to cover a broadleaf wood site. Initial selective clearance has been carried out at the trial site and an adjacent broadleaf wood site which is typical of the kind of land for which integrated vegetation management should be particularly suitable and effective. Both sites are now in the third-year growth season of the IVM regime

2.9 NIA_SSEPD_0026 Management of plug-in vehicle uptake on distribution networks

Start Date: March 2016

Duration: 31 months

Description:
This project will seek to inform an ENA Engineering Recommendation (or equivalent) for the connection, charging and control of new, large, plug-in vehicle (PIV) load to domestic properties. The focus of this project is on the collaborative approach required to achieve consensus on a solution that can be used to facilitate the roll out of controlled PIV charging.

Expected Benefits:
There are financial savings expected if network reinforcements necessitated by uptake of plug-in vehicles, can be deferred based on implementing the monitoring and control methodology proposed in this project.

Progress:
The project is still progressing with most of the objectives having been met. There has been significant stakeholder engagement activity so far as part of meeting the project's comprehensive staged plan. The output of the project has now been modified to include a deliverable covering the use of the Smart Metering infrastructure to provide a longer-term solution. The original intention to develop proposals for integration into business as usual (BaU) has been removed from the project as there is extensive high level and Parliamentary interest in this area and until the direction of travel becomes clearer it would not be possible to develop a BaU strategy. Details of the learning and outputs to date are covered in the NIA project progress report.

2.10 NIA_SSEPD_0027 Low Cost LV Substation Monitoring

Start Date: March 2016

Duration: 33 months

Description:
This project proposes a technical method to develop and test a quantity of low cost devices from different manufacturers which will measure voltage and current at the outgoing feeders from a number of secondary substations. Data will be transmitted via the GPRS network from each substation to a central data centre where it will be available to the network planners and other relevant licensee staff. This will be in order to allow informed decisions to be made by network planners and other staff with respect to operational decisions, network planning and customer service.

Expected Benefits:
Improved visibility of the Low Voltage (LV) network will help in the identification of areas where smart technologies can be implemented. Such technologies will allow deferral of underground cable reinforcement which will result in financial savings.

Progress:
The project is progressing and most of the monitoring systems have been in service for some time. Data has been collected over the past year and is already proving useful in identifying electric vehicle (EV) hotspots. With the progress on the installation of smart meters and the availability of half hour data from that source there will be learning to be pursued related to the interaction between the two data sources. Based on the learning so far, there is a high likelihood of the innovation going on to become business as usual.

2.11 NIA_SSEPD_0029 11kV Power Electronics Providing Reactive Compensation for Voltage Control

Start Date: June 2016

Duration: 42 months

Description:
This project proposes a technical method to deploy a newly developed power electronic reactive power compensation unit of a novel design which operates with a direct connection at 11kV. The aim of the project is to manage voltage changes due to changing customer loads and generation which may go outside of statutory limits in some cases. The device will be tested at Power Networks Demonstration Centre (PNDC) to ensure that it can operate over the full voltage and frequency envelope it is designed for.

Expected Benefits:
The proposed method will trial a new device with ability to quickly respond to voltage changes by supplying or absorbing reactive power. This technology can be retrospectively fitted on existing problematic circuits thereby allowing deferral of transformer, overhead line and underground cable reinforcement which will result in financial savings.

Progress:
The project is progressing with the operational requirements now having been determined for the function of voltage regulation. The supporting device documents indicate that the device conforms to the relevant standards for operational parameters. For the pole-mounted variant of the device, a pole structure has now been selected and the electrical protection scheme is being designed before it undergoes validation at the PNDC.

2.12 NIA_SSEN_0030 Whole System Growth Scenario Modelling

Start Date: October 2017

Duration: 12 months

Description:
A key role of a Distribution System Operator (DSO) is to undertake "Whole system planning". This means considering factors broader than the immediate demands on the local electrical network when considering how to meet customers' needs. Whole system planning requires the DSO to:

- Make decisions on investment in network assets, or flexibility
- Consider local energy scenarios to realise optionality value and make least-regret investments
- Consider all reasonable solutions across Distribution, Transmission, and other energy networks and sources

- Provide local investors, customers and communities with visibility to inform decisions in relation to their own investments

The foregoing has to be done in a manner which balances cost and reliability across all relevant energy networks. In this project, the analysis will consider the overall energy requirements of a local geographical area, considering the community; planning policy; transport policy; and other energy sources or sinks (such as gas networks). This has not yet been undertaken and will become increasingly important as decarbonisation shifts energy demands between fuels, and as additional decentralised generation seek to connect.

The project will develop a method for undertaking whole-system modelling of an area defined by a Grid Supply Point, including stakeholder engagement; local generation and demand; existing asset condition and replacement needs; and investment options, including distributed energy resources and demand response. The model will focus on the 33kV voltage level and will not address the individual building level. It will use the Future Energy Scenarios to project forwards from the present day. The method will be tested on three areas: Fort William, Dundee and Islay.

Expected Benefits:

This is an enabling project for the DSO transition and will allow the company to examine the scope for applying flexible and distributed energy resources to meet system balancing requirements in the areas modelled.

The proposed study will gather evidence to assess the need for anticipatory investments, and identify possible investment triggering factors. This will ensure that the risk of creating stranded assets is kept as low as possible through making the most effective use of flexible resources, demand side response, active network management, and constraints. It will enable an electricity DNO to assess the impact of whole system factors including the extension of gas networks; the uptake of electric vehicles; heat networks; and local development plans.

Progress:

The project consultant was appointed in April and has identified the relevant stakeholders. The project is currently in the data gathering stage.

2.13 NIA_SSEN_0031 Risk Assessment Modelling of Smart nEtwork Solutions (RAMSES)

Start Date: October 2017

Duration: 12 months

Description:
The RAMSES project aims to improve the understanding of risks associated with assets not owned by the DNO e.g. energy storage, demand side response, etc. It does this by using advanced modelling to simulate the effects of third party technologies on the network.

Expected Benefits:

Reduced investment and operational risk when contracting with third parties e.g. CMZ, energy storage, etc. Risks of outages will be reduced, by ensuring best practice standards (identified by the project) are followed by being written into contract agreements.

Progress:
The project is still in progress, but expected to be completed within the next few months, once model results have been analysed and learning disseminated.

2.14 NIA_SSEN_0032 Phase Identification Unit to Assist in Underground Fault Location

Start Date: February 2018

Duration: 15 months

Description:
The HAYden SYStems Phase Identification Unit is used to identify which phase a building is on without having to interface with the owners, thus minimising disruption (particularly when people are out during the day or asleep during the night). This project uses this technology to identify a number of primary and secondary goals:

- Primary - Location of sustained LV faults (generally the hardest and most expensive to find) – the aim is to minimise the digging required to identify the fault location
- Secondary – Confirmation of supply loss/restoration without disrupting the customer (or having to look in a window for lights)
- Secondary – Provides connectivity map of area which has undergone a fault which is important for future balancing works

The trial is expected to show if there is a CI/CML improvement through the use of this device.

Expected Benefits:
- With Unit costs around £1,300, payback achieved with two avoided digs.
- Future benefits from minimisation of customer disruption and ability to understand if users are back on supply without entry into the properties

Progress:
The project is progressing and from data interrogation, the devices are in more frequent use than initially expected. There are further details provided on some of the developments in the project so far, covered in Section 3 of this report.

2.15 NIA_SSEN_0033 ACSS Conductor Study

Start Date: March 2018

Duration: 1 months

Description:
This project will assess any potential benefits available from ACSS conductors in three OHL scenarios; single circuit 132kV wood pole; double circuit 132kV lattice steel reutilisation; and double circuit 275kV lattice steel reutilisation. It will also report a technology review of ACSS conductors.

Expected Benefits:
- The new conductor has potential to provide a new High Temperature Low Sag conductor option for OHLs

Progress:
The project has now completed with conclusions having been made on the viability of the conductor on the modelled scenarios. More details of the findings are covered in Section 3 of this report.

2.16 Collaboration projects led by other Network Licensees

Below is a list of other projects that SSEN is participating in. The projects are led by our collaboration partners hence further details of those projects can be found in their relevant summaries and project progress reports. To provide some indication of where those details can be found, the leading parties are given below next to each project.

- NIA_SPEN_008 Appeal (Wood preservatives) – Scottish Power Energy Networks
- NIA_WPD_008 Improved Statistical Ratings for Distribution Overhead Lines – Western Power Distribution
- NIA_UKPN_0029 Assessment and Testing of Alternative Cut-outs – UK Power Networks
- NIA_WWU_045 Eye in the Sky – Wales and West Utilities
- NIA_SPT_1801 Distributed Ledger Technology-enabled Distribution System Operation (Phase 1) – Scottish Power Energy Networks

3 Highlights of the year: Areas of significant new learning

3.1 Delivery of value through converting learning to business as usual

Rapid location of underground LV cable faults, which minimise customer interruptions and reduce repair costs is a significant business challenge. In support of this, we have been investigating this through a series of projects to evaluate and develop a set of tools that can be used either individually or in combination to address the problem. One such project was 'Thermal imaging Observation techniques for Underground Cable Networks (TOUCAN)' which has so far delivered significant learning and has successfully been rolled out to both distribution licence areas of SSEN.

The major learning point from this project was understanding that the capabilities for heat signature detection were not related to camera cost. The project team successfully secured funding from the business to procure the preferred FLIR E5 thermovision cameras and roll out training as well as the necessary process changes to enable full implementation of the outputs of the project into business as usual. To extend the potential benefits available from adoption of this method, dissemination activities have been rolled out through exceptional events, at LCNI conference and through direct engagement visits to peer DNOs.

In development of the fault location toolset for improved LV supply restoration, one approach, that of observing which customers do and do not have supply after a reported fault, provide some evidence of the area in which a fault is possibly located. However, this relies upon directly communicating with the customer or visible evidence of supply, such as witnessing that their lights are on. When customers are absent, gaining information on their supply status is not always possible. A recently registered project entitled 'Phase Identification Unit to Assist in Underground Fault Location' to try and address scenarios such as these. The project was conceived from the evaluation of the HAYSYS Phase Identification Unit (PIU) which was taking place in the business as a fast-follower of previous innovation trials by peer DNOs.

The PIU is a handheld self-contained device which can identify the phasing of a property from the magnetic field that is produced around the conductor. The device achieves this through communication of time-synchronised phase information between the PIU and a remote reference unit connected to a mains supply which is phase locked to the same frequency as that at the point of measurement. The pictures below show an image of the PIU and a satellite screenshot representing how the device enables provision of phase information of each property in a studied area, a potential precursor to building an LV connectivity model.

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Figure 6: Image of the HAYSYS PIU

Figure 7: Representation of phase information on an estate as provided by the PIU

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In this project, the PIU device is helping in the location of LV open circuit faults by showing clearly which phase is affected and highlighting which properties are not on supply without entry into properties or reliance on observed evidence of supplies. Once the last property connected on the faulty phase and with supplies still available is established using the PIU, it becomes easier to locate the exact point of fault as the faulty section will have been significantly narrowed.

When the project commenced, there was concern about how effective this method would work especially in densely populated areas where there is high likelihood of overlapping magnetic fields. To evaluate the method in a typical scenario, the project team decided to use a planned supply interruption arranged to repair a damaged cable on a densely-populated part of the SEPD network as a proof of concept. The device was used successfully to define the fault zone within 20 minutes of arrival and the zone was confirmed as correct by the stakeholders running the job. The screenshot below shows the magnitude of reduction in the fault zone to be investigated once the PIU device has established the open-circuit point.

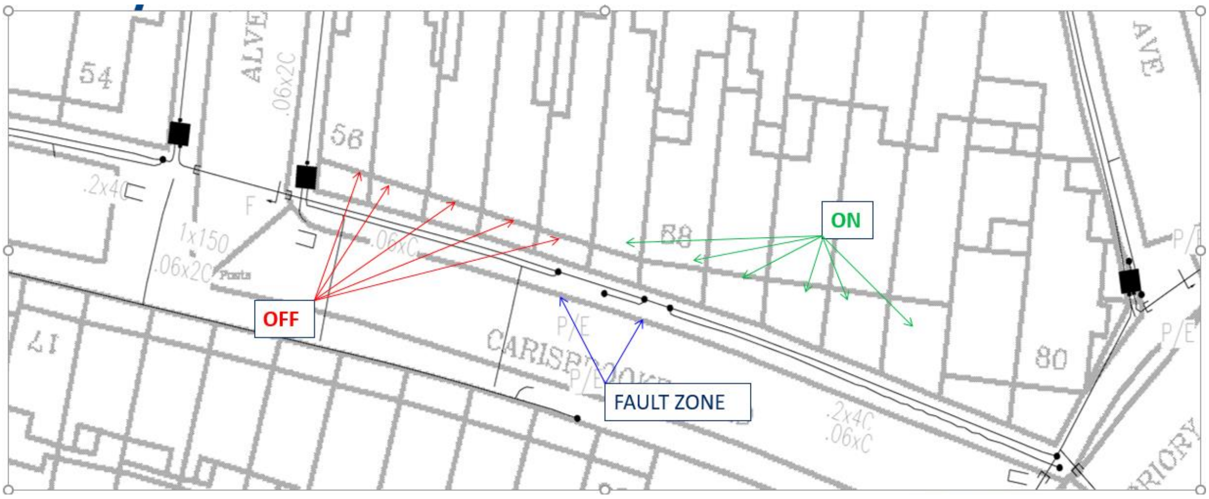

Fig 8: Reduction of extent of fault zone by use of the PIU

This project has only recently started and is ongoing. Over time, it will be possible to quantify the reduction in Customer Minutes Lost that will be achievable by using this method and making comparisons with like for like scenarios. Our records so far show significant use of the devices in SEPD and for a wider range of tasks than originally envisaged. Our belief in exploiting quick wins means we have some confidence already that this could inform interested parties to start delivering some benefits to customers, where deemed feasible, by using this device to hasten supply restoration of open circuit faults.

We have worked with our peer organisations such as UKPN to evaluate the new application of the PIU and knowledge sharing exercises will continue as we get new learning from wider use.

3.2 Leveraging the potential of demand side response to expedite connections

One of the just ended NIA projects, 'ACCESS – Local Constraint Management (Mull)', has produced learning that could provide another pathway for speeding up the connection process for customers. In recent years, community owned renewable energy projects have been promoted in GB. This initiative is confirmed by part of this project's name, 'ACCESS', which stands for 'Assisting Communities to Connect to Electric Sustainable Sources'. Despite the popularity of the stimulus, a challenge remained in that some of the projects were situated in areas already subject to grid constraints. The problem for community groups in constrained areas is that they cannot consider other locations for their projects, something that would be an option for a commercial developer.

The ACCESS project was aimed at addressing that challenge for the relevant scenarios by using a community energy project on the Isle of Mull as a trial set-up. The project demonstrated that a constrained generator can operate at its maximum output without impact on the electricity network through controlling loads in the local area to make optimal use of surplus generation.

Mull is connected to mainland Scotland via 33kV Scottish Hydro Electric Power Distribution (SHEPD) cables. At Garmony, on the eastern side of the isle, there is now a 400kW river hydro generator owned by Green Energy Mull on behalf of the Mull and Iona Community Trust. Since the river does not have a water reservoir at the installation, it is not possible to earmark generation for times of peak demand. Previously, Mull has always imported all electricity through the 33kV cables from the mainland. The addition of new generation to Mull, without a corresponding increase in demand, reduces the total power imported from the mainland, risking import reduction beyond which there is potential for unacceptable voltage rise on the mainland.

ACCESS received funding as part of Scottish Government's Local Energy Challenge Fund 2015 to develop the Garmony Hydro. Further funding came from project partners and NIA enabling the project to demonstrate the viability of developing and implementing locally managed generation and demand on constrained networks. This wider project involved installation of controllable loads in the form of storage heaters on participating customers' properties and providing controls for the Garmony Hydro. The natural system condition is that the power imported from the mainland plus the local generation remain in balance with the load on the Isle of Mull (consisting of pre-existing loads and the newly installed controllable loads). Monitoring equipment was installed on the appropriate points of the SHEPD network to ensure that the minimum import threshold from the mainland could not be breached. If the import level began to fall, the generator would either reduce its output or the controllable loads would be switched on to absorb the surplus generation thereby keeping the import levels above the threshold.

The NIA project had specific objectives related to management of network constraints and establishment of a framework for expediting connections in constraint managed zones. The viability of local demand side response was confirmed through the setting of an artificial constraint on the subsea cables feeding the Isle of Mull. The constraint was only artificial because studies have shown that a real constraint does not exist on that particular scheme under the current configuration. This provided a safe means to prove the concept without any undue risk to the operational network. SHEPD provided a network monitoring system which provided alerts to the community heating project if reduction of import from the mainland was imminent. This gave an indication of their system's failure to maintain their heating/generation plant and that if it was not rectified within a given time it would result in the tripping of the circuit breaker connecting Mull to the mainland. In addition, the signal transmission was done locally without being routed via SHEPD's Network Management Centre. Based on the SHEPD requirements in the project, a functional design specification has been produced for this and for future projects. The project outputs have now formed the basis for Alternative and Flexible Connections which SSEN now offers within their standard connection procedure. The flexibility option allows customers to connect to the network as an alternative to network reinforcement or until reinforcement is complete.

3.3 Leaving no stone unturned in assessing options for increasing capacity

One option for increasing capacity in networks is to re-string overhead lines with conductors that have higher current carrying ability. Most existing overhead lines in GB at EHV generally use Aluminium Conductor Steel Reinforced (ACSR) conductor. In recent years, to address the issue of increasing capacity of existing power corridors and re-conductoring of lines with limited refurbishment of supporting structures, alternative conductor technologies have been explored. Some High Temperature Low Sag conductor types and variants have already been trialled and adopted. As experience of using these new technologies is gained, learning is also emerging about some of the limitations of the technologies. For instance, composite cored conductors have exhibited higher installation risks than steel-cored conductors and there are currently ongoing efforts to develop methods of inspecting such conductors once they have been strung, an issue that is less of a problem for conductors such as ACSR where there is significant knowledge already in place. This realisation has resulted in the revisiting of modern steel-cored options with better capabilities than current ones. A recently completed project, 'ACSS Conductor Study' has generated some learning about potential future applications. ACSS (Aluminium Conductor Steel Supported) is claimed to have the following advantages over ACSR:

- Increased current carrying capacity with the existing supporting structures. For new lines, structures could be optimised to take advantage of its reduced sag. ACSS can operate at higher temperature and uses Aluminium strands with higher average conductivity on like-for-like dimensions
- Where Aeolian vibration is an issue and there is risk of failure from vibration fatigue, the conductor has immunity as there is no load placed on the annealed Aluminium wires

In the study performed as part of this project, the aim was to quantify the benefits available from ACSS and compare it to other new conductor types under specific modelled scenarios.

The study has reported on the overhead line capacity, support loadings and clearances under thermal and climatic loading for ACSS and two other conductors, All Aluminium Alloy Conductor (AAAC) and Aluminium Conductor Composite Core (ACCC). A lesson that arose from the project was that the standard ACSS wires files which are in the modelling environment, PLS CADD, do not adequately address some manufacturer's products. The project makes a recommendation to check the wire files with the conductor manufacturers before use.

The project outcomes have confirmed that this conductor is potentially viable as an alternative high temperature option for the use case of new build 132kV wood pole supported overhead lines. This learning supports consideration of the technology by network operators especially as more connections are being made at EHV level. The learning is therefore under consideration in SSEN with a view to develop scope for further investigation or trial, if deemed so. Further details about the study are contained in a full technical report that was produced as part of the study and which is available on request via the email address at the bottom of this report.

4 Further Information

The complete Innovation Strategy for SEPD and SHEPD can be found on the link below:

[2015 Distribution Innovation Strategy]

Innovation Strategy Update published in March 2016

[2016 Distribution Innovation Strategy Update]

Further information on all of the NIA projects summarised above can be accessed through the following link:

[ENA Smarter Networks Portal – SSEN Projects]

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