Innovation Funding Incentive Annual Report

31st March 2015

IFI Projects
April 14 – March 15

For SP Distribution plc. and SP Manweb plc.

Foreword

This is SP Energy Networks (SPEN) last Annual Report under the Innovation Funding Incentive (IFI) mechanism following its inception in 2005. This mechanism has resulted in a range of successful innovation being applied across the electricity supply industry. We, consequently, welcome the opportunity to continue innovation development in RIIO ED1 under the new Network Innovation Allowance (NIA) for Distribution projects.

Over the reporting period our Future Networks Team has worked hard to develop and deliver new innovative technologies that improve the way our network operates and brings benefits to our customers. This annual report for 2014/15 details forty two of these projects that embrace a range of technologies, and represent our highest ever IFI annual spend. These projects represent our commitment to seek opportunities to leverage associated research and development spend through collaboration with other Distribution Network Operators (DNOs), academia and several Small to Medium Enterprises (SMEs).

We have carried out extensive work to understand and manage the impact of low carbon technology on our network as well as the increasing role of mobile technology and advanced aerial surveying in our day to day activities managing the network. At the same time we have undertaken several projects that have the potential to deliver immediate benefits to customers and stakeholders, be it through low intrusions excavations or real time fault updates.

We now turn our attention to extract further value for our customers and stakeholders through the NIA for Distribution projects. This, alongside our Think Big, Start Small, Scale Fast approach will enable us to be at the forefront of innovative practice.

Going forward we will be seeking NIA innovation projects that align with our Innovation strategy, which is continually shaped through on-going customer, stakeholder and community engagement, and complement our RIIO ED1 Business Plan for 2015 (1st April) – 2023.

In closing, in our capacity as co-host with the Energy Networks Association (ENA) of the Low Carbon Networks and Innovation Conference (LCNI) in Liverpool on 24-26th November we look forward to welcoming all concerned to the UK’s major smart grid event for 2015.

Colin F. Taylor

Colin Taylor

Director of Engineering Services

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1. Introduction & Background

1.1 Context

Ofgem introduced the Innovation Funding Incentive (IFI) as a mechanism to promote and encourage network related Research & Development (R&D). The primary aim of the incentive is to encourage the electricity network operators to apply innovation in the way they pursue the technical development of their networks.

Ofgem recognised that innovation has a different risk/reward balance compared with a network operators' core business. The incentive provided by the IFI mechanism is designed to create a risk/reward balance that is consistent with research, development and innovation. The two main business drivers for providing this incentive at this time are the growing need to efficiently manage the renewal of network assets and to provide connections for an increasing capacity of renewable generation at all voltage levels. These are significant challenges that will both benefit from innovation.

1.2 Innovation Funding Incentive (IFI)

The IFI is intended to provide funding for projects focused on the technical development of distribution and transmission networks, to deliver value (i.e. financial, supply quality, environmental, safety) to end consumers. IFI projects can embrace any aspect of the distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning. The detail of the DNO IFI mechanism is set out in the Special Licence Condition C3, Standard Licence Condition 51 (for the Distribution Licences), the Electricity Transmission Licensees' IFI mechanism is set out in the special licence condition J5 Part 3 or special licence condition D5 part 2, and standard licence condition B16 Part C.

2. SP Energy Networks Structure

SP Energy Networks (SPEN) is the part of Scottish Power UK plc, which owns and operates the electricity transmission and distribution network of southern Scotland and the electricity distribution network of Merseyside and North Wales. Day-to-day operation of our network, approaching 112,000 km, is conducted by SPEN, a wholly owned subsidiary of Scottish Power UK plc. Since April 2007 ScottishPower has been part of the Iberdrola Group.

Our transmission and distribution licence assets come under three wholly owned subsidiaries:

- SP Distribution: The electricity network of 33kV and below in southern Scotland
- SP Manweb: The electricity network of 132kV and below in Merseyside and North Wales
- SP Transmission: The electricity network of 132kV and above in southern Scotland

IFI activity is co-ordinated centrally on behalf of these licences, this report relates to R&D activity undertaken on:

- SP Distribution plc., referred to as SP-D in this report
- SP Manweb plc., referred to as SP-M in this report

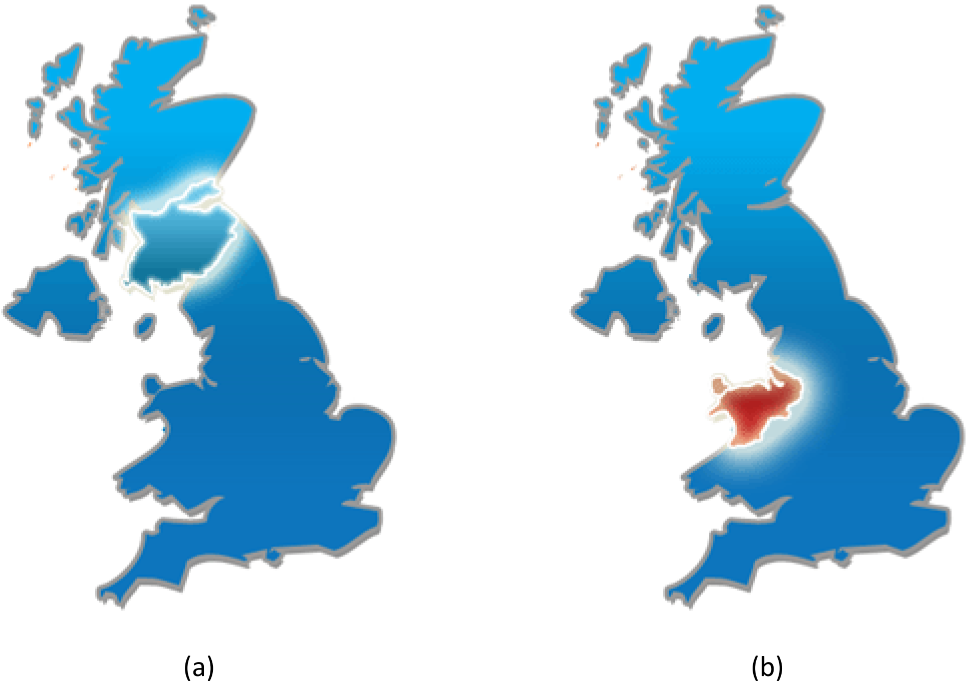
(a) (b)

Figure 1: UK Map showing the territory of (a) SP Distribution & SP Transmission and (b) SP Manweb

3. Overview

3.1 IFI Overview

A total of 42 IFI projects are being reported by SPEN on behalf of the two SPEN licence areas for the period 1st April 14 – 31st March 15.

The projects cover a breadth of R&D providers from academia, to consultants, to manufacturers with projects ranging in investment from £36k to £344k IFI input, and development timescales of between 6 months and 9 years.

Our R&D activity has increased significantly since the introduction of the IFI. We have continued to focus on leveraging our programme through collaboration with funding bodies, other network operators or external suppliers / manufacturers. In 2014/15 SP invested £3.9m of IFI money in a project portfolio with ~£1.2m invested in new projects during the period. Year-on-year spend is illustrated below with 2014/15 representing the highest innovation spend to date:

R&D growth in SPEN (SP-D, SP-M and SP-T*) since the introduction of the IFI

SP-D, SP-M and SP-T*	Expenditure (Internal + External)	No. Of Reported Projects	
2004/05 (Early Start)	£223k	12	
2005/06	£546k	36	
2006/07	£1,282k	41	
2007/08	£1,793k	50	
2008/09	£1,978k	38	
2009/10	£1,462k	35	
2010/11	£1,621k	27	
2011/12	£1,975k	40	
2012/13	£2,582k	50	
2013/14	£2,017k	47	
2014/15	£3,939k	42	

*SP-Transmission is included in IFI reporting up to and including 2012/2013. This is prior to the introduction of Ofgem's Network Innovation Allowance (NIA) for Transmission projects.

4. Summary Tables

The following tables have been adapted from the Regulatory Instructions and Guidance documents (RIGs).

IFI Summary - SP Distribution plc. Licence Area 14/15	
SP Distribution plc. Network Revenue	£356,000,000
IFI Allowance	£1,780,000
Unused IFI Carry Forward to 2014/15	£640,000
Number of Active IFI Projects	39
Summary of benefits anticipated from IFI projects 2014/15	[1]
External expenditure [2014/15] on IFI projects	£1,301,011
Internal expenditure [2014/15] on IFI projects	£446,942
Total expenditure [2014/15] on IFI projects	**£1,747,953**

IFI Summary - SP Manweb plc. Licence Area 14/15	
SP Manweb plc. Network Revenue	£432,000,000
IFI Allowance	£2,160,000
Unused IFI Carry Forward to 2014/15	£960,000
Number of Active IFI Projects	39
Summary of benefits anticipated from IFI projects 2014/15	[1]
External expenditure [2014/15] on IFI projects	£1,728,504
Internal expenditure [2014/15] on IFI projects	£462,461
Total expenditure [2014/15] on IFI projects	**£2,190,965**

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[1] Further detail on these tables is provided in Appendix A of this report.

Achievements for 2014/15

At the end of 2014/15 the highlights from the SPEN IFI portfolio included:

- Every IFI project undertaken by SPEN is taken before a panel of senior experts from across the business. Through this process we have:
    - 42 live projects
    - 9 new projects were authorised during the 2014/15 reporting period
    - Of the 42 projects, 33 are now complete and either awaiting adoption or formal closure. It is planned that the remaining projects will continue under NIA funding.

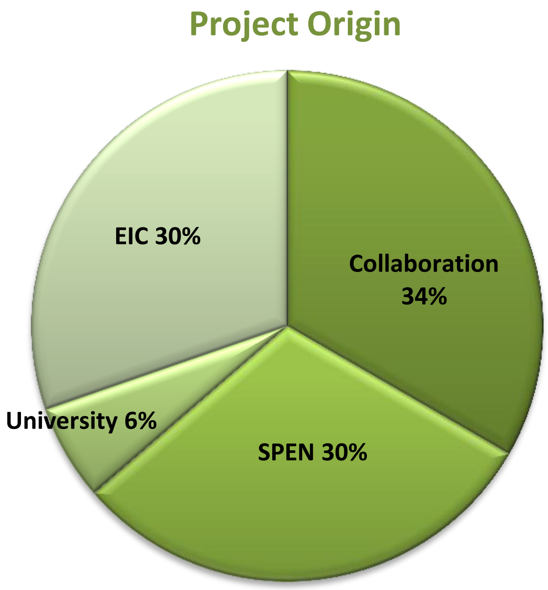
4.1 Development of Partnerships

During the reporting period the programme consisted of the following collaborative projects:

- DNO specific – Collaborative projects with some / all UK DNOs via EA Technology, ENA or through direct collaboration (see Appendix B for details).
- Direct university partnership – ScottishPower Advanced Research Centre (SPARC) and Power Network Demonstration Centre (PNDC) with the University of Strathclyde.
- Energy Innovation Centre (EIC) – A non-profit trust that oversees the management of the centre in collaboration with SPEN, Electricity North West, Scottish & Southern Energy, Northern Power Grid, UK Power Networks plus Northern Gas Networks, National Grid Gas, Scotia Gas Networks and Wales and West Utilities plus Offshore Renewable Energy Catapult.

4.2 Project Origins

As part of the overall strategy for the technology portfolio, SPEN aims to have a balanced mix of projects that originate from other sources and not just from within SPEN as illustrated below.



5. Highlights from 2014/15

This section provides details on a sample range of projects that have the potential to bring benefits in improvements to customer service, operational costs and energy usage/carbon emissions.

5.1 SPARC Project Summary (IFI 0615)

5.1.1 Fault Prognostics using NOJA PMAR Data

Fault diagnosis and prognosis are key parts of a control and protection engineer's role to ensure the effective and stable performance of electrical power networks. One challenge is to support the analysis and application of expert judgment to the, often, large data sets generated. To assist engineers with this task and improve network reliability, this research focuses on analysing previous fault activity on the overhead line, in order to obtain an 'early-warning' report to assist fault diagnosis and fault prognosis.

This project aims to design an integrated system applying a fault diagnosis/prognosis algorithm to available Supervisory Control And Data Acquisition (SCADA) alarm data and 11kV distribution network data captured from Pole Mounted Auto-Reclosers (PMARs) (provided by SPEN). The developed system will be capable of diagnosing the nature of a circuit's previous fault activity, underlying circuit activity and evolving fault activity and the risk of future fault activity, and will provide prognostic decision support for network operators and maintenance staff. The project will improve network performance by:

- Informing and assisting maintenance staff to take appropriate preventative action before incipient and transient circuit events evolve to the point of semi-permanent and permanent faults, thereby:
- Reducing the amount of nuisance tripping from semi-permanent faults.

This integrated decision support system consists of three analysis components:

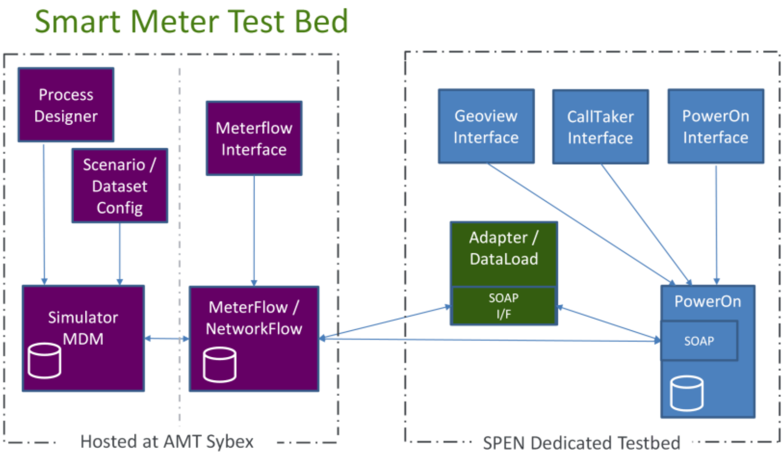
- Fault diagnosis is achieved by:
    - SCADA alarm data analysis for anomaly detection and problematic circuit location
    - PMAR data analysis for identification of semi-permanent faults
- Fault prognosis is based on:
    - Semi-permanent fault activities analysis for fault prognostics

The anomaly detector and PMAR data visualisation tool search for and identify frequent unsolicited openings and potential relevant semi-permanent fault activities. The anomaly detector will identify the periods or circuits of frequent unsolicited openings with associated PMARs based on analysis of SCADA alarm data (stored in the PSALERTS database). The PMAR data visualisation tool will present extracted/derived information of fault activities based on analysis of PMAR data associated with previous identified frequent unsolicited openings in order to identify semi-permanent faults.

Identified semi-permanent fault signature will be classified in order to identify patterns and trends in their occurrence. These patterns will be then be used in order to provide prognostic and 'early-warning' information about the likely development of fault behavior for the affected circuit. Timely intervention by maintenance staff to forestall the further development of semi-permanent and permanent faults can therefore be made.

5.2 Smart Meter Enablement (IFI 1304)

During the second half of 2014 the Smart Meter Test Bed was used to investigate 6 scenarios against the base functionality available in the SPEN Outage Management System (OMS), PowerOn. The test bed (shown below) provides the ability to simulate the anticipated meter messages for different network events and communicate them in a repeatable manner to test the OMS system.



The scenarios investigated ranged from a Single Premise call to a Primary Grid Loss. The current version of PowerOn only provides limited support for Smart Meter data as full functionality is expected in later releases, but the test environment has been invaluable in:-

- Identifying "issues" with the way that Smart Data will be presented to the DNOs, specifically around the timing of messages.
- Identifying the changes needed to PowerOn to enable it to consume Smart Meter data robustly.
- Identifying the changes in the business processes to achieve meaningful business benefits.
- Identifying the changes needed to PowerOn to support the proposed business processes.

Meter Details

Meter Number	Last Update Time	Status
1800025656073	15-APR-2015 13:10:54	In Progress

Audit Log

Time	Description	Operator Name	Control Position

Call History

Time	Category	Priority	Zone	Address	Town	Post Code	Reference	Operator
15-APR-2015 13:10:54	No Supply (Smart Meter)	1	GLASGOW NORTH	/2 22 GLAIVE ROAD	GLASGOW	G13 2HU	CALL-97674-k	USER
27-MAR-2015 10:32:34	No Supply (Smart Meter)	1	GLASGOW NORTH	/2 22 GLAIVE ROAD	GLASGOW	G13 2HU	CALL-97604-k	USER
27-MAR-2015 10:30:32	No Supply (Smart Meter)	1	GLASGOW NORTH	/2 22 GLAIVE ROAD	GLASGOW	G13 2HU	CALL-97539-k	USER
27-MAR-2015 10:28:20	No Supply (Smart Meter)	1	GLASGOW NORTH	/2 22 GLAIVE ROAD	GLASGOW	G13 2HU	CALL-97480-k	ER
26-MAR-2015 11:31:04	No Supply (Smart Meter)	1	GLASGOW NORTH	/2 22 GLAIVE ROAD	GLASGOW	G13 2HU	CALL-97406-k	USER
15-OCT-2014 13:25:26	No Supply (Smart Meter)	1	GLASGOW NORTH	/2 22 GLAIVE ROAD	GLASGOW	G13 2HU	CALL-80524-k	USER
15-OCT-2014 12:44:42	No Supply (Smart	1	GLASGOW	/2 22 GLAIVE	GLASGOW	G13 2HU	CALL-80461-k	USER

5.2.1 Summary of Findings

As a result of this trial, our understanding of the impact of Smart Meter data has been significantly enhanced and has influenced our proposed approach to the integration of Smart Meter data into our business processes.

A summary of the findings are as follows:-

1. PING functionality (a check of smart meter energisation status) can help both confirm genuine no-supply calls and also add value during multiple restoration stages.
2. Power outage messages can allow PowerOn to rapidly predict the correct incident

scope significantly in advance of customer calls. However, delayed Power Outage messages that arrive after the network has been restored need to be managed to avoid spurious re-interruptions.

3. Smart Meter Data in extreme circumstances could swamp the Control system and the volume of messages will need to be managed by a separate system. This can limit some benefits but is essential to ensure control of the network.
4. Based on our findings we believe there are a number of relatively straightforward functional changes that would provide benefits and would likely be common to GB network operators:
    a. Provide access to group PING functionality from various parts of the OMS user interface, in particular from Incident Scope screens.
    b. Provide visibility of the meter energisation status from various parts of the OMS interface, and ensure the status is driven by Power Outage, Power Restoration or PING messages.
    c. Support both the event time and the message arrival time for Power Outage messages.
5. The timing of Smart Meter messages needs to be raised with Ofgem to understand how they will affect regulatory reporting. For example, the event time within the message is always significantly earlier than the time when the message arrives from the DCC.

These findings have allowed us to more fully understand possible approaches to smart meter data management and the test environment will be maintained to allow further assessment of Smart Meter impacts.

5.3 VTOL: Beyond Visual Line Of Sight Remotely Piloted Aircraft System (IFI 1318)

Electricity distribution networks (steel tower and wooden pole circuits) and gas distribution networks (high pressure gas pipelines) require regular inspection in order to ensure that they remain fit for purpose and comply with HSE regulations. Emerging Unmanned Aerial Vehicle (UAV) technologies (such as small multi-rotor systems) are starting to be deployed, particularly for electricity asset inspections, for the inspection of steel towers in combination with the well proven approach of using manned helicopters. The benefits of such technology used for these types of inspection tasks are that they are relatively cheap to procure, are highly manoeuvrable, but they do have limitations with regards to payload carrying capacity, range, endurance as well as overall flight times. Repeatability of inspection data capture can also be an issue, as well as access to the assets and infrastructure that have been targeted for inspection.

This project is investigating the feasibility (from both a commercial, technical and regulatory perspective) of deploying similar, small Remotely Piloted Aircraft Systems (RPAS) but operating them Beyond Visual Line Of Sight (BVLOS) to augment and complement current asset inspection methods. If this can be achieved, then asset inspection costs have the potential to be substantially reduced, inspection tasks can be automated, such that truly repeatable inspection data can be not only gathered, but also analysed for different types of trend. One such example is degradation trend analysis of a specific asset or across assets of similar types - potentially automatically, using advanced software tools and techniques. If low-cost BVLOS operations can be achieved, then the electricity and gas distribution networks will have an additional asset and infrastructure inspection capability that they can deploy at a lower cost in most cases than current techniques, hence opening up new possibilities for increased frequency of inspection or a broader use of such technology in places where it is not used today for new asset inspection tasks such as inspecting wooden pole circuits from the air in addition to current steel tower circuits, or within the gas sector, inspecting difficult to access gas pumping stations.

5.3.1 VTOL: Project Progress

The first six months of the study were focused on establishing a clear and accurate confirmation of the industry's RPAS BVLOS operational requirements, combined with a high-level return on investment (ROI) analysis of each of the identified BVLOS asset inspection operations from a commercial, technical and regulatory perspective. The result of this work was the publication of a 209 page document that concluded that:

- The potential financial returns clearly outline the opportunity for either cost savings compared with current aerial inspection operations or for re-investing these savings into improving the inspection processes as the demands for energy increase and more demanding inspection capabilities are required by the regulatory authorities.
- Technically, the technologies required for RPAS operating BVLOS are accelerating and within the next couple of years will be mature enough to provide complete BVLOS solutions.
- The European Union and the UK Civil Aviation Authority (CAA) are working hard to establish a clear set of European regulations for light UAS (RPAS weighing <25kg) by 2016, paving the way for BVLOS operations within the next couple of years.

Following on from stage 1, VTOL Technologies developed three "Concept of Operation" virtual-reality environments in order to model and better understand the needs and requirements of inspecting steel tower (Ferrybridge, North Yorkshire), wooden pole (Isle of Wight) circuits and a high pressure gas pipeline (Inverness, Scotland) circuit. This work provided a brand new understanding of the options and techniques that could be successfully deployed for the identified inspection tasks. Key aspects of this work included looking at new camera technology techniques, optimal flight paths and flight inspection manoeuvres, flight safety procedures and presentation of safety case options to the CAA as well as evaluating inspection range and endurance requirements, as required by the DNOs and GDNs. What was truly surprising is that for one DNO alone, over 75% of their 132kV power line circuits are only 10km long, proving to be an excellent fit for the right type of RPAS to deliver successful BVLOS asset inspection data.

5.3.2 VTOL: The Innovative Solution Being Developed

Different types of RPAS architecture (multi-rotor, hybrid and fixed-wing designs) were also investigated to determine likely performance and ability to meet the Concept of Operation requirements. This work was achieved using advanced aircraft performance software analysis tools. What transpired from this work is that even with significant advances in power system technologies (battery systems, hydrogen fuel cell systems or other), it is unlikely that multi-rotor systems will be able to meet the range and endurance demands, since additional avionics systems such as longer range and therefore heavier communications technologies will be required, as well as additional collision-avoidance technologies siphoning off more of the on-board power. However, new RPAS hybrid aircraft designs, certainly at this stage, look as if they have the potential to meet the requirements demanded of true BVLOS operations, by substantially reducing RPAS power consumption, thus dramatically extending range and endurance.

5.3.3 VTOL: The Next Steps For The Project

The final stage of the project will be translating the confirmed Concept of Operation requirements into an industry standard BVLOS RPAS specification that can meet the GDNs and DNOs needs. This generic RPAS system specification(s) will consist of, but will not be limited to, specification data such as size, weight, range, endurance, airframe/energy/payload fractions, power consumption, etc., for an RPAS capability that is able to meet the categorised and prioritised Concept of Operation requirements. VTOL Technologies will also investigate the overall feasibility of the industry implementing the desired RPAS BVLOS operations, including the provision of an implementation roadmap.

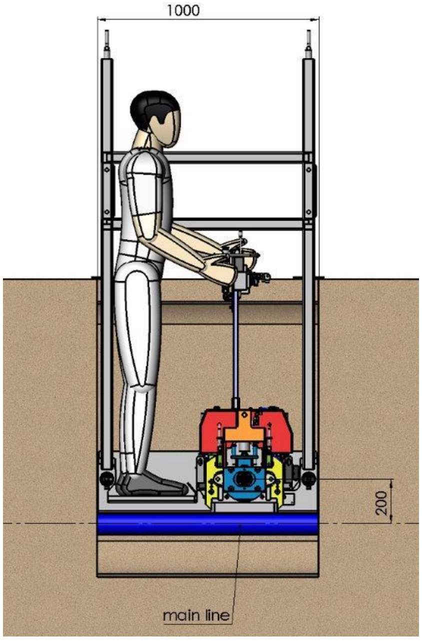
Although the CAA can only certify actual physical systems for flight operations BVLOS, providing an accurate flight operation model and simulating possible failures will enable the CAA to provide a clear indication as to the 'certifiability' of BVLOS RPAS for each of the identified and prioritised inspection tasks/operations, significantly reducing downstream selection, development and system integration risks. At this point in time, it is anticipated that there might be two or even three complete system specification options that emerge.

Once this project has been completed, the electricity and gas distribution sector will have a difficult decision to make, should they wait for the right industry-specific solution to emerge that can truly meet their requirements or should they pro-actively invest in the development of such a solution and if so, how should this be achieved?

5.4 Keyhole Trenchless Technologies (IFI 1417)

Renewing and upgrading underground LV cables and service connections can be a costly and time consuming activity. The standard unit cost for this activity does not take into consideration different circumstances which can significantly increase costs and inconvenience to customers; such as increase excavation and reinstatements resulting from ornate or decorative paving. These types of excavations can be significantly more expensive and time consuming, removing limited resources from front line activities, and reducing efficiencies.

Although the merits of conventional open cut trenching are well known there is an intrinsic risk to home owners and members of the public. To develop an alternative solution to this problem SPEN has been working with R&D partner, Tracto-Technik (TT), to design an innovative trenchless technology system (Mini-Mole) which could be used as viable alternative to traditional open cut trenching method current utilised for LV cable applications. The R&D phase, completed during IFI Keyhole Trenchless Technologies, will be manufactured into a full scale working prototype and extensively trialed to establish the benefit of the technique over conventional excavation methods for a variety of typical jobs.



Following field trials in December 2015 on an existing trenchless technology rig, more commonly used for larger cable applications, an extensive redesign has been completed. Working with TT along with both internal and external stakeholders, a number of innovative redesigns and modifications have been incorporated to improve flexibility of the rig, and importantly to reduce its size and footprint, which will allow it be utilised in a standard LV cable joint excavation. The resulting unit is expected to be available for trials in the summer of 2015 and Business as Usual application is expected in early 2016.

5.4.1 Conventional Approach vs. Mini-Mole

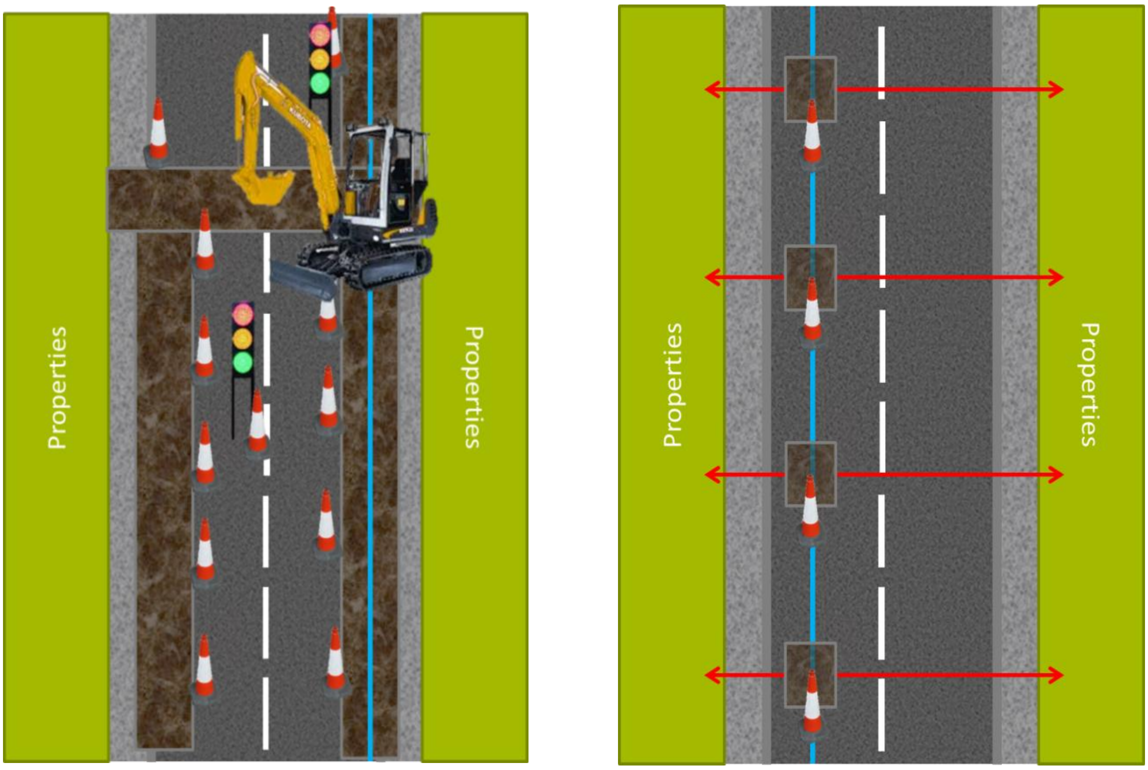
The pictures below illustrate the open trench work required in order to connect service cables.

The Mini-Mole has been designed to fit a standard excavation required for jointing LV cables, removing the need to complete costly and time consuming road crossings. The Mini-mole method will greatly reduce the footprint of the work, reducing excavation and reinstatement costs, improving the working environment and lead to a reduction on standard traffic management costs. In addition, a reduction of exposure to manual handling risk using this innovative Mini Mole Trenchless Technology is anticipated.

This new method of inserting new/renewing existing services will help to prevent costly re-instatement of footways, which during excavation/reinstatement can render the footpath off limits to some pedestrians, as well as restricting access and egress from properties.

Traditional Method

Mini-mole method



The above diagram outlines the potential difference between the traditional method with road crossing and traffic management vs. the Mini-Mole method with no open excavation road crossings and limited excavation requirements.

5.4.2 Potential Benefits of the Mini-Mole

Below is a list of benefits that this project could realise:

- Reduced cost due to less re-instatement, and much less removal of spoil
- Reduced labour hours, especially on long lengths of track
- Increased safety to employees and the public
- Less disruption to pedestrians/customers
- Reduced use of barriers and traffic management equipment
- Reduced carbon footprint, hence environmental benefits

Appendix A – Expenditure Breakdown of Projects between Licences

Summary Table Notes

During the collation of the 05/06 report we revised our methodology for NPV assessments for IFI projects. It is noted that the figures described in the tables should be interpreted with caution, as the figures quoted in the NPVs will only be realised upon completion of the project, and once fully adopted into the business.

Cost Breakdown

As SPEN operate distribution licenses for the SP-Distribution and SP-Manweb areas, successful developments relating to distribution assets undertaken in one part of the business will equally apply to the other. Given the different sizes of each network area and associated annual turnover, costs have been split against each licence as follows:

Licence Area	Percentage Split Distribution
SP-Distribution	46%
SP-Manweb	54%

Projects identified as only applying to one licence, or ones that apply in favour of one licences have been scaled accordingly (See Table A1). This is defined when the project inception document is developed.

Programme Management Costs

Internal costs for projects detailed in Appendix B are based on SPENs input to a project through meetings, correspondence, trials, etc. scaled by the appropriate hourly rate for an individual's grade.

Net Present Value (NPV) source

It is noted that IFI projects address a range of issues, and the benefits achieved, and those accounted for in the NPV can be categorised into the following areas:

- **Avoided cost** – A successful development may negate the need to spend money on network components. As an example the development of a high capacity circuit, would avoid the need for duplicate traditional circuits for a given network application.
- **Direct savings** – Successful development could result in a direct financial benefit, e.g. through reductions in operating costs, reduced exposure to Regulatory penalties, etc.
- **Managing risk** – A successful development would assist in reducing the risk profile of the company, either through greater understanding of causes / effects of actions on, or as a result of, network operation (equipment failure, etc.)
- **Strategic** – These projects impact on the longevity of the network, either through external influences such as changes in load / generation patterns, the impact of climate change or even skills / resources.

NB. Whilst an NPV calculation if possible for any project, and across any of these areas, it is recognised that as the assessment looks further to the future (as is the case for strategic projects), the benefits are more susceptible to risk, more uncertain, and consequently less robust.

As of 31st March 2015 the status of the 42 projects reported as well as those that have stopped is detailed below.

IFI Project Status			
No.	*Phase*	*Definition*	*External Cost*
9	*Live projects*	*Projects continuing under NIA*	*Yes (if milestones have been met)*
33	*Completed projects*	*Projects closed under IFI*	*Yes*

This breakdown accounts for reasons why not all projects have significant external spend.

Project Progress Curves

Expenditure profiles are described below to give an appreciation of costs that will be required prior to a project realising a stated benefit through the development cycle. Figure A1 shows a hypothetical expenditure profile for a development project. Expenditure is defined as:

- **External** – Money paid to 3rd parties for work (consultancy, purchase of equipment, monitoring, etc.)
- **Internal** – SPEN' staff time on eligible IFI development work multiplied by the appropriate hourly rate. The success of a project is highly dependent on the levels of internal support a project is given.
- **Overall investment** - The total cost of a project (predominantly external cost) of which the company is accessing through collaborative or external funding leverage. This is the combined investment from SPEN and other collaborative partners.

In line with sound project management, all IFI projects have been staged into milestones, i.e. the R&D provider will only receive payment upon successful completion of a defined stage.

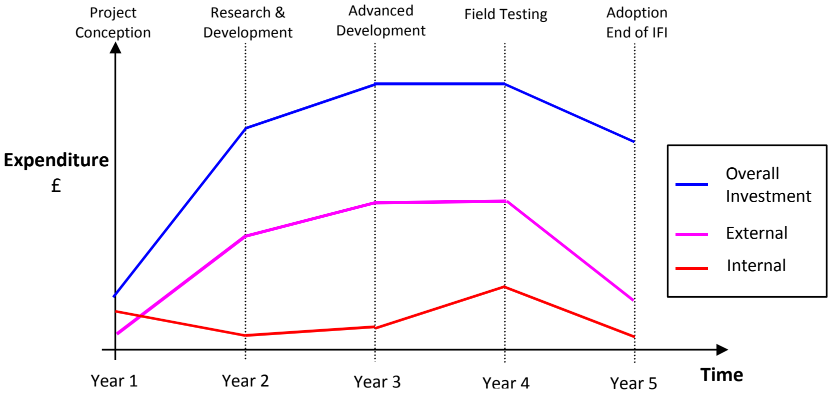


Figure A1: Example Expenditure Profile for an IFI Project

Project Description	Percentage split		£ split			
			SPD		SPM	
	SPD	SPM	External	Internal	External	Internal
IFI 0401 - Strategic Tech Prog	46%	54%	£ 104,150	£ 37,116	£ 122,263	£ 43,571
IFI 0507 Sensor Networks - Smart Dust	100%	0%	£ 12,488	£ 47,492	£ -	£ -
IFI 0509 - Superconducting Fault Current Limiter	46%	54%	£ 3,063	£ 6,487	£ 3,596	£ 7,615
IFI 0515 - Power Network Demo Centre	46%	54%	£ 20,943	£ 10,115	£ 24,585	£ 11,875
IFI 0615 - SP Advanced Research Centre	46%	54%	£ 67,808	£ 8,581	£ 79,601	£ 10,073
IFI 0621-3 Live Alert	46%	54%	£ 5,375	£ 6,487	£ 6,309	£ 7,615
IFI 0701 ENA Small Value Projects	46%	54%	£ 24,815	£ 6,487	£ 29,131	£ 7,615
IFI 1004 - Remote Access to Pole Mounted Auto Reclosers	100%	0%	£ 6,659	£ 25,358	£ -	£ -
IFI 1102 - Energy Storage Project	46%	54%	£ 5,115	£ 6,836	£ 6,004	£ 8,025
IFI 1104 - SF GB Electricity Demand Project	46%	54%	£ 3,063	£ 6,487	£ 3,596	£ 7,615
IFI 1203 - Psymetrix ACAM Phase 1	0%	100%	£ -	£ -	£ 54,659	£ 14,102
IFI 1207 - Smart 3 Phase Voltage Regulat	46%	54%	£ 5,375	£ 6,599	£ 6,309	£ 7,747
IFI 1209 - Substation Earth Integrity Monitoring System	46%	54%	£ 116,305	£ 6,487	£ 136,532	£ 7,615
IFI 1211 - Smart CCU Development	46%	54%	£ 5,375	£ 58,634	£ 6,309	£ 68,831
IFI 1215 - Self Repair MV underground	46%	54%	£ 35,609	£ 7,010	£ 41,802	£ 8,230
IFI 1216 - The Role of the Demand Side	46%	54%	£ 3,063	£ 6,487	£ 3,596	£ 7,615
IFI 1218 - Impact of Domestic Heating	46%	54%	£ 3,063	£ 6,487	£ 3,596	£ 7,615
IFI 1219 - Substation Efficiency	46%	54%	£ 6,804	£ 6,487	£ 7,987	£ 7,615
IFI 1302 - SUSCABLE 2	46%	54%	£ 25,296	£ 7,534	£ 29,696	£ 8,844
IFI 1304 - Smart Meter Enablement	46%	54%	£ 78,453	£ 11,607	£ 92,097	£ 13,626
IFI 1305 - Low Power Radio Alarm System	46%	54%	£ 5,375	£ 12,348	£ 6,309	£ 14,495
IFI 1307 - Mobile Phone Application Prototypes	46%	54%	£ 116,348	£ 36,625	£ 136,582	£ 42,994
IFI 1308 - HTIP	46%	54%	£ 39,118	£ 7,162	£ 45,922	£ 8,407
IFI 1310 - Cable Paper Moisture Analyser	46%	54%	£ 18,683	£ 6,487	£ 21,932	£ 7,615
IFI 1311 - Green Running	46%	54%	£ 39,705	£ 6,487	£ 46,610	£ 7,615
IFI 1312 - V2G	46%	54%	£ 96,621	£ 7,162	£ 113,424	£ 8,407
IFI 1315 - Ultrapole	46%	54%	£ 5,375	£ 6,487	£ 6,309	£ 7,615
IFI 1316 - Upgrading Legacy GM NCP to Plexman 2	46%	54%	£ 5,375	£ 10,952	£ 6,309	£ 12,856
IFI 1317 - Cable Core Temperature Monitoring	46%	54%	£ 5,375	£ 6,487	£ 6,309	£ 7,615
IFI 1318 - VTOL	46%	54%	£ 31,671	£ 6,487	£ 37,179	£ 7,615
IFI 1401 - VONAQ	46%	54%	£ 5,375	£ 6,487	£ 6,309	£ 7,615
IFI 1404 - Urban NCP Enhancement Project	0%	100%	£ -	£ -	£ 234,057	£ 14,102
IFI 1405 - Augmented Reality: Proof of Concept	46%	54%	£ 16,072	£ 6,487	£ 18,867	£ 7,615
IFI 1411 - eGenius	46%	54%	£ 28,329	£ 6,487	£ 33,255	£ 7,615
IFI 1412 - Phase ID	46%	54%	£ 10,396	£ 6,487	£ 12,204	£ 7,615
IFI 1413 - Portable RAFL	100%	0%	£ 92,420	£ 16,182	£ -	£ -
IFI 1414 - PD-VMX	0%	100%	£ -	£ -	£ 43,484	£ 14,102
IFI 1416 - ROAMES - LiDAR	46%	54%	£ 106,320	£ 6,487	£ 124,811	£ 7,615
IFI 1417 - Keyhole Trenchless Technologies	46%	54%	£ 145,630	£ 12,865	£ 170,957	£ 15,103

Totals	SPD		SPM	
	External	Internal	External	Internal
	£ 1,301,011	£ 446,942	£ 1,728,504	£ 462,461
Ratios	74%	26%	79%	21%

Table A1: Overview of 14/15 projects showing application between licences

Appendix B – Project Reports IFI Projects

April 14 – March 15

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 0401 STP 2 – Overhead Lines</i></td></tr>
<tr><td>Description of project</td><td colspan="10">A DNO research and development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £26,896
External £54,339
Total £81,235</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £76,282
External £439,672
Total £515,954</td></tr>
<tr><td>Project Cost</td><td colspan="2">£341,137</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The Module 2 programme for budget year 2014/15 aimed to improve operational performance, maximise potential benefits, improve financial performance, and minimise risk associated with overhead lines. A full list of projects and deliverables are available from SPEN or EA Technology.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">If successful projects in this Module may increase the performance and reliability of overhead line networks</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-5 years - dependent on project</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">Range 3-5 years - dependent on project</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">Range 49-95% - dependent on project</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">→</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£42,652</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">With the decision made to close STP at the end of DPCR 5 and IFI, the activities undertaken in 2014/15 have been centred on closing down all existing projects within this module as well as one new project.
Probabilistic Approach to Overhead Line Rating
A test rig has been built to monitor the temperatures of a range of overhead line conductors over a range of applied currents and design temperatures in order to determine a robust, statistical methodology for calculating conductor rating applicable to UK distribution networks. This STP project is now complete, although operation of the test rig will continue under a new NIA project. The results will ultimately lead to an update of ENA ACE 104 (derivation of overhead line ratings applicable to high voltage distribution systems) and review of ENA P27 (Overhead Line Ratings).</td></tr>
</table>

Potential for achieving expected benefits	Over the course of DPCR5 Module 2 of STP has delivered a host of innovative projects, processes and techniques that the member DNOs can utilise to improve the management of overhead lines. A full list of projects and deliverables can be made available from SPEN or EA Technology.
Collaborative Partners	Other DNOs
R&D Providers	EA Technology

<table>
<tr><td>Project Title</td><td colspan="10">***IFI 0401 STP 3 – Cable Networks***</td></tr>
<tr><td>Description of project</td><td colspan="10">A DNO research and development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £26,896
External £94,663
Total £121,559</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £89,485
External £518,447
Total £607,932</td></tr>
<tr><td>Project Cost</td><td>£413,360</td><td colspan="4">Projected 2015/16 costs for SPEN</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The Module 3 programme for budget year 2014/15 aimed to improve operational performance, maximise potential benefits, improve financial performance, and minimise risk associated with cable networks. A full list of projects and deliverables are available from SPEN or EA Technology.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">If successful projects in this Module may increase the performance and reliability of cable networks</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-2 years - dependent on project</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">Range 3-5 years - dependent on project</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">Range 45-100% - dependent on project</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">→</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£42,013</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">With the decision made to close STP at the end of DPCR 5 and IFI, the activities undertaken in 2014/15 have been centred on closing down all existing projects within this module as well as one new project.
Improving the Performance & Management of Cut Outs
This project investigated the reliability of service terminations, including failure modes, performance and asset management requirements. Several detailed recommendations have been made and the results will feed into a review of BS standard BS 7657:2010 – ‘Specification for cut-out assemblies up to 100A rating, for power supplies to buildings’. This STP project is now complete, although some further long-term cut-out testing will continue under a new NIA project.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Over the course of DPCR5 Module 3 of STP has delivered a host of innovative projects, processes and techniques that the member DNOs can utilise to improve the management of cable networks. A full list of projects and deliverables can be made available from SPEN or EA Technology.</td></tr>
</table>

Collaborative Partners	Other DNOs
R&D Providers	EA Technology

Project Title	***IFI 0401 STP 4 – Substations***			
Description of project	A DNO research and development collaboration hosted by EA Technology			
Expenditure for financial year	Internal £26,896 External £77,411 **Total £104,307**	Expenditure in previous (IFI) financial years	Internal £77,995 External £413,033 **Total £491,028**	
Project Cost	£345,174	Projected 2015/16 costs for SPEN	Internal £0 External £0 **Total £0**	
Technological area and / or issue addressed by project	The Module 4 programme for budget year 2014/15 aimed to improve operational performance, maximise potential benefits, improve financial performance, and minimise risk associated with substations. A full list of projects and deliverables are available from SPEN or EA Technology.			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	No	No	No
Expected Benefits of Project	If successful projects in this Module may increase the performance and reliability of substations			
Expected Timescale to adoption	Range 1-4 years - dependent on project	Duration of benefit once achieved	Range 1-6 years - dependent on project	

Probability of Success	Range 30-95% - dependent on project	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
					→	→				

Project NPV	(Present Benefits x Probability of Success) – Present Costs	£32,721
Project Progress March 2015	With the decision made to close STP at the end of DPCR 5 and IFI, the activities undertaken in 2014/15 have been centred on closing down all existing projects within this module as well as one new project. **132kV Transformer Post Mortems** This project is now complete. The project carried out post-mortem examinations of 35 132kV transformers with a particular focus on relating mechanical strength of Low Voltage (LV) winding papers to transformer oil analysis and condition, in order to provide empirical evidence to establish a robust link between non-invasive tests and actual transformer condition. Based on this evidence, data thresholds have been modified to give a more accurate Health Index assessment. Greater confidence in the Health Index is expected to allow the serviceable life of 132kV transformers to be safely extended by between 5 or 10 years beyond their currently predicted End of Life (EOL).	

Potential for achieving expected benefits	Over the course of DPCR5 Module 4 of STP has delivered a host of innovative projects, processes and techniques that the member DNOs can utilise to improve the management of substations and their associated assets. A full list of projects and deliverables can be made available from SPEN or EA Technology.
Collaborative Partners	Other DNOs
R&D Providers	EA Technology

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 0401 STP 5 – Networks for Distributed Energy Resources</i></td></tr>
<tr><td>Description of project</td><td colspan="10">A DNO research and development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £0
External £0
Total £0</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £78,709
External £458,450
Total £537,159</td></tr>
<tr><td>Project Cost</td><td>£349,243</td><td colspan="4">Projected 2015/16 costs for SPEN</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The Module 5 programme for budget year 2014/15 aimed to improve operational performance, maximise potential benefits, improve financial performance, and minimise risk associated with networks for distributed energy resources. A full list of projects and deliverables are available from SPEN or EA Technology.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">If successful projects in this Module may increase the performance and reliability of networks for Distributed Energy resources</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-3 years - dependent on project</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">Range 2-5 years - dependent on project</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">Range 51-100% - dependent on project</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">→</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£28,841</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">With the decision made to close STP at the end of DPCR 5 and IFI, the activities undertaken in 2014/15 have been centred on closing down all existing projects within this module.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Over the course of DPCR5 Module 5 of STP has delivered a host of innovative projects, processes and techniques that the member DNOs can utilise to improve the management of distributed energy resources. A full list of projects and deliverables can be made available from SPEN or EA Technology.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Other DNOs</td></tr>
<tr><td>R&D Providers</td><td colspan="10">EA Technology</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0507 – Sensor Networks (Smart Dust) – Phase 2</i></td></tr>
<tr><td>Description of project</td><td colspan="4">“Smartdust” is a concept developed by the University of California that is based on a self-configuring wireless sensor network, capable of transmitting low bandwidth information in a series of short hops. Data acquired and transmitted from sensors is relayed through a gateway for data interpretation. SPEN led a feasibility study into the use of this technology for detecting the passage of fault currents on 11kV overhead line networks.

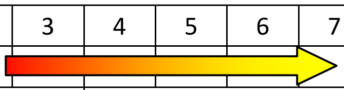
Following on from this work, a collaborative project has been scoped between EDF Energy, Central Networks and SPEN to develop a product based on this principle for the remote signalling of fault passage indication on overhead line networks.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £47,492
External £12,488
Total £59,980</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £113,741
External £231,882
Total £345,623</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>Phase 1 = £16k
Phase 2 = £191k</td><td>Projected 15/16 costs for SPEN</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">This project considers a cheap and reliable method of collection of fault passage indication data. A centralised location for overhead line faults would significantly reduce the time required to resolve faults on the network and consequently reduce Customer Minutes Lost (CML) associated penalties. This technology would be especially suited to transitory fault location.

Significant analysis has been undertaken on the deployment characteristics of GSM/GPRS Fault Passage Indicators Vs Radio communicating sensors, using SP Distribution fault histories. The analysis considering the relationship between sensor cost, deployment penetration and improvement to CML figures. The key conclusion is that a cheap, low power semi-mesh radio based system:
• Allows a much higher percentage of locations of be monitored economically than any other option, across all price points and time savings
• Offers SPEN a much higher NPV than any other option

Owing to these factors, a significantly higher percentage of network can be monitored (from 10% for GSM devices to above 70% coverage for radio sensors), increasing the likelihood that they will be targeting faults (rather than solely focussing on worst performing circuits).</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td>Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Sensor Networks implemented as a method of fault passage indication (FPI) could have an enormous effect on how faults on the overhead network are located. They could have a huge impact on CI/CML figures as the technology would be effectively pin pointing faults on the network. This results in a significant financial saving and improved customer service. The low power radio communication option will allow for greater flexibility on remote networks where traditional communications may not be viable due to poor coverage or service strength.</td></tr>
</table>

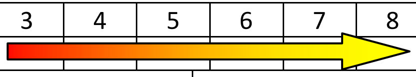
<table>
<tr><td>Expected Timescale to adoption</td><td>5 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="4">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£554.5k</td></tr>
<tr><td>Project Progress March 15</td><td colspan="10">A working prototype has been extensively tested on site on a poorly performing circuit in West Lothian. Following the full deployment and initial tests, several software and hardware changes were implemented designed to improve the reliability and consistency of the communications. The upgraded system has been extensively tested although it has not operated due to a fault on the system.

This project is now closed</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">This new approach will allow control engineers to identify the location of a fault within 1km, and hence rapidly deduce the best supply restoration strategy. It will also allow linesmen to be sent directly to the affected area to investigate the fault, without having to patrol long lengths of overhead network. Whilst the overall effect should be a reduction in CML for permanent faults, it will more importantly be able to capture the source of transient fault activity that can cause multiple supply interruptions. In the longer term, this system can become duplex, allowing control commands to be sent to specific wFPI locations.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">WPD</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Willow, E.ON Power Technology</td></tr>
</table>

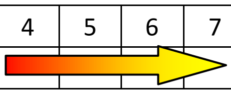
<table>
<tr><td>Project Title</td><td colspan="12"><i>IFI 0509 – Superconducting Fault Current Limiter</i></td></tr>
<tr><td>Description of project</td><td colspan="12">This project aims to design, develop and trial three 12kV Superconducting Fault Current Limiting (SFCL) devices on three different UK networks.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="4">Internal £14,102
External £6,659
Total £20,761</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £91,847
External £474,193
Total £566,042</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="4">£2,345,967</td><td colspan="4">Projected 15/16 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The development of a non-linear ‘high-temperature’ superconducting ceramic in series with a circuit breaker for the clamping and clearance of fault energy.
When the material is operated at below its critical temperature it loses all electrical resistance, thereby allowing load current to flow with negligible losses. Either the increased current density caused by fault current, or the loss of cooling medium (liquid nitrogen) causes the temperature of the superconducting material to rise and it reverts to a normal resistive state.
Being a solid state device, the SFCL has been proven to operate in a few milliseconds, after which the impedance remains high until the fault is cleared by conventional means (protection operated circuit breakers, fuses, etc.). The SFCL’s operation is sufficiently fast to ensure that the first peak of the fault current is limited. The subsequent limited current can be set to suit a specific application.
Three devices (one per DNO) will be constructed and installed covering a range of applications: transformer tails, bus section, interconnected network connection. The successful completion of this project is likely to pave the way for higher voltage devices.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">To develop, understand and address the issues associated with the connection of an 11kV fault current limiting device to the network.
Successful trials will result in the development of commercially available devices that are capable of clamping fault levels to within network design limits. Once proven, this will open up another option for tackling network fault level, potentially providing an alternative to network reinforcement.</td></tr>
<tr><td>Expected Timescale to Adoption</td><td colspan="3">3 years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="6">20 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="3" rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td colspan="5"></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="6">£-267,191
Project NPV is negative due to the low TRL / high costs upon commencement</td></tr>
</table>

Project Progress March 15	This project was effectively reported as being closed in the 2013/14 IFI Report, with only recovery of the SFCL planned for 2014/15. As of March 2015 the SFCL is yet to be recovered from site, any subsequent costs incurred removing the unit and having it recycled will be done outside of IFI.
Potential for achieving expected benefits	As reported in 2013/14, through undertaking this pilot trial SPEN has gained valuable knowledge and experience that has influenced our future strategy for the deployment of fault current limiting technology. At this time however it is unclear if fault current limiting technology will be readily adopted and this is largely down to the size, cost and complexity of the lifetime ownership of the systems presently available on the market. This project has been instrumental in encouraging the development of fault current limiting systems for the UK market, there are now several units available and either on trial or adopted as BaU by other UK DNOs.
Collaborative Partners	Electricity North West, Northern Power Grid, Applied Superconductor Ltd
R&D Providers	Applied Superconductor Ltd

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0515 – Power Network Demonstration Centre (PNDC)</i></td></tr>
<tr><td>Description of project</td><td colspan="4"><p>Development of a full scale 11kV and LV prototyping network as a test-bed / proving ground for active network management techniques and other ‘high risk’ technologies.</p><p>Whilst not a technological development in itself, this project is a fundamental enabler of technology, with significant potential to accelerate adoption of significant / radical developments across a range of IFI projects.</p></td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £21,990
External £45,527
Total £67,517</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £71,795
External £532,853
Total £604,648</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£7,200,000</td><td colspan="2">Projected 15/16 costs for SPEN</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4"><p>In partnership with collaborators, this project aims to:</p>
Provide a demonstration network to allow the testing of new technologies on a ‘real’ network
Offer a real network that will incorporate 11kV and low voltage equipment, containing real loads, real generation and test real technologies
Create a facility which will be open to Academia, R&D Establishments, Manufacturers, and Network Operators
<p>The vision is to create a physical scale model that can represent different urban, suburban and rural electrical networks. The proposed system will incorporate real network components: cables, overhead lines, switchgear, transformers, protection and control equipment, in order to ensure it is both representative and credible to the real thing. Real Time Digital Simulators (RTDSs) will be used in parallel to model an underlying, more comprehensive network, effectively expanding the scale of the system.</p><p>Technologies coming more prominently into play over the next 15 years, e.g. micro-generation, storage, fault current limiters, etc., will be included on the test network so as to test their effect, and vice-versa, on distribution systems.</p></td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4"><p>Benefits to DNOs from such a facility include:</p><p>Safety – A test network with dedicated staff will offer a facility to train staff in the operation of a more complicated network. Specific what-if scenario courses can be run through repeatable simulation, in the same manner as flight simulators are used to train pilots.</p><p>Risk mitigation – A real time simulator, with likely penetrations of high volume DG and microGen will indicate the technologies that will need to be developed in order to manage the increased risk this might pose to the network and/or our customers.</p><p>Acceleration of trials / increased adoption rate – The ability to operate the whole network through a vast range of loading conditions in a short period of time, will lead to the end of long duration (12-24mth) network trials of new technologies.</p></td></tr>
</table>

<table>
<tr><td>Expected Timescale to adoption</td><td>1 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">90%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td colspan="6"></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£709,171</td></tr>
<tr><td>Project Progress March 15</td><td colspan="10">Activity April 2014 - March 2015
Working with fellow PNDC members SPEN have undertaken several projects under 5 Core Research themes:
1. Asset Management
- Tower condition assessment
- Asset data collection investigation
2. Network & Demand Side Management
- Dynamic LV network phase rebalancing
- Evaluation of embedded generation export limitors
3. Power Electronics & Distributed Energy Resources
- Demonstration of power quality issues associated with PV grid penetration
4. Protection & Control
- Development of a solution for detecting overhead line (OHL) collision and block auto-reclosing
- Development of a solution for the automatic detection of live cross arms in 11kV and 33kV networks
- Investigation into SEF protection mal-operation
- Testing dynamic line monitoring solution
- Testing of fault passage indicators
- Testing of locomotion SASensor HMV functions
5. Sensors & Measurements
- Development of a methodology to measure VT frequency response
- Testing Tollgrade Lighthouse Sensors
Following on from the end of IFI the PNDC Core Research themes will continue to generate proposals that help to progress the development and integration of new technologies to the UK DNOs, however any of the proposals taken forward will be either funded as Business as Usual (BaU) or will be registered as a standalone projects that are fully compliant with any available funding mechanisms, e.g. NIA, NIC.</td></tr>
</table>

Potential for achieving expected benefits	During 2014/15 SPEN has been able to utilise the unique test environment at the PNDC to expedite the development and delivery of new technology to our network. SPEN utilised the PNDC for the IFI projects listed below, in doing so proven the benefit of the PNDC to the UK. **IFI 1209 Substation Earth Integrity Monitoring System:** For this project the PNDC was utilised to carry out a trial installation of the Cresatech Copper Theft System (CuTS) and several simulated theft events to prove the unit was fit for purpose. In doing so both SPEN and Cresatech were able to address practical issues encountered during the installation ahead of rolling out the solution to the network. Subsequently a live demonstration was given to internal stakeholders to demonstrate the devices performance which resulted in a business buy-in to proceed to a field trial of 80 CuTS units. **IFI 1404 Urban NCP Enhancements** For this project the PNDC was utilised to develop and deliver a test programme to assess the performance of Nortech's Directional Fault Passage Indicators (dFPIs). Through this test programme SPEN were able to gain sufficient confidence in the performance of the dFPI to progress to field trials. **IFI 1308 HTIP** For this project the PNDC was utilised to develop and deliver a test programme to assess the performance of HTIP's Voltage Optimiser (VO). Through this test programme SPEN and HTIP were able to identify a number of areas where the VOs performance needed to be enhanced prior to field trials being undertaken.
Collaborative Partners	Scottish & Southern Energy, Scottish Enterprise and University of Strathclyde
R&D Providers	See Collaborative Partners

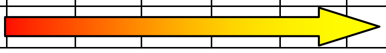
<table>
<tr><td>Project Title</td><td colspan="11">IFI 0615 – ScottishPower Advanced Research Centre (SPARC)</td></tr>
<tr><td>Description of project</td><td colspan="11">Three work streams have been progressed as part of the SPARC programme:
• Asset Engineering: Field based activities, concentrating on the technologies used to gather and interpret data then control and manage individual assets.
• Asset Strategy: Office, desktop, PC based analytical activities including the analysis of data, concentrating on underlying trends of asset populations (from asset ageing to network performance).
• System Development: Forward looking network design activities considering the connectivity between the assets. It should consider both the medium term (5 years) and longer-term trends (>10 years), which will affect the design of the network (e.g. load, generation, standards, regulations, Ofgem incentives/penalties).
• A number of related projects have been developed within each work stream.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £18,654
External £147,409
Total £166,064</td><td>Expenditure in previous (IFI) financial years</td><td colspan="9">Internal £52,311
External £869,765
Total £922,076</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£460,083</td><td>Projected 15/16 costs for SP-EN</td><td colspan="9">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">• Asset Engineering research stream focuses on methods and technologies that enable better use of individual assets.
• Asset Strategy research stream focuses on methods and tools that enable better management of populations of assets.
• System Development research stream focuses on analytical techniques that provide SP with better capability to plan and design the power system.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td colspan="4">Technological substitution</td><td colspan="5">Radical</td></tr>
<tr><td>No</td><td>Yes</td><td colspan="4">No</td><td colspan="5">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">Research activities will seek to realise business benefits across a range of areas including system performance, OPEX and CAPEX. Key areas have been identified in the SPARC proposal, which are being used to form the basis of a more comprehensive programme of deliverable projects.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">Varies per project</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">TBC
In development for the core projects in each work stream</td></tr>
</table>

Project Progress March 15	**'Asset Technology' Theme: Develop an intelligent decision support system for overhead line fault prognosis utilising available Pole Mounted Auto-Reclosers (PMAR) data.** This research assesses the feasibility of data mining techniques to identify 'interesting' data patterns and trends that are indicative of anomalous current activity, and where possible distinct modes of network behaviour representative of specific network defects (e.g. cracked insulators). The initial feasibility study is being taken forward as a PhD research project. • Two tools have been developed to support the identification and diagnosis of fault events. • An *Anomaly Detector* analyses SCADA alarm data stored in a SP Energy Networks database in order to identify circuits and periods of time for which there are frequent unsolicited circuit breaker openings. This guides the selection of PMARs of interest for more detailed analysis • A *PMAR Data Visualisation Tool* extracts data from PMAR sources, and derives and presents information about fault behaviour based on an analysis of previous PMAR data associated with protection activity and unsolicited openings. • On the basis of this work, trends and patterns in transient event data are now being analysed to identify means of predicting the nature of a subsequent permanent fault, as well as how soon it is likely to occur. • A conference paper (*"Automatic analysis of pole mounted auto-recloser data for fault prognosis to mitigate customer supply interruptions"*) has been presented at the 2014 *Universities Power Engineering Conference*. A paper has been submitted to the *2015 Intelligent Systems Application to Power Systems (ISAP2015)* conference.
Potential for achieving expected benefits	The '**Fault prognosis utilising available Pole Mounted Auto-Reclosers (PMAR) data'** PhD will enable SP to predict and classify future fault activity to allow maintenance staff to take appropriate preventative action; and ultimately improve network reliability, protect expensive plant, reduce the number and duration of outages, and improve customer service, avoiding regulatory penalties arising from unplanned network interruptions. Key SPEN personnel have been engaged at technical and strategic levels though regular project meetings and SPARC strategy meetings to ensure that research is progresses along the TRL development scale towards deployment within the organisation. In addition, a key function of these strategy meetings (involving all SPARC personnel, and held bi-annually) has been to ensure that the pipeline of prospective research projects is maintained and that they remain relevant to the strategic objectives of SPEN. This project is now closed. Project outcomes will be reviewed upon completion of the Closed Down Report.
Collaborative Partners	N/A
R&D Providers	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="10">***IFI 0621 – 3 Live Alert/Energised Alert***</td></tr>
<tr><td>Description of project</td><td colspan="10">The Energised Alert is a high voltage detection device, currently capable of detecting voltages of above 2kV. The project’s objectives are to:
• To extend the voltage sensing range downwards from 2000 Volts
• To undertake a full market appraisal
• To undertake full evaluation of technology whilst in operation
This project aims to take the Energised Alert from TRL 4 to 8.</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td colspan="2">£14,102</td><td colspan="3" rowspan="3">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal</td><td colspan="2">£33,344</td></tr>
<tr><td>External</td><td colspan="2">£11,684</td><td colspan="2">External</td><td colspan="2">£37,811</td></tr>
<tr><td>**Total**</td><td colspan="2">**£25,786**</td><td colspan="2">**Total**</td><td colspan="2">**£71,155**</td></tr>
<tr><td rowspan="3">Project Cost</td><td colspan="3" rowspan="3">£ 65,815</td><td colspan="3" rowspan="3">Projected 2015/16 costs for SPEN</td><td colspan="2">Internal</td><td colspan="2">£0</td></tr>
<tr><td colspan="2">External</td><td colspan="2">£0</td></tr>
<tr><td colspan="2">Total</td><td colspan="2">**£0**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The Energised Alert senses any increase in electrical potential, above a predetermined threshold, of devices to which it is attached. Once triggered it is linked to an audible alarm, allowing the recognition and management of this potentially deadly hazard in a controlled manner. Its use will, therefore protect the operator, other employees and any members of the public in the vicinity from casual, but more importantly, avoidable electrocution.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">Successful development of the Energised Alert would:
• Help prevent electrocution accidents and fatalities
• Ensure ‘live line’ maintenance can be carried out in a safe manner
• Allow operators to proactively respond to incidents on their network</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">1 Year</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">25 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td colspan="5">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">-£49,420</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">Stage Four extension was agreed and has now been completed; there are 10 prototype units ready for live trials.
Stage Five was added to the project during the stage 4 extension; however this has now been cancelled due to the IFI funding closing.
This project is now closed.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The project is on target to achieve the expected benefits.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Northern PowerGrid, Electricity North West, SSE</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Live Alert</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0701 – ENA IFI Projects</i></td></tr>
<tr><td>Description of project</td><td colspan="4">The Energy Networks Association (ENA) represents all the UK network operators. Several projects have been initiated by the ENA R&D Working Group and have been funded through the IFI.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £14,102
External £53,946
Total £68,048</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £32,224
External £96,000
Total £128,224</td></tr>
<tr><td>Project Cost</td><td>c£50,000</td><td>Projected 2015/16 costs for SPEN</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The projects listed below address issues which have been identified by the ENA working groups as significant – requiring technical investigation and development. There are a number of projects that have been completed and reported in previous IFI years and for that reason these projects are not reported here.

Reactive Power (REACT): In the last 2 years, there have been significant difficulties in managing voltage levels during minimum demand periods. Analysis of this issue has shown that the root cause is related to the significant decline in reactive power relative to active power. Whilst minimum active power demands have fallen by around 15% in the last 5 years, reactive power has declined by 50% in this time. Current trends for 2012 show that this reduction is continuing, broadly, across the country. In order to better understand the challenge of manage voltage levels within licence standards and to plan for additional future reactive compensation requirements, a thorough understanding of the reactive power trend needs to be developed.

DS2030: The DECC/Ofgem Smart Grid Forum was created by the Department of Energy and Climate Change (DECC) and Ofgem to support the UK's transition to a secure, safe, low carbon, affordable energy system. The main issue discussed within the DECC/Ofgem Smart Grid Forum is how electricity network companies will address significant new challenges as they play their role in the decarbonisation of electricity supply. The Smart Grid Forum has established a number of Work Stream (WS) to examine particular aspects of future networks.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">These projects have the potential to provide a wide range of benefits. In some cases, they will help to understand developing network related issues and allow design and operations to be altered to address them. In other cases they will allow us to better understand risks to our network.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 - 10 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 – 20 Years</td></tr>
<tr><td>Probability of Success</td><td>25 - 75%</td><td colspan="3"><table><tr><td colspan="9">TRL Development (Start – Current)</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td></td><td colspan="6"></td><td></td><td></td></tr></table></td></tr>
</table>

<table>
<tr><td>Project NPV</td><td>(Present Benefits x Probability of Success) – Present Costs</td><td>£100,000</td></tr>
<tr><td>Project Progress
March 15</td><td colspan="2">

Reactive Power (REACT): The objectives corresponding to the First Year Report Stage 1 and the Second Year Six-month Report have been met within the last 12 months and the corresponding reports delivered. Two additional brief project status reports have also been delivered.

It is important to highlight that the project was initially planned to start in May 2013 but it actually did in August 2013. The Second Year Final Report Stage 2 is on track and will be completed by August 2015.

The outcomes of the project are in accordance with the initial objectives of the project proposal. More specifically, the following tasks have been accomplished:

- Identification of historic network and demand changes and trends.
- Quantification of effects on reactive demand during minimum load from different distribution-based factors (i.e., demand trends in primary substations, network changes, penetration of photovoltaics).
- Assessment of future reactive demand at transmission-distribution interfaces of different DNOs.
- Production of improved network models, which unlike original DNO models mimic transmission-distribution interfaces during periods of minimum load, to be used for further studies

DS2030: Works during the second half of 2014 focussed on defining the four representative networks that will be used for the study and the future scenarios that will be applied. The base networks were finalised and agreed in November 2014 and, following additional development work, the scenarios were finalised in early 2015.

In addition, an international review was conducted to capture learning from work in other countries and this was concluded in September 2014. An updated version will be produced towards the end of the study to ensure any more recent work is identified.

Towards the end of 2014, the key questions the DS2030 project aims to answer were reviewed. Minor revisions were agreed with the project Steering Group and WS7 in February 2015.

Since the start of 2015, efforts have focussed on defining the detailed methodologies to be used in the network analysis studies. These were presented as a series of discussion papers which were reviewed and agreed by the Steering group and WS7. This stage is largely concluded and studies are now commencing.

Both projects have been transitioned to the NIA scheme.

Further information is available at the Smarter Networks Portal, please see links below

http://www.smarternetworks.org/Project.aspx?ProjectID=1460#project-details

http://www.smarternetworks.org/Project.aspx?ProjectID=1623#downloads

</td></tr>
</table>

Potential for achieving expected benefits	**Reactive Power (REACT):** The objectives corresponding to the First Year Report Stage 1 and the Second Year Six-month Report have been met within the last 12 months (May 2014 to May 2015) and the corresponding reports delivered. Two additional brief project status reports have also been delivered. The progress on the project includes: • The methodology to improve original DNO network models in order to mimic in time-series simulations the GSP behaviour during periods of minimum load. • The identification of historic changes and trends using DNO network and monitoring data. • The quantification of effects on reactive power from PV penetrations, network changes and demand trends in primary substations. • The assessment of future reactive demand at GSPs of 4 DNOs for different trend-based scenarios. **DS2030:** The DS2030 project is expected to achieve its intended benefits. It will provide a set of generic nodal distribution network models that have been demonstrated to be technically viable to meet the needs of 2030 users. These models have now been developed and their viability will be demonstrated in the coming months. The models will be used to show how specific methods/solutions can be used to ensure technical viability of the networks and when particular methods/solutions may need to be applied. This analysis will be provided in the Stage 4 &5 results report. The final Stage 6 report for the project will use the outcomes of the studies to address the questions posed by the Smart Grid Forum about future distribution system operation, including a discussion of the roles and responsibilities of a DNO in 2030 in terms of supporting whole system optimisation, contrasted with the position today. Where appropriate this will highlight further specific development work that could be carried out
Collaborative Partners	National Grid; SPEN; Scottish and Southern Energy; Electricity North West; Western Power Distribution and Northern Power Grid
R&D Providers	TNEI; Engage Consulting Limited; Imperial College London; Met Office; EA Technology Ltd (and partners); Earthing Solutions; KEMA and Redpoint Energy; Inertek; CAPCIS.

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1004 – Remote Access to Pole Mounted Auto Reclosers</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The Noja pole mounted auto recloser (PMAR) incorporates a protection module, the MPM, which can be accessed to retrieve active and historical data relating to both protection activity and statistical metering.
This can only be accessed via an RS232 port within the Noja Control Panel that is mounted below the Main Tank, out with the Safety Distance, and above the Anti-climber. Access to this panel requires a specialist skill. It would a business and safety advantage if additional functions of this equipment could be accessed without having to ascend the pole.
The proposal from Nortech suggests that by adding an ‘Envoy’ module to a Noja, remote access of the data within a Noja would be possible.
Nortech has proved that the ENVOY can talk to the NOJA, but this needs to be proved in an operational situation.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £25,358
External £6,659
Total £32,018</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £49,705
External £40,907
Total £90,612</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">£76,800</td><td colspan="3">Projected 15/16 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The project aims to address the issue of safe and automated remote access to active and historical data from SPEN’s population of Noja PMAR.
The project will enable circuits to be ranked accordingly to agreed performance indicators e.g. circuits with most trips which could inform operational and maintenance activities.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Health and Safety benefit realised by negating the need to climb PMAR poles to access information
• Automatic collection of all Noja PMAR event logs, removing the need to drive to site and consequent delays in getting data
• Summary analysis of PMAR activity with dashboard showing league table of operations
• Central storage of event logs</td></tr>
<tr><td>Expected Timescale to Adoption</td><td colspan="3">3 years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">10 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">90%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="3"></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£343,820</td></tr>
</table>

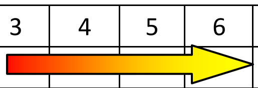
Project Progress March 15	Development of a browser dashboard has enabled a summary of the available data is in use and has introduced additional features that have been added at the request of operation users. The Dashboard can be configured to provide for automated alerts, by either email or text message, for user defined parameters or conditions arising. This project is now closed.
Potential for achieving expected benefits	The Envoy units are installed in the field on an as-required basis by the districts with key staff trained to install, commission, and analyse the recovered data. There have been many successes from using this equipment to monitor transient activity that is all too often very difficult to determine the cause. Having access to Envoy data in almost real time allows the field crews to be directed to possible fault locations knowing the actual affected phase and level of fault current that has passed, is a good start to identifying the cause.
Collaborative Partners	None
R&D Providers	Nortech

<table>
<tr><td>Project Title</td><td colspan="9">IFI 1102 – Energy Storage Project</td></tr>
<tr><td>Description of project</td><td colspan="9">The aim of this project is to investigate the role of energy storage systems (ESS) in smart grids.
The need to investigate the role of electrical energy storage has been identified at governmental level. The Parliamentary Renewable and Sustainable Energy Group (PRASEG) inquiry into ‘Renewables and the grid: access and management’ cites storage as a ‘possible solution for addressing variable renewable energy generation’ and highlights the need for ‘Long term, further research and development’ and ‘clear political and regulatory signals’(PRASEG, 2010). In the UK Low Carbon Transition Plan (HM Government, 2009) storage is included in the list of key elements of a UK smart grid.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £14,861
External £11,119
Total £25,980</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £29,147
External £61,677
Total £90,824</td></tr>
<tr><td>Project Cost</td><td colspan="2">£326,000</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">• Economic assessment with respect to traditional reinforcement options
• Identification of appropriate locations for energy storage systems
• Consideration of most appropriate sizes and capacities for energy storage systems
• Determine appropriate operating strategies for energy storage systems.
• Understand the effects of operating strategies on the ageing of the energy storage systems
• Evaluate the current and future value of operating an energy storage system to generate revenue through energy market arbitrage
• Investigate the regulatory issues surrounding the ownership of energy storage systems by DNOs</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">Yes</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">Produce learning outcomes and decision support information which can be disseminated within the DNO community which will enable the cost effective and beneficial adoption of energy storage systems.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>▬</td><td>▬</td><td>→</td><td></td><td></td><td></td></tr>
</table>

Project NPV	(Present Benefits x Probability of Success) – Present Costs	Not known at this stage
Project Progress March 2015	Recent outputs have been produced in a number of areas and are summarised below. Papers produced on the decisions and influencing factors that determine sizing and location of electrical energy storage systems: Crossland AF, Jones D, Wade NS. Planning the location and rating of distributed energy storage in LV networks using a genetic algorithm with simulated annealing. *International Journal of Electrical Power & Energy Systems* 2014, 59, 103-110. Anuta OH, Barteczko-Hibbert C, Wade NS. Future low carbon technologies, impacts and energy storage solutions on UK distribution networks. *CIRED workshop* 2014, Rome. Paper on the ageing considerations which must be included when deploying and operating energy storage systems: Wang L, Liang DH, Crossland AF, Taylor PC, Jones D, Wade NS. Coordination of Multiple Energy Storage Units in a Low Voltage Distribution Network. *IEEE Transactions on Smart Grid* 2015. Paper with potential application of energy storage looking at the present day but also at likely future changes: Crossland AF, Wade NS, Jones D Extraction of 9,163 real LV network models from DNO GIS database to assess overvoltage from PV and consequent mitigation measures. *CIRED* 2015, Lyon. Paper with recommendations for how the regulatory regime could be changed to facilitate the cost effective adoption of energy storage systems: Anuta OH, Taylor PC, Jones D, McEntee T, Wade NS. An international review of the implications of regulatory and electricity market structures on the emergence of grid scale electricity storage. *Renewable and Sustainable Energy Reviews* 2014, 38, 489-508. This project is now closed.	
Potential for achieving expected benefits	The adoption of energy storage systems in distribution networks continues to be held back by the lack of validated business cases that show a sufficient income generating potential in comparison to the costs. This investigation has shown that against particular future scenarios, energy storage can compete with conventional network reinforcement. The full potential of energy storage is more likely to be realised when the effects of increases in distributed generation and electrification of transport and heat present greater effects in the networks. Recent developments in the provision of home energy storage systems from Moixa, Daimler and Tesla are likely to make the findings from this project increasingly relevant as storage is added to the network by consumers.	
Collaborative Partners	Electricity North West	
R&D Providers	Newcastle University	

<table>
<tr><td>Project Title</td><td colspan="4">***IFI 1104 – SF GB Electricity Demand Project***</td></tr>
<tr><td>Description of project</td><td colspan="4">This project will identify practical solutions, incentives and pathways to realise the potential resource which flexible electricity load could offer into the GB electricity market.
The project will evaluate and understand potential GB electricity demand-side response as a resource across all sectors (including how micro-gen fits in); develop a clearer understanding of the economic value and potential of this resource to different market actors and to different customers over the next 10-15 years; and systematically evaluate the key consumer, commercial, regulatory and policy issues and interactions.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £14,102
External £6,659
Total **£20,761**</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £16,976
External £29,226
Total **£46,202**</td></tr>
<tr><td>Project Cost</td><td>£348,895</td><td>Projected 2015/16 costs for SPEN</td><td colspan="2">Internal £0
External £0
Total **£0**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">**Key Themes for the project include:**
Customer Response & Consumer Issues – A key focus for the project has been to understand successful and cost-efficient demand-side participation from the various customer groups perspective. This includes gaining experience through LCNF trial and other similar initiatives in the UK and beyond.
Commercial – As a consequence of the different roles that demand-side services are likely to play in the future electricity market, the nature of the commercial agreements required and the kind of information sharing that is necessary to make it work effectively all require to be explored.
Regulatory – The workstream focuses upon the regulatory factors (current and future) that impact upon the development of an active electricity demand side market within GB. This includes a review of current agreements between market participants, interaction with industry and statutory codes, incentives in price controls, settlements and third party requirements.
Public Policy Issues – This work package will consider the likely economic value and potential contribution of demand-side to greater cost efficiency across the electricity sector, security of supply, carbon reduction, business and market models, interactions with electricity market reform, smart metering as well as energy efficiency schemes such as CRC Energy Efficiency Mechanism, Green Deal and Energy Company Obligations.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Co-ordinated through a Smart Demand Forum, the project is expected to develop a substantive knowledge-base and provide thought-leadership and visibility for GB electricity demand–side issues, by bringing together three key strands: practical demand-side and load-management experiences, including from Low Carbon Network Fund projects; a top-down technical and economic overview; and, expert analysis of the key consumer, commercial, regulatory and policy issues.</td></tr>
</table>

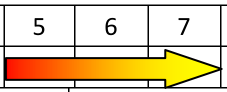
<table>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">15 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="3">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">TBC</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">The project has made significant progress through the publication of several papers on issues associated with GB Electricity Demand and Use of Demand Side Response which are available at www.sustainabilityfirst.org.uk (GB Electricity Demand Project). The following papers were published during the reporting year:
• Paper 12 - The household electricity demand-side & the GB electricity markets : realising the resource published July 14
• Paper 13 – Realising the Resource: GB Electricity Demand Project Overview published in October 14
The project is now closed.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The project is on track to realise expected benefits.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">BEAMA
Cable & Wireless
Consumer Focus
British Gas
EDF Energy
Elexon
E-Meter (a Siemens Business)
E.ON UK
National Grid
Northern Powergrid
Ofgem
UK Power Network</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Sustainability First</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1203 – Psymetrix ACAM Phase 1</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The objective of this project is to prove the concept of an Active Network Management (ANM) approach known as Angle Constraint Active Management (ACAM). Then initiate its development into an operational scheme capable of facilitating the connection and management of additional Distributed Generation (Phase 2).</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £14,102
External £54,659
Total £68,761</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £61,119
External £152,287
Total £213,406</td></tr>
<tr><td>Project Cost</td><td colspan="3">£320,655</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The project will contribute to the UK environmental targets by enabling a greater penetration of renewable generation on to the electrical network.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">Yes</td><td colspan="2">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• To prove and quantify the additional capacity that an ACAM scheme could introduce
• To prove the correlation of modelled ACAM angles against network PMU measurements
• To identify the operational requirements of an ACAM scheme
• To gain the necessary evidence to justify an operational trial of the ACAM scheme</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td colspan="4"></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£187,974</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">This project is now completed.
During 2014/15 Psymetrix were able to overcome several technical issues with the communication to the installed PMUs to gain sufficient network data to analyse the potential performance and capacity increase that would be ascertained by an ACAM scheme.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">This project was envisaged to be delivered in two Phases, this initial first phase was aimed at proving the ACAM concept would deliver additional capacity and could be technically viable solution. In delivering their final</td></tr>
</table>

	report on Phase 1, Psymetrix have provided SPEN with sufficient evidence to decision on whether to progress to Phase 2. At the time of writing this report no decision has yet been made on the progression to a Phase 2 Pilot trial under NIA. Aside from the proving the ACAM concept the project has also delivered invaluable DNO experience in operating PMUs at distribution voltages and utilising GPRS communications at remote geographical locations.
Collaborative Partners	Psymetrix
R&D Providers	Psymetrix

<table>
<tr><td>Project Title</td><td colspan="10">IFI 1207 – Smart 3 Phase Voltage Regulator</td></tr>
<tr><td>Description of project</td><td colspan="10">The distribution network controlled using transformers and tap-changing has proven reliable, however controllability of voltage is limited at best and faces the greatest challenge in remote and rural areas.
An active series voltage regulator to be developed by Gendrive Ltd (supported by EA Technology) aims to provide a more stable and smarter local supply. The unit proposed will in effect prevent or at worst delay the cost of reinforcing problematic distribution circuits.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £14,346
External £11,684
Total £26,031</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £10,404
External £50,178
Total £60,582</td></tr>
<tr><td>Project Cost</td><td colspan="3">£225,000</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Although voltage issues in rural/urban areas are not currently a major issue, ongoing work in a number of Low Carbon Network projects suggests that the increasing load scenario (particularly heat pumps) that will develop in the next 20 years will generate increases in customer supply problems. The smart voltage regulator unit offers the potential to solve issues in problem feeder circuits as well as providing an opportunity to moderate harmonic and to a certain extent power factor issues that are also anticipated to grow.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• The unit would be able to service feeders carrying up to 500 Amps, and provide voltage stabilisation capacity up to +/-30 volts
• Fluctuation in voltage amplitude on the distribution-side will be de-coupled from the load-side, so it can be regulated whenever the distribution voltage varies outside of normal operating limits
• Distributed Generation on the customer side will suffer fewer loss-of-mains trips whenever voltage rises above the permitted voltage range, as the effective network voltage (load-side) can be reduced
• Heavy load will not cause excessive voltage drop as the voltage regulator will act to increase the load /consumer voltage</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">35%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td colspan="3">⟶</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£76,055</td></tr>
</table>

Project Progress March 2015	This project is now closed. As reported in 2013/14 this project was placed on hold due to the R&D provider going into administration. Over the course of 2014/15 the Collaboration Partners agreed to close this project at its present point.
Potential for achieving expected benefits	This project demonstrated that there were limitations in the technological solution being developed by GenDrive on the basis of its size and suitability for being located on LV feeders. This project has delivered negative learning and has identified further requirements for the specification of any future LV feeder voltage regulators. It is likely that the learning generated in the early stages of this project will be utilised in a future project(s) that look to develop solid state devices.
Collaborative Partners	Scottish Hydro Electric Power Distribution plc, Electricity North West Limited, Northern Powergrid Limited, UK Power Networks (Operations) Limited and Energy Innovation Centre Limited
R&D Providers	Gendrive Ltd, (supported by EA Technology)

<table>
<tr><td>Project Title</td><td colspan="11">IFI 1209 – Substation Earth Integrity Monitoring System</td></tr>
<tr><td>Description of project</td><td colspan="11">This aim of this project is to develop a system for monitoring the removal/theft of earth straps from Transmission and Distribution substations or other installations</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £14,102
External £252,837
Total £266,939</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £20,293
External £148,011
Total £168,304</td></tr>
<tr><td>Project Cost</td><td colspan="3">£189,347</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="5">Internal £23,000
External £26,000
Total £49,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">The project will explore three separate work streams
1) Use of RFID technology using RFID tags bonded to earth straps that are monitored (pinged) by a monitoring unit on site to detect their presence.
2) To prove the concept of using SWR (Standing Wave Ratio) as used in radio/antenna optimisation to provide detection of real time “earth tamper” activity.
3) Develop the Cresatech Copper Theft Sensor (CuTS) prototype unit for application at SPEN substations.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">There is no off the shelf product available for permanent installation in a substation which can detect the presence of adequate earthing and real time theft detection.
Expected benefits of the project include:
• Potential avoidance of a ‘Danger of Death’ incident, major or minor accidents or ill health
• Help to ensure that Electricity Safety, Quality and Continuity Regulations (ESQCR) are met
• Notification that earthing Copper or other infrastructure has been stolen
• Deterrent to thieves if coupled with sound/light alarm on site</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">15 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="3"></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£71,378</td></tr>
</table>

Project Progress March 2015	**RFID Tags and SWR** This project has been closed as it was decided to concentrate efforts on the Cresatech CuTS units as they were at a higher Technology Readiness Level and consequently represented a greater likelihood of success. **Cresatech CuTS Prototype Unit** Over the past 12 months the following outputs have been achieved; • Limited roll-out of units to primary and secondary substation sites • Development of an online portal to remotely evaluate and update all installations • Evaluation of the effectiveness of the monitors at detecting copper theft and tampering of key infrastructure • A programme for a pilot roll-out of 80 units has been developed • Evaluation of how the monitors interact with substation environments • Evaluation the of monitor performance and how they could be developed further has been undertaken This project will be continued under NIA funding.
Potential for achieving expected benefits	The potential for achieving expected benefits of the Cresatech CuTS prototype unit is being evaluated during the pilot roll-out phase of this project.
Collaborative Partners	Scottish & Southern Energy (Cresatech Project), Energy Innovation Centre
R&D Providers	Nortech Online Ltd and Cresatech

<table>
<tr><td>Project Title</td><td colspan="10">***IFI 1211 – Smart CCU Development***</td></tr>
<tr><td>Description of project</td><td colspan="10">To enable retrieval of complex data from Network Controllable Points (NCP) Intelligent Electronic Device (IED), for example the Noja Pole Mounted Auto Recloser (PMAR), it is necessary to develop a digital radio that will interrogate the DNP3 mapping and transmit the information to the relevant source primary substation. In tandem with this, the project will also develop a new style Central Control Unit (CCU) to accept the data and display it locally as well as sending it via an IEC 86870-5 -104 com-link for remote display.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £127,464
External £11,684
Total £139,148</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £159,021
External £96,556
Total £255,577</td></tr>
<tr><td>Project Cost</td><td colspan="2">£88,000</td><td colspan="4">Projected 2015/16 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The project will:
• Develop a new CCU for accepting complex digital data and analogue values.
• Develop a digital radio to interrogate IED devices operating with DNP3 protocols.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">Yes</td><td colspan="2">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• This project will ensure the retrieval of complex data from NCPs and interrogation of DNP3 mapping which will consequently improve knowledge transfer.
• Recovering detailed information on secondary network HV loading and phase imbalance will help to ensure the system is optimally configured. This data may provide additional insight into network behaviour and assist in preparing for this.
• This project will provide immediate access to data to understand fault modes and provide the ability to model the network in real time and load it dynamically, or improve efficiency.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><1 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">90%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">→</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">Not determined at this stage</td></tr>
</table>

Project Progress March 2015	Much work has been carried out on this development project. A field trial has commenced at St Andrews for digital control and recovery of analogue data from IEDs. IEC SCADA link remains outstanding, which is reliant upon the installation of an 86870-5-104 comms link to complete the project. This work is behind schedule. Mapping the CCMU into SCADA also remains outstanding. There is an overlap with the RIIO-ED1 programme, which has resulted in creep in specification with a corresponding reduction in time allocated to this project. Control points have been successfully commissioned into PowerOn via the legacy protocol for this work stream. This project is now closed.
Potential for achieving expected benefits	The potential for achieving expected benefits is considered to be very high
Collaborative Partners	SmartGridNetworks
R&D Providers	SmartGridNetworks

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1215 – Self Repair MV Underground Cables</i></td></tr>
<tr><td>Description of project</td><td colspan="10">There is a recognised need in the UK electricity distribution network for extruded polymeric cables to be capable of self-repair if the protective outer sheath is damaged during installation and operation. In-situ cable self-repair would be valuable as the damage is likely to be localised and not obvious from inspection of the cable because it is usually impractical and/uneconomic to inspect an underground asset.

An initial study will review, rank and laboratory-trial a number of new candidate materials technologies. This would be followed by laboratory trials on one or more candidate repair technologies. If successful, commercial development of an improved performance Medium Voltage (MV) cable system could follow in collaboration with one or more cable companies to produce MV cables that would be suitable for installation in the UK power network.</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£15,240</td><td colspan="4" rowspan="3">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal</td><td colspan="2">£11,208</td></tr>
<tr><td>External</td><td>£77,411</td><td colspan="2">External</td><td colspan="2">£106,508</td></tr>
<tr><td>Total</td><td>£92,651</td><td colspan="2">Total</td><td colspan="2">£117,716</td></tr>
<tr><td rowspan="3">Project Cost</td><td colspan="2" rowspan="3">£302,270</td><td colspan="4" rowspan="3">Projected 2015/16 costs for SPEN</td><td colspan="2">Internal</td><td colspan="2">£0</td></tr>
<tr><td colspan="2">External</td><td colspan="2">£0</td></tr>
<tr><td colspan="2">Total</td><td colspan="2">£0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">New developments in self-repairing polymers and reactive chemical technologies could potentially be capable of providing a repair function for a variety of cable sheath defects and damage that may occur.

This would reduce the necessity to repair damaged underground cables, reduce customer disruption from premature cable failure and nuisance trips.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Critical review of existing self-repair technologies to meet the needs of MV cable self-repair
• Second stage trialling of top candidate self-repair technologies and selection of system(s) for MV cable development
• Recommendations on commercial development of the IP generated within the cable industry
• To patent at least one and possibly two candidate self-repair technologies</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">4 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>→</td><td>→</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£15,340</td></tr>
</table>

Project Progress March 2015	• 4 specific repair technologies have been identified and tested • A number of cable manufacturers have shown significant interest in the project including the provision of material samples and cable samples • Several material suppliers have engaged positively in the project including the provision of material samples • 3 test rigs have been built and used for testing • The project has made good progress and identified further work with a new stage 4 to be carried out. This looked at the merging of two different repair technology classes to gain the best possible self-repairing mechanisms. • All stages of the project are now complete with the Final Report Issued detailing the following: - Results of the trialling and evaluation of land-based and undersea cable self-repair technologies - Economic assessment on what technologies to adopt - Recommendation on best route to commercialise and deliver self-repair cables to DNO's - Best approach to exploit the technology for wider adoption in global markets
Potential for achieving expected benefits	Project is now complete and met all expected benefits of the project
Collaborative Partners	SSE and Energy Innovation Centre
R&D Providers	Gnosys Ltd

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 1216 – The Role of the Demand Side in Delivering Effective Smart Grids</i></td></tr>
<tr><td>Description of project</td><td colspan="4">An International Energy Agency Project commenced in June 2012 with four international participants, namely, Korea, Netherlands, Norway and Sweden to investigate the role of consumers in delivering effective Smart Grids. EA Technology has been appointed to lead a UK team which will include Distribution Network Operators, Energy Suppliers and others.
Customers have a key role to play in ensuring the successful transition to a Smart Grid environment with energy production and demand integrated, whereby on-demand response to end users is no longer provided, and renewables optimised whilst minimising fossil fuelled generation and network reinforcement. As a consequence customers will be required to adopt new approaches to the way they consume electricity.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £14,102
External £6,659
Total £20,761</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £25,736
External £23,726
Total £49,462</td></tr>
<tr><td>Project Cost</td><td>£19,925</td><td>Projected 2015/16 costs for SPEN</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Whilst there is a considerable focus on the technological aspects of delivering smart grids, little is understood of the extent to which consumers are willing to embrace new technologies and initiatives that enable their use of energy to be actively managed. There is a real risk that if customers do not adopt new approaches to the way that they consume electricity, Smart Grids may not be able to achieve their full potential.
This project will enable SPEN to understand the factors that influence customer reactions and attitudes towards Smart Grids; gain an independent view of risk and rewards of Smart Grids from the customers' perspective; understand how customer needs can be aligned with those of industry stakeholders; understand the importance of the demand side in ensuring effective Smart Grid delivery; identify measures and tools that could be used to ensure customers are willing and able to contribute to successful Smart Grid deployment; and design customer propositions that allow and enhance the use of the 'smartness' of a grid.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td>No</td></tr>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="10">Understand the importance of the demand side in ensuring the effective delivery of Smart Grids
Gain an independent view of the risks and rewards of Smart Grids from the customers' perspective
Understand how the needs of the customers can be aligned with the needs of the industry stakeholders
Identify measures and tools that could be used to ensure customers are willing and able to contribute to the successful deployment of Smart Grids
Establish Best Practise guidelines to ensure the demand side contributes to the delivery of effective Smart Grids.
The outputs from the project are likely to lead to incremental changes to processes as this is more likely to be acceptable to demand side customers</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>→</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">N/A</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">This project is now closed</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">There is real potential for achieving the expected benefits based upon the current level of activity being undertaken to determine the role and appetite of customers to engage effectively in the delivery of Demand Side activity to enable the transition to Smart Grids.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">EON, ENW and NG</td></tr>
<tr><td>R&D Providers</td><td colspan="10">EA Technology</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="9">IFI 1218 – Impact of Residential Heating and Building Standards on Demand Profiles</td></tr>
<tr><td>Description of project</td><td colspan="9">There are a number of changes to the built environment that will impact on the way that domestic properties are heated and constructed. Government policy is that all new homes will be constructed to net zero carbon standard by 2016 and housing providers are carrying out a process of refurbishment on existing multi-occupancy residences. There will be a greater reliance on electricity to provide heating in the future and low carbon heating will become more common in domestic properties. This project will examine the impact of heating technologies and building standards on low carbon homes at the BRE Innovation Park at Ravenscraig and representative multi-occupancy residences in the central belt.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £14,102
External £6.659
Total £20,761</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £20,571
External £3,801
Total £24,372</td></tr>
<tr><td>Project Cost</td><td colspan="3">£96,000</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="3">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">This project will examine the impact of and provide a range of up to date ADMD and demand profiles to allow for more appropriate network design. This will be achieved through monitoring the power flows and demand profiles at the various properties and through using this data to model demand profiles and ADMD values for different combinations of heating type, building standard and low carbon technology.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">No</td><td colspan="2">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">• Successful project completion will bring about improvements to the time required to carry out design for areas with high take-up of low carbon heating, zero carbon homes and multi-occupancy homes.
• Improved data on buildings and technologies being assessed will facilitate new tools, designs and academic outcomes
• Significant improvements in network design for low carbon buildings and multi-occupancy residences which will contribute towards the goal of developing the grid for the future
• Project will improve on accuracy of cable sizing through improved ADMD values, improving accuracy of cable sizes for domestic properties.
• Use of monitored data to model demand profiles and ADMD values for different combinations of heating, building standard and low carbon technology</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">15 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>→</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£84,113</td></tr>
</table>

Project Progress March 2015	• Gridkey monitors installed at Toryglen site covering high concentration of heat pump installations on site. • Project has taken advantage of data captured at high density PV site in Wrexham. Modelling undertaken by Strathclyde University and applied to designs in recent PV cluster applications to SPEN in ARC trial area. • Ravenscraig low carbon homes development did not progress as planned to produce sufficient data. Data capture is proposed if site matures, analysis to be undertaken internally in SPEN, outcomes may revise design guidance. • Housing build delayed at proposed CHP heating high rise site in Glasgow. • Profiles captured and ADMD values have been quantified for CHP in flatted properties. • Tool developed to calculate ADMD value based on data captured. This project is now closed.
Potential for achieving expected benefits	High
Collaborative Partners	Building Research Establishment (BRE)
R&D Providers	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1219 – Substation Efficiency</i></td></tr>
<tr><td>Description of project</td><td colspan="10">Substations are critical to the successful operation of the distribution network. SPEN maintains thousands of substations as part of the network, ranging in type, age and construction quality. Given the drive for carbon reductions and current high operation costs of substations means that there is a need to find energy efficiency savings for substations. Current issues include; over and under heating, lack of control, lighting defects and the need to install ventilation. This can lead to reduced asset life, battery effectiveness reduction, sticky breakers, high costs and energy waste.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal
External
Total</td><td colspan="2">£14,102
£14,792
£28,894</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal
External
Total</td><td colspan="2">£29,115
£91,289
£120,404</td></tr>
<tr><td>Project Cost</td><td colspan="4">£139,800</td><td colspan="2">Projected 2015/16 costs for SPEN</td><td colspan="2">Internal
External
Total</td><td colspan="2">£0
£0
£0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Monitoring and metering will be used to carry out an assessment of the thermal and electrical auxiliary loads required by substations. Modelling will be used to make an assessment of the entire Scottish network and will allow the total cost of operating substations to be quantified. Substation trials of innovative technology will be carried out at 10 Primary Substation sites to assess their effectiveness and applicability to the network as a whole.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Use of monitored data to develop extrapolated model to make an assessment of substation network as a whole
• Successfully trial energy efficiency measures at 10 Primaries on the network with learning from trials to direct future rollout
• Increased asset life due to improved environmental control which will reduce the need to replace assets
• Lowered heating and lighting bills and reduced maintenance requirements for substations</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£850,809</td></tr>
</table>

Project Progress March 2015	• Tinytag monitors installed to cross section of SPEN substation estate, data captured and collected • Analysis of data carried out with assistance from University of Strathclyde • At 19 substations metering installed to capture electrical consumption • Work started on installing improved heaters and control to these substations • Future work focussed on assessing outcomes of substation improvements and cost benefits from rollout • Review of current substation light and power installation specification to be undertaken This project is now closed.
Potential for achieving expected benefits	High
Collaborative Partners	None
R&D Providers	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1302 – SUSCABLE 2</i></td></tr>
<tr><td>Description of project</td><td colspan="10">SUSCABLE 2 project is the second phase of a project for the development of a new design of high operating temperature power cable. The objective of SUSCABLE 1 was to develop new power cable material technologies with reduced whole-life environmental impact, increased power system efficiency with enhanced sustainability (increased peak-load thermal tolerance) and increased security of supply in urban and environmentally sensitive areas. The outcome of SUSCABLE 1 was new polymer blends with high thermal stability materials with enhanced electrical performance, reduced production costs and improved environmental performance.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £16,378
External £54,992
Total £71,370</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £6,401
External £2,108
Total £8,510</td></tr>
<tr><td>Project Cost</td><td colspan="3">£143,333</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="4">Internal £15,000
External £70,000
Total £85,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The project aims to deliver a 35kV cable based on the new materials and also put in place the design for a 400kV cable based on the experience built up in making the 35kV cable.

First generation PVC insulation restricted cable ratings to 60 - 70°C, subsequent cross linking (XLPE) to prevent the plastic melting offered a continuous rating at 90°C while the new thermo plastics under consideration offer the prospect of an operating range of 120°C to 150°C which would lead to significantly cheaper cables (lower conductor cross section for equal rating).</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">Design, develop and test a 35kV MV cable that is compatible with 120°C continuous operating temperature and 150°C conductor emergency rating.
Materials refinement to achieve the MV design, processing and cable production processes.
Cable manufacturing and testing with structured development to generate experience that will be of value in 400kV design, manufacture and testing.
Having cable insulation that is thermally stable at higher continuous and emergency rating offers significant safety benefits</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">→</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£71,499</td></tr>
</table>

Project Progress March 2015	The project began in June 2014 and has made significant advance in the 9 months to March 2015. The original bi-polymer polypropylene blends from SUSCABLE 1 have been reproduced with materials sourced from multiple suppliers globally and found to perform equally well electrically and thermally as the best blends from SUSCABLE 1. Multi-sourcing has also been achieved for new tri-polymer blends and the first tri-polymer blends have been formulated. Anti-oxidant packages to protect the materials in processing and use have also being selected and are being sourced. Trial blends at volume levels large enough for cable manufacturer process trials have been produced and are being evaluated by the cable makers. MV cable designs have been finalised and cable rating studies begun for underground cable deployment. Review work has also been completed on the deployment options for both MV and HV cable designs for potential deployment in distribution and transmission networks and offshore applications. The response of materials suppliers to requests for materials took much longer than planned but the results have been worthwhile. This delay has created some knock-on delays to later tasks but good progress is being made across the whole project. The cooperation and commitment of the cable companies who are co-funding the project is high. Project continuation under NIA funding is under consideration.
Potential for achieving expected benefits	The prospects look good for achieving the original objectives, and possibly more, as the electrical assessment of the materials and their ease of processing indicates they would also suit HVDC applications in addition to HVAC beyond the MVAC cable development being pursued in this project. It is noted that the additional objective to achieve a MVAC cable core to support HVAC cable development is also being achieved.
Collaborative Partners	National Grid, ORE Catapult, Nexans, General Cable Silec, University of Southampton and GnoSys Global
R&D Providers	GnoSys Global Ltd and University of Southampton

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1304 – Smart Meter Enablement</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The overall goal of the project is to determine the basic infrastructure and processes required to innovatively store and use Smart Meter data within SPEN management systems and to ensure SPEN is capable of meeting its regulatory requirements for connecting to smart meter infrastructure.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £25,233
External £170,550
Total £195,782</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £20,892
External £114,429
Total £135,321</td></tr>
<tr><td>Project Cost</td><td colspan="3">£383,000</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The project aims to take an innovative view of how Smart Meter data can enhance the way network management and operations can work rather than just appending additional information to the existing processes</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Readiness for the implementation of smart meters and accession to new Smart Energy Code
• Ability to innovatively use smart meter data</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2"><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2">➡</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">N/A at this trial stage</td><td colspan="4"></td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">• The smart meter test bed has been deployed and is functioning
• The smart meter simulator is in the final stages of acceptance testing
• Some learnings are already identified and we have engaged with GE to try alternative smart meter processing in PowerOn
This project is now closed as the smart meter test bed is now business as usual</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">We have begun to use the simulator to assess the potential for realising benefits from smart meter information. We expect the trial results will help identify which information is most likely to generate benefits.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Kyria, potentially GE, AMT-Sybex other DNO.</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Kyria, potentially GE and AMT-Sybex.</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="10">***IFI 1305 – Low Power Radio Alarm System***</td></tr>
<tr><td>Description of project</td><td colspan="10">This project is to develop a low cost simple radio that will interface into the existing NCP radio communications infrastructure using spare I/O channels to recover single digital data alarms. Although a ground mounted NCP RTU is able to control up to three objects, in many installations only two are used. By developing a way to utilise the digital channels of the un-used control channel, the existing NCP asset could be used as a route for remote alarms into SCADA.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £26,843
External £11,684
Total £38,527</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £21,969
External £110,776
Total £132,745</td></tr>
<tr><td>Project Cost</td><td colspan="3">£104,277</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total **£0**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">HV secondary substations equipped with basic monitoring, or sensing devices, are largely blind to SCADA as the infrastructure required to recover a few digital alarms is not cost effective. Returning single digital data points for battery alarms, watchdog alarms, fault passage indications, etc. would give visibility of the secondary network and ensure such conditions were reported into central systems.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">Yes</td><td colspan="2">No</td><td colspan="2">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Development of a low power radio for last-mile communication
• Development of an interface into an RTU in a secondary S/S for recovery of low-bandwidth data applications external to the NCP system</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1.5 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">90%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="3">⟶</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">-£15,760</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">Prototypes have been delivered and a workshop trial and demonstration to the business has been conducted. Funding has been secured via RIIO-ED1 for roll-out of the radio onto the network initially for recovery of alarms from HV customer Susbstations. This project is now closed.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The potential for achieving expected benefits is considered to be very high.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Smart Grid Networks</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Smart Grid Networks</td></tr>
</table>

Project Title	***IFI 1307 – Mobile Phone Application Prototypes***		
Description of project	This project has two distinct sub-projects that are designed to prototype the concept of business applications on the SPEN mobile phone platform. **Incident Dispatch & Status Management (IDSM)** The current process for identifying incident status of jobs is inefficient, phone based, time consuming and not customer focused. This project will provide a solution which will allow field staff to enter status updates directly into PowerOn using a Windows 8 mobile phone application. The project will use core SPEN IT platforms and will provide a greatly improved customer service in a more efficient manner. The purpose of this project is to provide the Zone team leaders / OCC Incident Controllers the ability to assign incidents to 300 field crews (North and South) during operational hours / outwith normal working hours and monitor status updates without incurring direct communication delays. These staff will use Geofield Central to allocate and track the status of incidents. In the field, the frontline staff will utilise GeoField TouchBase on a Windows 8 Mobile phone. This will provide them the ability to provide updates directly into PowerOn in or near Real time to provide updates without incurring delays or requiring secondary input. In addition, they will be able to capture photographic evidence of incidents (e.g. Fire Damage, or Third Party Damage) and send to the SharePoint document management solution. In the event of Mobile phone signal not being available due to location, the field staff will revert to the existing voice status update process. **Cable Head Register and Service Position Inspection Application (CHR & SPIA)** Under the Electricity Safety, Quality and Continuity Regulations (ESQCR) legislation, all service positions and internal mains require to be routinely inspected. For SPEN this represents the inspection and classification of approximately 3.4 million premises as there is no existing inspection regime or asset register. This project will focus on providing a solution to allow field operatives to replace paper-based asset surveys with a mobile alternative. A mobile app will be developed to make filling in surveys simple for the user as well as ensuring SPEN has an automated means of collecting data, eliminating the issues arising through the accumulation of paperwork. A associated database will be developed that will serve as an asset register and hold asset data such as the asset health and give greater control over the management of cable head inspections and audits.		
Expenditure for financial year	Internal £79,619 External £252,930 **Total £332,549**	Expenditure in previous (IFI) financial years	Internal £13,324 External £276,784 **Total £290,109**
Project Cost	£360,936	Projected 2015/16 costs for SPEN	Internal £0 External £0 Total **£0**

<table>
<tr><td rowspan="1">Technological area and / or issue addressed by project</td><td colspan="10">**Incident Dispatch & Status Management (IDSM)**
This prototype will develop a mobile application that will immediately insert updates into the incident management system (GE PowerOn) that are visible to the incident controller.
Cable Head Register and Service Position Inspection Application (CHR & SPIA)
Cable Head Inspection will ensure ESQCR compliance by providing a simple survey form to capture critical cable head data and store it in a central database. The solution will firstly be rolled out to IQA (external contractor) who will use their own Windows 8 tablet devices to capture the cable head survey data. A new VPN connection has been set up, to allow the survey data to be returned from the contractor devices to ESRI and SharePoint via Geofield Exchange.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">**Incident Dispatch & Status Management (IDSM)**
Introduction of Incident Dispatch work status messaging will deliver benefits in terms of a reduction in telephone calls and updates required to be handled by the Incident Control teams in the OCC and NMC. It is anticipated that an FTE saving of 3 people would be made and these resource would be re-deployed on LV Control resulting from increased work coming from the LV Control Project.
Cable Head Register and Service Position Inspection Application (CHR & SPIA)
• Ensure ESQRC compliance for service inspections
• Hold all cable head data centrally in ESRI
• Ensure readiness for SMART meter roll out
• Enhanced productivity by replacement of paper based surveys with electronic forms.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">8 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="3">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">N/A at this stage</td></tr>
</table>

Project Progress March 2015	**Incident Dispatch & Status Management (IDSM)** • Application development complete and User Acceptance Testing (UAT) carried out • Initial concept demonstrated and tested with pilot users • Training carried out with all users • IDSM rolled out to all zones • IDSM now in operational support • Project complete • Project closedown **Cable Head Register and Service Position Inspection Application (CHR & SPIA)** • Sigma Seven Survey Form and server side components released – UAT commenced • ESRI auto update development release – UAT commenced • Sharepoint sites set up - UAT commenced • VPN created – UAT commenced • Geofiled release installed on 4 tablets and released to the business for testing/training • End – to – end testing commenced
Potential for achieving expected benefits	IDSM realising benefits and being used by the business.
Collaborative Partners	**Incident Dispatch & Status Management (IDSM)** IRW **Cable Head Register and Service Position Inspection Application (CHR & SPIA)** IQA
R&D Providers	Sigma Seven

<table>
<tr><td>Project Title</td><td colspan="10">***IFI 1308 – HTIP***</td></tr>
<tr><td>Description of project</td><td colspan="10">This project will develop a microprocessor controlled, silicon-based solid state technology for voltage regulation, suitable for voltage optimisation for small premises initially - homes and small businesses. The technology replaces transformer technology with low cost electronics, active solution and small footprint suitable for meter box installation. Initial work at the Centre for Advanced Photonics and Electronics, University of Cambridge, has validated the technology and confirmed the potential for transformer replacement at a fraction of the size and cost.
The aim of this project will be to:
1. Continue the development of a low cost, small footprint, high efficiency voltage optimiser.
2. Produce several prototype models for pre-commercialisation testing.
3. Produce a technical specification for manufacture.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £15,569
External £85,040
Total £100,610</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £7,011
External £31,156
Total £38,167</td></tr>
<tr><td>Project Cost</td><td colspan="2">£76,516</td><td colspan="4">Projected 2015/16 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total **£0**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Overvoltage is inherent in the supply of electricity as suppliers allow for transmission losses and periods of high demand, add to this distributed generation then the result is that the voltage tends towards the higher end of the permitted range. This is wasteful and results in additional energy consumption and cost and reduced equipment reliability and lifespan due to higher operating temperatures. The problem is worldwide.
The UK domestic and small business sectors alone represent over 30 million premises for which cost-effective solutions are not readily available as all existing solutions are based on transformers with corresponding size, weight, high cost and no-load losses.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="2">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">The benefit of such a project will be to deliver a voltage optimising device to the market which is affordable and will be easy to be retrofitted. The device will allow customers who may be affected by over voltage to obtain a device that will give them energy savings whilst protecting vulnerable equipment. For the DNO’s the device might provide them with a device to optimise the voltage at a local level.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>━━</td><td>━━</td><td>━━</td><td>━▶</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£340,000</td></tr>
</table>

Project Progress March 2015	Initial prototype developed and tested at the PNDC
Potential for achieving expected benefits	The potential for HTIP to deliver an affordable, compact solid state, 'Voltage Optimiser' is very high. They have demonstrated that the technology is viable and that it can be built to a compact size using an affordable bill of materials. The next iteration of the HTIP VO will be close to being market ready at which point UK customers and DNOs can assess its performance and the benefit it provides.
Collaborative Partners	DECC and Energy Innovation Centre
R&D Providers	HTIP Ltd

<table>
<tr><td>Project Title</td><td colspan="4">***IFI 1310 – Cable Paper Moisture Analyser***</td></tr>
<tr><td>Description of project</td><td colspan="4">Most of the HV cables in service in the UK and Worldwide use paper as an insulation medium. In many cases fault energy in these cables will create a break in external shielding of the cable. This quite often exposes the paper to moisture present in surrounding air, soil or even water in ducts. Despite being soaked in oil the paper maintains its hygroscopic properties which means it will rapidly absorb water. The level of absorption will depend on the water availability in the environment, oil availability in the cable, time, temperature etc. In such cases jointers need to make sure the remaining moisture level in the cable is minimal and to ensure that the paper will provide appropriate HV insulation. If the level of moisture in the paper is too high faults are likely to occur in the same place.

There are two main problems that jointers face. The first is to establish the level of moisture content in the cable at the point of the joint as this is undefined currently. The second is to decide how much of the cable needs to be replaced as a result of moisture ingress. This decision is very important as any further cuts in the cable significantly increase the price of repair due to the cost of excavation and customer minutes lost (CML).

A ‘hot oil bath' method is currently utilised to determine the moisture content, this method is time consuming in the field and potentially hazardous, additionally it is not objective and has no clear standard. The project will establish if an alternative method can be developed using a multi frequency capacitance approach.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £14,102
External £40,615
Total £54,717</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £5,140
External £21,207
Total £26,347</td></tr>
<tr><td>Project Cost</td><td>£231,450</td><td>Projected 2015/16 costs for SPEN</td><td colspan="2">Internal £0
External £0
Total **£0**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The project consists of two stages:
• **Stage 1** will develop the measurement methodology in a laboratory environment to establish proof of principal for the multi capacitance approach and try to establish an objective standard for paper moisture measurement
• **Stage 2** will develop a number of prototype instruments for DNO trial</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Successful completion of the project will result in:

• Improved reliability of cable jointing so reducing a fault re-occurring
• Replacement of a hazardous method
• Reduced environmental impact through reduced excavation as a result of fault re-occurrence
• Reduced CI and CMLs occurring from a more reliable repair</td></tr>
</table>

<table>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td>→</td><td>→</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£505,000</td></tr>
<tr><td>Project Progress
March 2015</td><td colspan="10">The project had successfully completed the first stage and is showing good promise. A technology and system has been identified that can operate with the necessary levels of sensitivity whilst also being small and portable for ease of use by cable jointers.
The project did not continue to stage 2 due to a disagreement with the commercial terms which had been signed up to in the Direct Investment Agreement (DIA). EA Technology have therefore decided to cease the project at the end of stage.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">EATL has progressed well with the project and many of the concerns present at earlier stages have been addressed. Outputs from experimentation have been promising with a clear correlation between moisture content and impedance through multi-frequency scanning. Further stages will build on this promising start and is showing a real potential to deliver the expected benefits identified at the start of the project.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">ENW, NPG, UKPN, EA Technology Limited, Energy Innovation Centre</td></tr>
<tr><td>R&D Providers</td><td colspan="10">EA Technology Limited</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1311 – Green Running</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The pressure on LV resources and capability will grow continually in the years ahead. The ability to understand the nature of loads on the network as well as smaller scale Distributed Generation (DG) will become increasingly important in informing network reinforcement decisions, outage planning, and reconfiguration.
This project seeks to prove whether a technology developed for the building energy management profession can work successfully in identifying network loads and energy sources on the distribution network</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £14,102
External £86,315
Total £100,417</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £4,906
External £36,615
Total £41,521</td></tr>
<tr><td>Project Cost</td><td colspan="2">£163,000</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Load and DG detection, being able to identify types of load on a network from their harmonic signatures.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">Load and DG detection, being able to identify types of load on a network from their signatures.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">→</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£1.8m</td></tr>
<tr><td>Project Progress
March 2015</td><td colspan="10">Stage 1 – Upgrade prototype system using real DNO data, completed
Stage 2 – DNO discussion and direction meetings, completed
Stage 3 – Develop a prototype (i.e. custom software, FPGA solution or using existing DNO hardware) completed
Stage 4 – 1st Stage prototype – trial development of a number of prototypes for each DNO, completed
Stage 5 – 2nd Stage prototype DNO trials, completed
Project is now complete.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The system has been used in building management settings already and is seeking to develop their prototype for DNO so there is a good level of confidence the system will be successful.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">SSEPD, Energy Innovation Centre</td></tr>
</table>

R&D Providers	Green Running

Project Title	***IFI 1312 – V2G***
Description of project	With consumer and governmental pressure to reduce transport CO_2 emissions, automotive manufacturers are spending vast sums of money on developing alternatively-fuelled vehicles. Electric Vehicles (EVs) and associated hybrids have seen a number of manufacturers' products launched or about to be launched. One of the additional benefits of having increasingly large numbers of EVs is the potential to assist the grid in load and frequency management. The aim of this project is to investigate the potential of battery-powered vehicles to use their excess rechargeable battery capacity to provide power to the grid in response to peak load demands.

Expenditure for financial year	Internal External **Total**	£15,569 £210,045 **£225,614**	Expenditure in previous (IFI) financial years	Internal External **Total**	£8,180 £2,108 **£10,288**
Project Cost	£813,000		Projected 2015/16 costs for SPEN	Internal External Total	£0 £0 **£0**

Technological area and / or issue addressed by project	EV integration with the grid.

Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	No	Yes	No	No

Expected Benefits of Project	If successful, DNOs will be able to control EVs in a manner that helps to mitigate the effects of EV charging on peak demand and hence ensure EVs can be connected without the need for network reinforcement.

Expected Timescale to adoption	3 Years	Duration of benefit once achieved	20 Years

Probability of Success	35%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
						⇨				

Project NPV	(Present Benefits x Probability of Success) – Present Costs	£7,709

Project Progress March 2015	Project progress with respect to identified learning outcomes was as follows: 1. Assess the suitability of a bi-directional charger/inverter for mounting within the car. • The equipment in a laboratory bench environment performed in line with expectations. • The testing at Southampton University of the actual charger/inverter operation was successful. 2. To investigate communication with vehicle equipment to direct charge/discharge regimes in a safe manner. • Communications integration was demonstrated over the internet. The equipment has been installed into the prototype vehicle and operated correctly. • Following installation in the prototype vehicle full testing of the vehicle system is due for testing around mid-May 2015. 3. To investigate the effect of a charge/discharge cycle on battery life. • Results of the 153 automated test cycles undertaken to date reveals no deterioration of the battery. 4. To ascertain the efficiency of the charge/discharge cycle applied to automotive lithium ion batteries. • No data received to date.
Potential for achieving expected benefits	High, due to the significant potential of this technology as a form of energy storage to complement the increasing development of renewable technologies. In addition, the desire to delay or avoid the construction and operation of fossil fuel powered plant increases the potential for this technology to be implemented. SPEN has decided not to progress this project to the next phase. Consequently we will be closing this project.
Collaborative Partners	SSEPD, WPD, UKPN
R&D Providers	Future Transport Systems / University of Southampton

<table>
<tr><td>Project Title</td><td colspan="4">***IFI 1315 – Ultrapole***</td></tr>
<tr><td>Description of project</td><td colspan="4">Wooden poles are used extensively throughout the utility networks to carry LV and HV overhead networks across open countryside and in rural areas. Current Health & Safety legislation demands that risk assessments are regularly undertaken to assess their health status in terms of the remaining load bearing strength of the pole, which is usually buried to a good depth in soil or tarmac. The pole may extend to several metres in height.
Currently, this assessment requires the use of ladders and climbing equipment to assess the state of the pole close to its main load bearing area (the top one third of its length) and at the root of the pole. This is both time consuming and involves some risk to the operative, either in climbing or digging around the base of the structure.
There are currently several invasive instruments on the market for detecting wood rot, based on both acoustic (hammer in nail, tap and listen) and ultrasonic (slice shadow) technologies. Ultrasound works in this environment by detecting changes in wood density which results in an acoustic path impedance variation between different wood densities. This change can be caused by rotted fibres within the pole, or other features such as drilled holes etc. This density change produces a discernible energy reflection at the boundary which can be analysed and visualised in an instrument.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £14,102
External £11,684
Total **£25,786**</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £4,906
External £26,541
Total **£31,447**</td></tr>
<tr><td>Project Cost</td><td>£75,000</td><td colspan="2">Projected 2015/16 costs for SPEN</td><td>Internal £25,000
External £10,000
Total **£35,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Testing of wood poles by existing methods such as hammer test can be subjective in nature and result in the inappropriate replacement of poles with residual life. As the result of testing is localised to the point of test, abnormalities elsewhere along the length of the pole can go undetected which can result in the failure of the overhead line under adverse weather conditions leading to CI and CML penalties for the company.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>No</td><td>Yes</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• The ability to scan very rapidly long pole lengths for the presence of ‘acoustic anomalies’ such as the presence of rot in the pole.
• Increased knowledge and understanding of condition of wood poles, allowing targeted maintenance and replacement based on condition of asset.
• Reduced costs of surveying poles (no climbing of pole). More accurate rot assessment (scanning whole pole) therefore less waste from misdiagnosis.
• Reduced failure of wood poles leading to reduced CIs/CMLs from overhead lines and improved network performance.
• If this non-intrusive testing methodology is proven it will reduce risk exposure for linesmen, operational staff and third parties.</td></tr>
</table>

<table>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">25 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">35%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td colspan="4">→</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£802,753</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">The project started in January 2014. Initial kick off meeting completed. Supply of test material established and test equipment ordered.
Stage 1 Exploration, Science Review/Technology Assessment was completed in September 2014. There were delays with the Legal agreement when Electricity North West and Northern PowerGrid no longer wished to be part of the project and subsequent delays in moving to Stage 2.
Stage 2 of this project will be continued under NIA funding.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Project started in January 2014, potential for achieving expected benefits as per above probability of success.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">SSEPD and UK Power Networks</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Acuity Products Ltd</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4">***IFI 1316 – Upgrading Legacy GM NCP to Plexman 2***</td></tr>
<tr><td>Description of project</td><td colspan="4">Smart Grid Networks (SGN) and SPEN have together developed a 2nd-generation NCP control and communication system that provides an increased awareness of network behaviour (Plexman system).

One of the key components in this system is the RFO150 radio with an enhanced protocol that is compatible with all legacy NCP equipment other than the RADIUS NCP RTU (NMS100).

The majority of 1st-generation NCPs on the network are fitted with NMS100 RTUs and therefore cannot take advantage of the new system, nor can they be employed to support the communication system of any surrounding 2nd generation equipment.

SGN have been approached to develop an inexpensive solution to interface the RFO150 radio into the NMS100 RTU to enable the legacy system to benefit from the significant enhancements offered by the new system at a very low capital cost. The new Plexman system is likely to be the model for the 2nd-generation NCP to be deployed across the network via the RIIO-ED1 NCP asset expansion program. To facilitate deployment, it is important that the system is backward compatible with the legacy NCP asset base.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £23,808
External £11,684
Total £35,492</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £8,552
External £44,707
Total £53,259</td></tr>
<tr><td>Project Cost</td><td>£33,166</td><td colspan="2">Projected 2015/16 costs for SPEN</td><td>Internal £0
External £0
Total **£0**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The aim of the project is to develop an inexpensive solution to interface the RFO150 radio into the NMS100 RTU to enable the legacy system to benefit from the significant enhancements offered by the new system at a very low capital cost.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The system will provide the following benefits:
• Enable the 2nd-generation system to be fully compatible with the entire legacy NCP asset base.
• An inexpensive solution to provide all 2nd-generation NCP system functionality to the legacy system including:
• Significantly enhanced radio communications
• Analogue data recovery
• Enhanced digital I/O
• Remote radio and IED programming
• Increased robustness of any future Plexman radio system</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 Year</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
</table>

<table>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">90%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="3">→</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£2,796,290</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">The workshop trial was successful and the device will be rolled out onto the system in RIIO-ED1 investment programmes.
This project is now closed and the technology has now been adopted as Business As Usual</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The potential for achieving expected benefits remains very high</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">None</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Smart Grid Networks Limited</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="3"><i>IFI 1317 – Cable Core Temperature Monitoring</i></td></tr>
<tr><td>Description of project</td><td colspan="3">DNOs need to know the current flowing in a cable in order to assess how close it is to operation at its limit – its “ampacity”. The commonly used existing method utilises a current transformer (CT) applied around each signal phase. However this approach has some drawbacks, particularly when used with three-phase underground cables. It requires that the supply to the customer is interrupted and that the phases are physically separated at the measurement point, so that the CT can be placed around each phase. This potentially restricts where measurements can be made. Furthermore the CT technology is relatively costly for large scale deployment, particularly for monitoring at many points in a more distributed generation network or a “smart grid”.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £14,102
External £11,684
Total £25,786</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £4,906
External £52,741
Total £57,647</td></tr>
<tr><td>Project Cost</td><td>£206,000</td><td>Projected 2015/16 costs for SPEN</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">There is a need for a low cost substitute for a CT that can be easily retro-fitted without supply interruption. There is a strong relationship between cable current and its operating temperature, so it is proposed to provide a simple, low cost retro-fit temperature sensor, for instance applied in the same way as a cable tie, that can be used by a DNO to easily deduce cable current to a reasonable accuracy level (e.g. +/-5 to +/-10%).</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="3"><table><tr><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr><tr><td>No</td><td>No</td><td>Yes</td><td>No</td></tr></table></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">The expected benefit of this project is the validation of a concept for an easily retro-fitted sensor for measuring and/or deducing the temperature of the core of a 3-phase electricity network power cable.
Using cable temperature to infer the current in a cable offers the possibility to use this approach to provide a lower cost, more easily installed alternative to current transformers. It also provides a retro-fit alternative to fibre-optic cable temperature sensing.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td>Duration of benefit once achieved</td><td>25 Years</td></tr>
<tr><td>Probability of Success</td><td>35%</td><td colspan="2"><table><tr><td colspan="9">TRL Development (Start – Current)</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td></td><td></td><td colspan="3">⇨</td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td>£194,965</td></tr>
</table>

Project Progress March 2015	The project started in December 2013. Stage 1 – (Analytical and experimental proof of principle work) has been completed. The direct temperature measurement technique has been adopted as the favoured method. Stage 2 (Proof of Concept Laboratory Prototype) was successfully completed in July 14. Stage 3 (Proof of Concept & Live Trial) began in Sept 14 with a Site trial in March 15. Project is now complete.
Potential for achieving expected benefits	The project has shown that cable core temperature can be predicted with reasonable accuracy from easily accessed measurements of the cable exterior, and there may be techniques to improve the impacts of thermal lag so that a temperature sensing method can provide a range of useful measurements to assist with network management.
Collaborative Partners	Scottish Hydro Electric Power Distribution, Electricity North West, Northern Powergrid, UK Power Networks and Energy Innovation Centre
R&D Providers	The Technology Partnership plc

<table>
<tr><td>Project Title</td><td colspan="5">***IFI 1318 – VTOL***</td></tr>
<tr><td>Description of project</td><td colspan="5">The use of helicopters to inspect overhead line assets is an expensive exercise and significant cost savings could be realised by the deployment of unmanned aerial systems. A number of the UK DNOs are already successfully using unmanned aerial systems (UAS) for inspection tasks. However these systems are not suited to Beyond Visual Line Of Sight [BVLOS] operations.

To achieve this demanding goal of BVLOS, requires an expert approach to addressing the following three critical issues for electricity overhead-lines:

• Clearly defining BVLOS operations for which Civil Aviation Authority Approval (CAA) can be sought and secured.

• A financial analysis that can provide a clear indication as to where categorised BVLOS operations will provide the best Return On Investment [ROI] for the DNOs and be viable for current and/or as yet undefined future operations.

• Specifying a Remotely Piloted Aerial System (RPAS) that can provide a long endurance capability and fly BVLOS as well as meeting CAA regulatory requirements.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£14,102
£68,851
£82,953</td><td>Expenditure in previous (IFI) financial years</td><td>Internal
External
Total</td><td>£9,583
£11,541
£21,124</td></tr>
<tr><td>Project Cost</td><td colspan="2">£416,000</td><td>Projected 2015/16 costs for SPEN</td><td>Internal
External
Total</td><td>£15,000
£10,000
£25,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The goal of this project is to be able to define an industry standard electricity specification for Remotely Piloted Aircraft Systems operating Beyond Visual Line Of Sight for electricity distribution network aerial inspection operations, confirmed by the UK Civil Aviation Authority. By the end of the project, the industry will be in a position to decide whether it wants to invest in such systems and if affirmative, fund acquisitions or development as necessary and with the goal of starting to introduce such systems into service for BVLOS operations in a stepwise manner, in close co-operation with and as agreed by the CAA.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td colspan="2">No</td><td>No</td><td>No</td><td>Yes</td></tr>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="10">A UAS offers significant cost savings when compared to helicopter deployment. Being able to operate beyond the visual line of sight will result in significantly more circuit kms being surveyed during inspection periods.
Other benefits that unmanned aerial systems will bring include:
• Minimising environmental impact with greatly reduced fuel consumption.
• Minimised disruption to land owners, livestock and local residents during inspection.
• Reduced risk to life and limb by using un-manned apparatus to retrieve data.
• Reduced Civil Aviation restrictions in the vicinity of airports, chemical plants, MOD land etc.
• Limit the effect of stand down time due to bad weather or strong winds.
• Reduced numbers of "missed towers" by not having to avoid motorways, railways or housing estates etc.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">30 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">10%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>➡</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£624,442</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">Stages 1 was successfully completed in Sept 14, Stage 2 (Establish base operational simulation environments) started in Oct 14 and completed Jan 15. The Project is currently in Phase 3 (Develop the ConOps incorporating flight manoeuvres and flight paths within the simulation environment for evaluation and test)
This project will be continued under NIA funding.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The approach of this project is designed to address the CAA requirements at every stage in order increase the potential for achieving expected benefits.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">SHEPD, UKPN, Northern Powergrid Limited, Northern Gas Networks, Scotland Gas Networks plc., Southern Gas Networks plc.</td></tr>
<tr><td>R&D Providers</td><td colspan="10">VTOL</td></tr>
</table>

Project Title	***IFI 1401 – VONAQ***			
Description of project	As per IFI 1315 Ultrapole: Wooden poles are used extensively throughout the utility networks to carry LV and HV overhead networks across open countryside and in rural areas. Current Health & Safety legislation demands that risk assessments are regularly undertaken to assess their health status in terms of the remaining load bearing strength of the pole, which is usually buried to a good depth in soil or tarmac. The pole may extend to several metres in height. Currently, this assessment requires the use of ladders and climbing equipment to assess the state of the pole close to its main load bearing area (the top one third of its length) and at the root of the pole. This is both time consuming and involves some risk to the operative, either in climbing or digging around the base of the structure. There are currently several invasive instruments on the market for detecting wood rot, based on both acoustic (hammer in nail, tap and listen) and ultrasonic (slice shadow) technologies. This project differs to Ultrapole by utilising a different type of sensing technology that has already been deployed in an off the shelf solution for the European Telecommunication Industry. The VONAQ product utilises an acoustic sensor head that provides a quantifiable score for telecommunication pole health. This project will look to identify if the VONAQ product can be calibrated to provide the same function for electrical distribution poles. This will require significant field trials given the range of poles and their associated furniture on UK networks.			
Expenditure for financial year	Internal £14,102 External £11,684 **Total £25,786**	Expenditure in previous (IFI) financial years	Internal £0 External £0 **Total £0**	
Project Cost	£266,525	Projected 2015/16 costs for SPEN	Internal £15,000 External £70,000 Total **£85,000**	
Technological area and / or issue addressed by project	As per IFI 1315 Ultrapole: Testing of wood poles by existing methods such as hammer test can be subjective in nature and result in the inappropriate replacement of poles with residual life. As the result of testing is localised to the point of test, abnormalities elsewhere along the length of the pole can go undetected which can result in the failure of the overhead line under adverse weather conditions leading to CI and CML penalties for the company.			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	No	No	Yes	Yes

<table>
<tr><td>Expected Benefits of Project</td><td colspan="10">

- The ability to scan wooden distribution poles for the presence of ‘acoustic anomalies’ such as the presence of rot in the pole.
- Increased knowledge and understanding of condition of wood poles, allowing targeted maintenance and replacement based on condition of asset.
- Reduced costs of surveying poles (no climbing of pole). More accurate rot assessment (scanning whole pole) therefore less waste from misdiagnosis.
- Reduced failure of wood poles leading to reduced CIs/CMLs from overhead lines and improved network performance.

If this non-intrusive testing methodology is proven it will reduce risk exposure for linesmen, operational staff and third parties.
</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">>8 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="4">⟶</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">See cost benefits in NIA_NPG 0001 Registration Document</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">As of March 2015 this project had been fully specified by the Collaborative Partners and a full project plan developed, however given the delays in the signing of a NIA compliant agreement the official start of this project has been held back until ED1.
See NIA_NPG 0001</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">As this project looks to convert an existing market product and convert it to meet the requirements of DNOs, there is a high probability that this project will deliver the expected benefits. However, it is still unclear if the tension and weight placed on distribution wood poles will render this solution unfeasible.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">SSEPD and NPG</td></tr>
<tr><td>R&D Providers</td><td colspan="10">VONAQ</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5"><i>IFI 1404 – Urban NCP Enhancement Project</i></td></tr>
<tr><td>Description of project</td><td colspan="5">In DPCR5 SPEN rolled out multiple Network Controllable Point (NCP) schemes across the rural 11kV networks. These NCP schemes utilise remote fault sensor and tele-switching technology to quickly identify and switch out the zone of the circuit that contains the fault and restores supplies to all the other zones. The schemes have been proven to be effective in improving the security of supply for our customers, as such; In ED1 SPEN is giving consideration to rolling out further NCP schemes but this time focussing in on our meshed 11kV urban networks that do not have unit protection already.
This project focusses on the development and trial of two emerging technologies that could potentially enhance the performance of an Urban NCP scheme.
1. Directional Fault Passage Indicators (dFPIs)
Identifying the faulty ‘zone’ on an 11kV meshed network is significantly more challenging than on a radial circuit. For traditional Fault Passage Indicators (FPIs) to work it would require SPEN to un-mesh the network, doing so requires additional reinforcement and loses the operational benefits of a meshed network.
dFPIs have the potential to locate faults without the requirement to un-mesh the network, as such one part of this project looks at the development and trial of a low cost dFPI that could facilitate the rollout of Urban NCP schemes.
2. Automated Link Box Sectionalisers (ALBS)
NCP schemes segregate 11kV circuits into ‘zones’ typically breaking a circuit (Primary – Primary) into four zones. These zones can be automatically switched in/out to remove 11kV network faults and restore customer supplies. To do so effectively it is important that there is not a Low Voltage (LV) path for the fault current to flow from a healthy zone to the one with a fault in it. Where the meshed LV network means there are existing links between zones, prior to the NCP scheme becoming operational SPEN has to undertake significant reinforcement work on the LV network which may preclude the scheme.
The development of LV automation products in DPCR5 now means that it may be possibly to install LV ALBS on the network that automatically un-mesh and re-mesh LV networks during faults and restoration. If this proves to be the case then this technology will open the rollout of Urban NCP schemes to circuits previously precluded. This project looks to develop and trial several ALBS devices to see if they can perform this function reliably without the need for communications.</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£14,102</td><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td>£0</td></tr>
<tr><td>External</td><td>£234,057</td><td>External</td><td>£0</td></tr>
<tr><td>Total</td><td>£248,159</td><td>Total</td><td>£0</td></tr>
<tr><td rowspan="3">Project Cost</td><td colspan="2" rowspan="3">£248,159</td><td rowspan="3">Projected 2015/16 costs for SPEN</td><td>Internal</td><td>£50,000</td></tr>
<tr><td>External</td><td>£250,000</td></tr>
<tr><td>Total</td><td>£300,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">This project looks at the development and application of emerging sensor and automation technologies in a novel arrangement to speed up the location of faults and restoration of customers.</td></tr>
</table>

Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	No	No	Yes

Expected Benefits of Project	• Reliable low cost dFPIs that can be applied across UK 11kV networks to speed up the location and restoration of faults. • Proven ALBS that can be utilised by UK DNOs to reliably auto-sectionalise LV networks without the need for communications.

Expected Timescale to adoption	2 Years	Duration of benefit once achieved	7 Years

Probability of Success	75%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
							→	→		

Project NPV	(Present Benefits x Probability of Success) – Present Costs	See cost benefits in NIA_SPEN 0007 Registration Document

Project Progress March 2015	The dFPIs developed by Nortech have been tested in several operational scenarios at the PNDC and their performance has given SPEN confidence enough to press ahead with the trial of 50 units out on the network. These units are now being manufactured and will be ready for deployment in Q3 of 2015. SPEN has worked with three manufacturers of LV automation products (EPS, Kelvatek and EA Technology) to outline the functionality required from the ALBS devices. In doing so SPEN has gained confidence that all three manufacturers have the capability of tailoring the functionality of their products to meet the requirements of the NCP schemes. As such all three manufacturers are now manufacturing devices for SPEN to trial in Q3 of 2015. This project will be continued under NIA funding from Q3 2015 to ensure that the dFPIs and ALBS are trialled appropriately.
Potential for achieving expected benefits	The dFPIs developed have been tested at the PNDC, so SPEN has already gained confidence in their potential to perform as required and therefore deliver benefits. Network trials are still required though to fully understand and assess their performance. Working with the manufacturers of the LV automation products has given SPEN confidence in the technology, however until network trials take place we will not be able to identify if ALBS technology is ready for BaU deployment.
Collaborative Partners	Electricity North West (Supplying EPS ALBS devices to SPEN)
R&D Providers	Kelvatek, EA Technology, EPS and the PNDC.

Project Title	***IFI 1405 – Augmented Reality: Proof of Concept***
Description of project	The proof of concept trial was conducted to investigate the use of mobile augmented reality within SPEN for the display of utility assets. It was designed to determine whether new technology and existing asset data could be integrated to provide benefits for both internal and external stakeholders. To guide the feasibility testing, two primary use cases were identified; • In-situ display of planned above ground to demonstrate to land owners / customers how an area of interest would look once the assets were built • With currently available technology and existing internal data would an augmented reality application be a viable addition or alternative to mobile GIS for the location and identification of buried assets by field-based staff

Expenditure for financial year	Internal £14,102 External £34,939 **Total £49,041**	Expenditure in previous (IFI) financial years	Internal £0 External £0 **Total £0**
Project Cost	£28,280	Projected 2015/16 costs for SPEN	Internal £0 External £0 Total **£0**

Technological area and / or issue addressed by project	Augmented Reality (AR) is a common term for the process of taking context relevant digital information and overlaying it on live images of the real-world, predominantly captured through a video camera. Two main types of 'mobile' augmented reality exist and are possible using modern 'smart' devices such as phones, tablets and wearable devices; Spatial and Computer Vision (CV). The proof of concept project utilised the Awila Cloud API which was developed primarily for delivering Spatial AR visualisations (a 'scene').

Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	No	Yes	No	No

Expected Benefits of Project	The project expected to aid our learning and understanding into how our GIS data can be viewed for the benefit of our customers and employees for a range of applications including but not limited to, land owner negotiations, cable fault finding, asset tracking and the visualisation of proposed developments.

Expected Timescale to adoption	Not applicable at this stage	Duration of benefit once achieved	N/A

Probability of Success	5%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
			➡							

Project NPV	(Present Benefits x Probability of Success) – Present Costs	N/A

Project Progress March 2015	The project has successfully identified and analysed the technical challenges involved in creating an augmented reality scene from GIS data. It facilitated the development of solutions for these challenges, whilst breaking new ground in both disciplines in the process. The in-situ display of existing and planned assets was been successfully demonstrated and was shown that available technology could be a viable addition or alternative solution to for current mobile GIS solutions. However the overriding conclusion to this project is without significant investment in R&D there are elements of the solution that cannot be fully automated, even if the required hardware is currently available on the market. From this perspective we have identified cost-effective semi-automated processes which would suffice in the vast majority of cases, and satisfied the use cases defined for the pilot. Accuracy in both device and object positioning, as well as scaling, are of paramount importance in creating and trusting the scene being rendered on screen. The pilot solution was unable to accurately represent existing data, therefore further experimentation and validation under controlled conditions would be required before the solution could be adopted. This project is now closed.
Potential for achieving expected benefits	Further experimentation and validation under controlled conditions would be required before the potential for achieving expected benefits could be determined.
Collaborative Partners	ESRI UK
R&D Providers	Augmented Technologies

<table>
<tr><td>Project Title</td><td colspan="9"><i>IFI 1411 – eGenius</i></td></tr>
<tr><td>Description of project</td><td colspan="9">The development of a prototype Non-Intrusive Load Measurement (NILM) unit for domestic properties that autonomously detects the consumption profile of common appliances and loads in the property from a single voltage and current measurement close to the meter cabinet. In doing so the NILM can communicate to a mobile device App to show the residents in real time and historically how their appliances have contributed to their total consumption and electricity bill. The NILM can also be utilised to identify and make recommendation for the replacement of appliances that have a higher than expected consumption.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £14,102
External £61,584
Total £75,686</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td colspan="3">£49,900</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="3">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">It is thought that the eGenius NILM can be utilised by DNOs to educate customers, particularly the fuel poor, to understand how each appliance contributes to their electricity bill. In doing so the NILM empowers the customers with the knowledge to make changes that will hopefully lead to a reduction in their consumption.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">Proof that NILM technology can deliver the type of analysis required to educate customers of their consumption patterns and the contribution each appliance makes to their total electricity bill. If the NILM concept can be proven in this project it opens the door to customer trials of the technology to ascertain what societal benefits it can release.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">8 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="8">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td colspan="2">➡</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">Not applicable at this stage</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="9">As of March 2015 the IFI project is closed. The project partners have successfully delivered the first prototype NILMs and the corresponding iTunes App to assess their performance in a domestic environment.
There is presently no further planned expenditure on this project, however over the course of 2015 SPEN will assess the performance of the NILM prototypes by trialling them in the properties of SPEN employees. SPEN will provide feedback on these trials to the project partner who is planning to continue the development the NILM post IFI.
A decision will be made by SPEN in Q4 2015 on whether to pursue a NIA funded customer trial planned for Q4.</td></tr>
</table>

Potential for achieving expected benefits	At the close of the IFI project the potential for NILMs to deliver their expected benefits is still unknown; however, through SPENs ongoing trials it is expected that this will be come much clearer prior to the end of 2015. The eGenius NILM certainly has the ability to identify the consumption profiles of appliances with a simple load pattern and high power draw, i.e. kettle, hair dryer, coffee machine, bottle steriliser. But it is not yet certain how the NILM will perform ascertaining the performance of appliances with a lower consumption (lighting etc.) and appliances with complex load profiles such as washing machines and dishwashers.
Collaborative Partners	SSEPD and Energy Innovation Centre
R&D Providers	Green Running

Project Title	***IFI 1412 – Phase ID***
Description of project	The identification, desktop and field evaluation of LV Phase Identification devices presently available on the market in the EU and North America.

Expenditure for financial year	Internal £14,102 External £22,599 **Total £36,701**	Expenditure in previous (IFI) financial years	Internal £0 External £0 **Total £0**
Project Cost	£36,701	Projected 2015/16 costs for SPEN	Internal £0 External £0 Total **£0**

Technological area and / or issue addressed by project	The identification of the phase that each individual customer is connected to on the LV network can provide benefits for the customer and DNO in terms of enabling the connection of low carbon technologies (LCT) or the acceleration of fault location and restoration. Present Phase Identification equipment utilised by DNOs requires authorised staff to install the equipment and only allows a small section of the network to be identified at a time before the equipment needs to be relocated. This project is aimed at finding a Phase ID device that: • Does not require authorised staff to install it • Covers a large section of the network from one installation point • Generates instant results at each property

Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	No	No	Yes

Expected Benefits of Project	The identification of a Phase ID technology that can be utilised by UK DNOs and framework partners. With the device capable of being safely installed and operated by non-authorised staff, generating instant results at the premise. Such a device can be utilised by DNOs and contractors to map the network connectivity on the network as an incremental addition to routine inspections meter / cut out inspections.

Expected Timescale to adoption	1 Years	Duration of benefit once achieved	8 Years

Probability of Success	75%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
							→	→		

Project NPV	(Present Benefits x Probability of Success) – Present Costs	£50,000

Project Progress March 2015	This project is now closed. Threepwood Consulting have now completed a thorough desktop and field evaluation of several Phase ID devices and they will be delivering their findings in Q3 2015.

Potential for achieving expected benefits	High/Medium. Prior to commencing this project SPEN was aware of there being several Phase ID devices available in North America and Europe, but we were unsure how suitable they would be for our specific requirements for an ideal solution.
Collaborative Partners	None
R&D Providers	Threepwood Consulting

<table>
<tr><td>Project Title</td><td colspan="9"><i>IFI 1413 – Portable RAFL</i></td></tr>
<tr><td>Description of project</td><td colspan="9">This proof of concept project aims to investigate the feasibility of a portable Radiometric Arc Fault Locator (RAFL) to identify the location and to facilitate the quicker resolution of arc fault incidents.
This scope of this project will aim to modify an existing partial discharge (PD) monitor, which will then be tested in the field on a poorly performing circuit.
The key stages of the project are as follows:
- Hardware Modification
- Software Modification
- Laboratory simulation and factory testing and by on-site installation</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £16,182
External £92,420
Total £108,602</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td colspan="3">£77,864</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="3">Internal £25,000
External £25,000
Total £50,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">Transient faults on the overhead line (OHL) distribution network can be costly to repair, impact on customer service and quality of supply and contribute to an increase in Customer Interruptions (CIs) and Customer Minutes Lost (CML) penalties. DNO capabilities generally centre on sufficient detection and protection capability but no fault location capability. Certain transient, intermittent faults are not apparently obvious to field staff. The circuit continually trips, field staff manually reset and re-energise, but this does not address the root cause.
These faults are frustrating, time consuming and costly to locate. Repeated manual resetting is an inefficient use of resource. Accumulated CIs and CML and the associated penalties they incur are real consequences of an inability to establish the root cause of relatively minor, but frequent incidents.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">Successful completion of this project will provide a system that will provide the following benefits:
- The ability to accurately detect and locate arc faults
- The ability to monitor and trend arc fault occurrence over time
- Faster resolution to fault situations
- A reduction in CI / CML penalties</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="3">16 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td>→</td><td>→</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£0.23M to £0.93M for 8 years</td></tr>
</table>

Project Progress March 2015	Project kick off meeting held in March. Initial design requirements and onsite testing have been partially completed. The project has been transferred over to NIA funding.
Potential for achieving expected benefits	This project is expected to provide all Network Licensees with an understanding whether this technology can successfully provide accurate fault location of OHL networks. SPEN have undertaken Cost Benefit Analysis (CBA) utilising the Ofgem ED1 CBA tool and has identified a number of feasible scenarios and benefits achieved from the use of RAFL as a method to locate OHL arc faults. The CBA identified an 8 year NPV ranging from £0.23M to £0.93M.
Collaborative Partners	Energy innovation Centre
R&D Providers	Elimpus

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1414 – PD-VMX</i></td></tr>
<tr><td>Description of project</td><td colspan="10">Continuously monitoring partial discharge (PD) will provide a health check on assets and allow for targeted investment on problem units before potential failure occurs. The monitored switchgear will reduce the potential risk of serious injury or fatality resulting from a disruptive failure. The PD system will be able to detect PD from within the cabinet, particularly from bushings.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £14,102
External £43,484
Total £57,586</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td colspan="2">£63,600</td><td colspan="3">Projected 2015/16 costs for SPEN</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Currently handheld PD monitors can be used to manually check PD activity before switching on higher risk assets however it does not give a reliable indication or consistent measurement and is very much down to the users understanding and interpretation. Fixed PD monitoring solutions are available on the market but they are expensive and do not provide the detailed understanding of PD on particular circuit breaker panels. This project aims to develop a low cost PD monitoring solution that will have the ability to monitor individual panels</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">Successful completion of this project will deliver a prototype of a scalable, online product capable of detecting, locating and monitoring partial discharge in VMX cabinets. This system could then be deployed as both a safety tool and condition assessment device helping provide a safer working environment as well as real time measurement of asset performance.

Continuous monitoring of PD activity, trending and analysis will give the network a better understanding of the phenomena and thus a more informed view on asset management.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 Year</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">16 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>➡</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£0.15m for 16 years</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">The IFI project has supported the development of a prototype unit which will be installed at a substation location. The prototype has been developed for VMX switchgear and further work is required to fully evaluate the effectiveness or otherwise of the product, and whether it could be a viable option for a large variety of switchgear.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The prototype unit has been developed and test extensively in laboratory conditions, however until it has been evaluated on site over a representative period of time it is too early to quantify the potential benefits it may achieve.</td></tr>
</table>

Collaborative Partners	UKPN and Energy Innovation Centre (EIC)
R&D Providers	Elimpus

<table>
<tr><td>Project Title</td><td colspan="11"><i>IFI 1416 – ROAMES-LiDAR</i></td></tr>
<tr><td>Description of project</td><td colspan="11">A ‘proof of concept’ trial of a LiDAR based aerial surveying solution developed in Australia that generates a virtual world 3D representation of DNO overhead (OHL) assets. In doing so enables DNOs to take accurate measurements from OHL assets to their surrounding environment, identifying ground clearances, vegetation encroachment, pole lean etc.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £14,102
External £231,131
Total £245,233</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td colspan="3">£245,233</td><td colspan="4">Projected 2015/16 costs for SPEN</td><td colspan="4">Internal £150,000
External £1,350,000
Total £1,500,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">This project looks to identify if aerial surveys of distribution OHL assets can be utilised to replace present manual inspections carried out periodically by UK DNOs.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">Should this technology proof to be successful, then it potentially has ramifications about how DNOs undertake all OHL asset inspections and work programmes. The adoption of this technology would ultimately lead to a significant reduction of the manual inspections undertaken by UK DNOs on OHL assets, whilst simultaneously generating precise network models that can be utilised within the DNOs other work programmes.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">>8 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2">⇒</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£2.63m over 8 years</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="11">As of March 2015 two LiDAR surveys and two ROAMEs virtual world representations of the trial area have been successfully generated by Fugro. These models and the functionality that they offer were assessed. To this end SPEN was impressed by the performance of the solution to proceed with a larger more comprehensive pilot project.
Through NIA_SPEN 0002 Virtual World Asset Management, SPEN will look to thoroughly assess the benefits realised through the adoption of this solution and identify how the solution can be best integrated into present DNO systems for asset management.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="11">High, however given the high cost to implement such a solution SPEN believes the NIA pilot project is essential to ensuring the benefits can be achieved if applied across the UK.</td></tr>
</table>

Collaborative Partners	Fugro Geospatial B.V.
R&D Providers	Fugro Geospatial B.V.

<table>
<tr><td>Project Title</td><td colspan="10">***IFI 1417 – Keyhole Trenchless Technologies***</td></tr>
<tr><td>Description of project</td><td colspan="10">The aim of this project is to create a new trenchless technology unit that can be inserted into the ground via an excavated joint bay, and then drill under the ground rather than open up a trench. The underground drilling will be controlled from above and once installed the service cable will be pulled back through.

This installation approach should result in reduced excavation and reinstatement costs and improved customer service due to the reduced interruption to customers/the public and improved traffic flow at the areas of excavation. The new unit will also decrease the time taken to complete the job, which in turn will reduce cost of labour, and may also allow more jobs to be undertaken.</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td colspan="2">£27,968</td><td colspan="3" rowspan="3">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal</td><td colspan="2">£0</td></tr>
<tr><td>External</td><td colspan="2">£316,587</td><td colspan="2">External</td><td colspan="2">£0</td></tr>
<tr><td>**Total**</td><td colspan="2">**£344,555**</td><td colspan="2">**Total**</td><td colspan="2">**£0**</td></tr>
<tr><td rowspan="3">Project Cost</td><td colspan="3" rowspan="3">£309,928</td><td colspan="3" rowspan="3">Projected 2015/16 costs for SPEN</td><td colspan="2">Internal</td><td colspan="2">£25,000</td></tr>
<tr><td colspan="2">External</td><td colspan="2">£25,000</td></tr>
<tr><td colspan="2">Total</td><td colspan="2">**£50,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">• Costs of excavating and the reinstating the ground when upgrading/removing a service, or inserting a new service into a property
• Improving safety to employees/contractors that excavate and reinstate
• Reducing the adverse impact to both the customer and the local environment that can result from conventional trench excavation interruption</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="2">Yes</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">This project is expected to produce cost savings and efficiency improvements for the business. The cost savings are expected to come from reduced excavation and reinstatement costs. Other benefits include improved customer service by reducing installation times and the disruptive impact of open trench excavation.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>⇨</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">Not known at this stage</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="10">The project was initiated at the end of November 2014, when the original equipment provided by Tracto-Technik UK was trialled. This trialling identified development needs such that the equipment might be deployed successfully in the electricity supply industry.

This project will be continued under NIA funding.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The project’s potential to realise expected benefits is considered high, as the Cost Benefit Analysis (CBA) undertaken shows that financial savings have the possibility of being high. Early incorporation into Business-as-Usual (BAU) is anticipated (by 2016) after trialling, evaluation and further modification, as required of the developed unit.</td></tr>
</table>

Collaborative Partners	IQA
R&D Providers	Tracto-Technik UK