Innovation Funding Incentive
Annual Report

31st March 2014

IFI Projects
April 13 – March 14

For SP Distribution plc. and SP Manweb plc.

Foreword

SP Energy Networks (SPEN) is committed to delivering a network of the future that's both efficient for our customers and enables the deployment of renewables technologies that will allow the UK to meet its environmental targets. To meet this goal we have during 2013/14 increased our commitment to Distribution innovation projects to help realise the significant customer benefits that innovation can offer, as identified in our RIIO ED1 Business Plan for 2015 – 2023.

We have listened to our customers and stakeholders so that the projects that we have started in the past year meet their requirements of delivering quickly in areas such as network resilience and facilitating more renewable connections. These alongside our existing projects form a balanced portfolio of forty seven projects that embrace a range of technologies from concept through to trial and demonstration. Once again we have achieved significant leverage of R&D spend through collaboration with other Distribution Network Operators (DNOs), academia and several Small to Medium Enterprises (SMEs). Alongside our IFI activities we have further progressed our Low Carbon Network Funded (LCNF) projects and we have established a healthy portfolio of Transmission Network Innovation Allowance (NIA) projects.

SPEN is committed to realising the benefits that innovation can bring for our customers, stakeholders and communities and we will continue to shape our innovation strategy around their needs. These benefits can only be properly realised when they are implemented within the business and for us become 'Business As Usual' which is a process we are committed to.

Without Innovation we would not be able to meet the new challenges of today nor realise the benefits that a low carbon economy will bring tomorrow. Innovation comes from many sources including SMEs, academia, large industry partners and of course our partner DNOs all of whom we will continue to work with to realise the benefits that innovation will bring. Innovative technologies have a significant role to play in helping drive down the cost of renewables, electricity networks and helping maintain and improve our high standard of operations. An example of this is the suite of initiatives SPEN is undertaking to develop technologies that address copper theft from substations which is a national health and safety issue.

Our innovation roadmap will be shaped by opportunities to add value, improve costs and to ensure that SPEN's electricity network is ready to support the UK's green economy aspirations.

Frank Mitchell
CEO, SP Energy Networks

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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

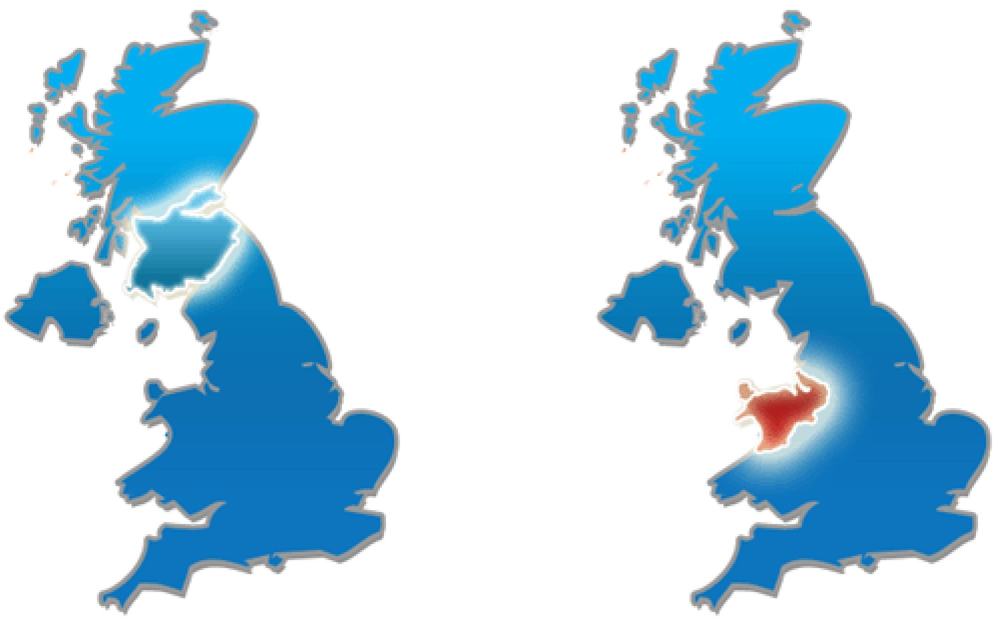
SP Energy Networks (SPEN) is the part of ScottishPower UK Ltd, which owns and operates the electricity transmission and distribution network of southern Scotland and the electricity distribution network of Merseyside and North Wales. Day-to-day operation of our network, approaching 112,000 km, is conducted by SPEN, a wholly owned subsidiary of ScottishPower Ltd. 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

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3. Overview

3.1 IFI Overview

A total of 47 IFI projects are being reported by SPEN on behalf of the two ScottishPower Network licence areas for the period 1st April 13 – 31st March 14.

The projects cover a breadth of R&D providers from academia, to consultants, to manufacturers with projects ranging in investment from £10k to £350k IFI input, and development timescales of between 6 months and 4 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 2013/14 SP invested £2m of IFI money in a project portfolio with a total value of ~£24m:

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

*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 13/14	
SP Distribution plc. Network Revenue	£363,700,000
IFI Allowance	£1,818,500
Unused IFI Carry Forward to 2013/14	£650,000
Number of Active IFI Projects	32
Summary of benefits anticipated from IFI projects 2013/14	[1]
External expenditure [2013/14] on IFI projects	£888,616
Internal expenditure [2013/14] on IFI projects	£288,238
Total expenditure [2013/14] on IFI projects	**£1,176,854**

IFI Summary - SP Manweb plc. Licence Area 13/14	
SP Manweb plc. Network Revenue	£384,300,000
IFI Allowance	£1,921,500
Unused IFI Carry Forward to 2013/14	£760,000
Number of Active IFI Projects	33
Summary of benefits anticipated from IFI projects 2013/14	[1]
External expenditure [2013/14] on IFI projects	£625,570
Internal expenditure [2013/14] on IFI projects	£215,025
Total expenditure [2013/14] on IFI projects	**£840,596**

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

Achievements for 2013/14

At the end of 2013/14 the highlights from the SPEN IFI portfolio included:

- Every IFI project undertaken by SP is taken before a panel of senior experts from across the business. Through this process we have:
    - 47 live projects
    - 13 new projects were authorised during the 2013/14
    - Of the 47 projects, 14 are now complete and either awaiting adoption or formal closure

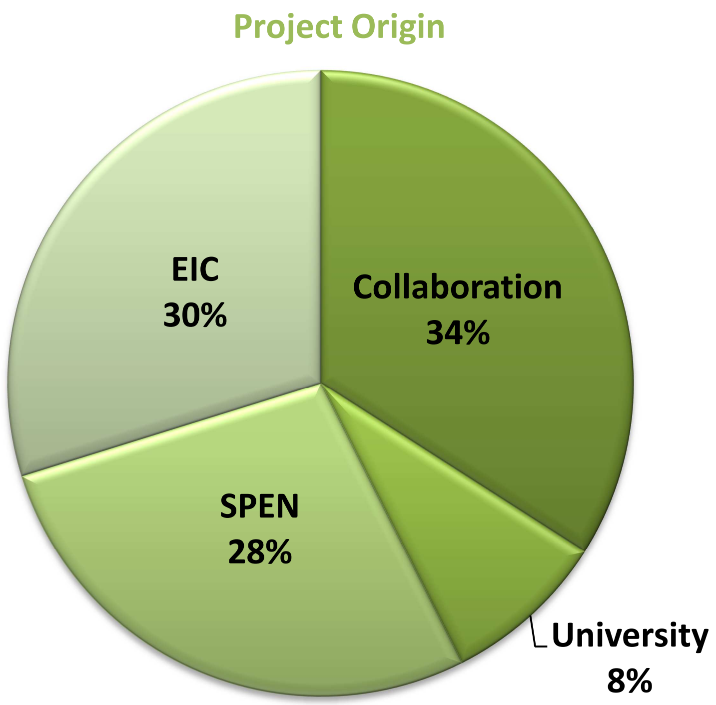
4.1 Development of Partnerships

The current programme consists 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) with the University of Strathclyde.
- Energy Innovation Centre – A non-profit trust that oversees the management of the centre in collaboration with ScottishPower, 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.

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.



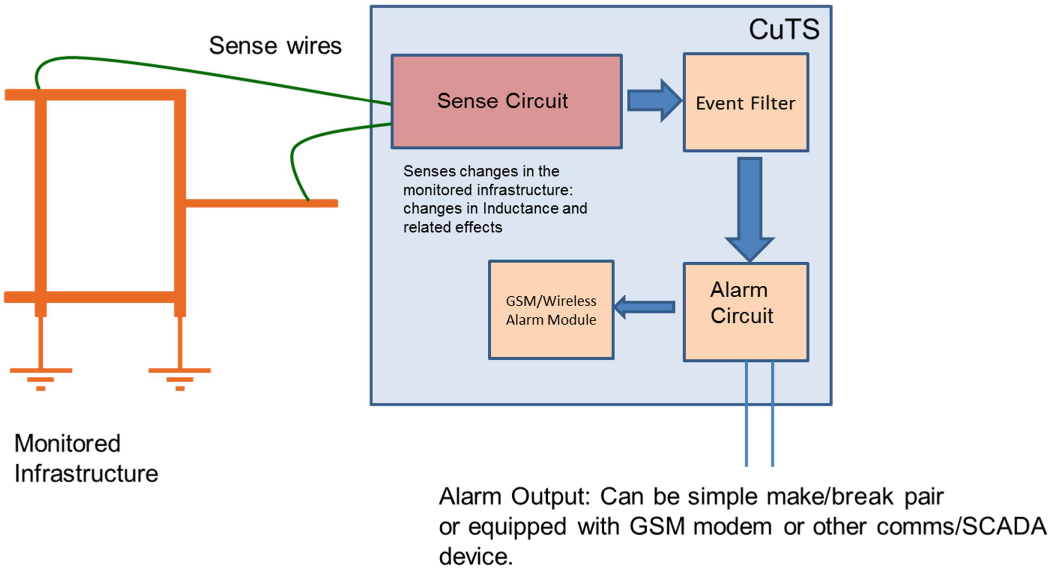
5. Highlights from 2013/14

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 Substation Earth Integrity Monitoring System

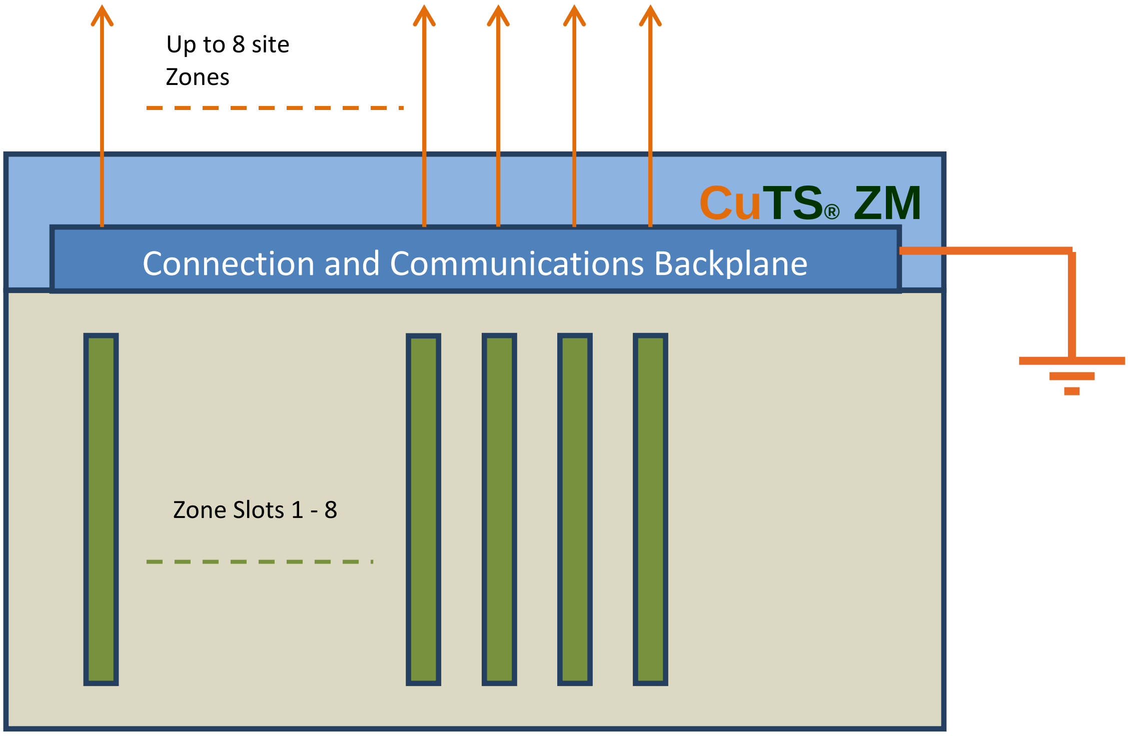
The legislative changes to increase regulation of the scrap metal industry and eliminate cash payments for scrap metal have had some success in reducing the number of metal thefts. However, theft of copper earthing systems remains a serious safety risk for engineers, customers and metal thieves as well as an operational performance risk for electrical networks. While marking technologies help identify cable theft when the thieves or receivers are caught, preventing theft in the first place remains a desirable target. On larger sites, security can be improved by technologies detecting trespass but there are many smaller sites where this approach is cost prohibitive. Such detection does not address the issue of what is happening on site upon such intrusion. The ideal solution is a low-cost method of detecting tampering with the earthing system itself.

SPEN has been working with the manufacturer Cresatech Ltd to further develop a novel method of reliably detecting the cutting and removal of sections of the earthing infrastructure. The CuTS® system monitors for changes in the inductance characteristics of the site's earthing network. Sense wires are connected to the earthing system, as shown below. Once connected the unit is simply tuned, either automatically or manually, locally or remotely via the operational software. Normal site variations and events such as faults are filtered out by the on-board filtering logic module, ensuring such occurrences do not trigger false alarms.



Major design goals included sensitivity to disconnection of small parts of the earthing system; no measurable effect on the earthing infrastructure; stability under a wide range of conditions including lightning strikes and fault conditions; a low rate of false alarms; resistance to circumvention and low cost of deployment.

While a single detection zone as illustrated above is suitable for smaller sites such as secondary substations, primary substation sites are divided into multiple detection zones, utilising exactly the same CuTS® detection board system. The multiple zone monitoring cards are housed, powered and wired from within a single enclosure on site as shown below. A single sense wire is deployed to each zone to provide the monitoring capability across the site. Cable reels are also a target for thieves, due to the ease of removal and the volume of copper involved. A CuTS® zone can also be used to monitor single or multiple cable reels on a site, raising an alarm state as soon as the cable is moved. This application of a CuTS® zone board is simple and effective.



An example of a multi-zone unit installed on a customer site. In this installation armoured cables were specified which are terminated in the marshalling box.

CuTS® incorporates a number of features designed to improve reliability and minimise the possibility of tampering. The unit is tamper-proof, with no external interfaces except for the sense wires and an isolated port for an alarm connection to SCADA systems. The system incorporates a GPRS modem and battery backup so that alarms can be sent even if power to the site is off.

The CuTS® unit has proven remarkably stable in operation. The unit has overvoltage protection on its sense inputs and does not react to stray currents or voltages in the earth system. Independent trials conducted by Cresatech in Colorado USA have shown that CuTS® is not susceptible to lightning strikes triggering false alarms or causing the unit to alter its operational characteristics.

Interestingly, despite being deployed on sites with a history of multiple thefts, no theft has yet occurred on a CuTS® site, suggesting that CuTS® has a strong deterrent effect.

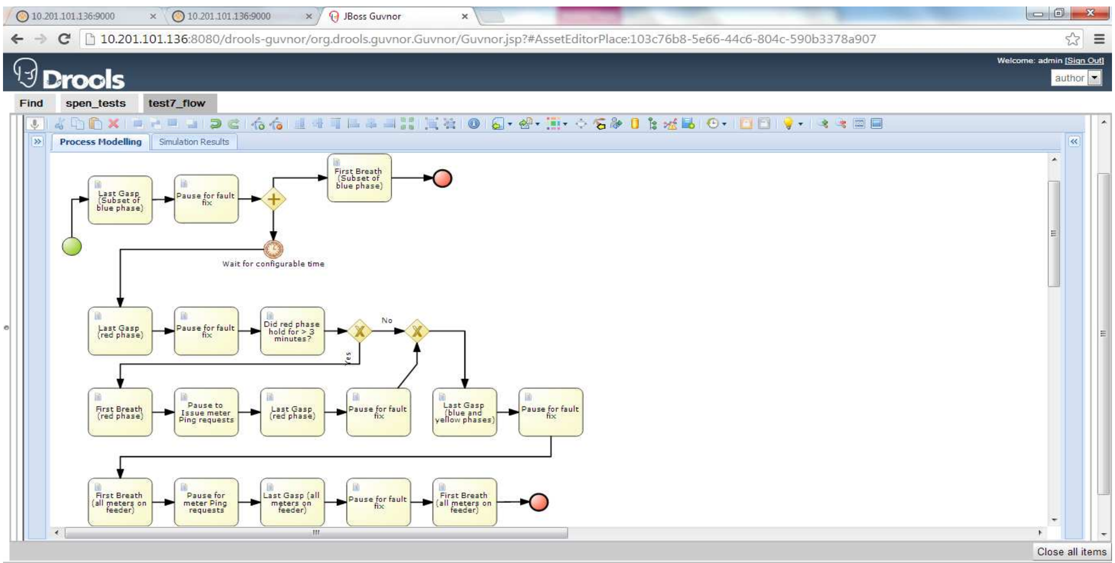
It is planned to install a demonstration single-zone CuTS® unit on the Power Networks Demonstration Centre (PNDC) at Cumbernauld and over the next 3 months pilot the CuTS® units in a range of different environments, from primary substations through to smaller secondary sites.

5.2 Smart Meter Enablement

AMT-Sybex was selected as our collaboration partner and the project was subsequently started in September 2013. By the end of March 2014 a functioning smart meter simulator and outage management (GE PowerOn Fusion) test bed system were available in our Hamilton office. The test bed has been used both internally (our operations team) and externally (by GE and AMT-Sybex) to help improve the understanding of how smart meter data will be managed in outage and customer service scenarios.

We aim to complete scenario testing and produce results for the IFI trial in the third quarter of 2014.

5.2.1 Development of Smart Meter Simulator



SPEN collaborated with AMT-Sybex to develop a smart meter simulator which allows us to flexibly create different network incident scenarios and evaluate the impact smart meter information will have in these situations. This allows SPEN, using assumptions about the final industry solution for smart meters, to refine its potential use of smart meter information within the business and assess how variations in our expected information from smart meters affect the potential benefits. We anticipate that all other DNOs, and indeed suppliers, will benefit from the inclusion of this simulation approach in their smart meter preparations.

In addition to the smart meter simulator, we have also engaged with GE to provide a PowerOn test bed solution, which is our current operational outage management system. With this system in place we are evaluating how smart meter information can be effectively used in our incident and outage handling processes.

After evaluating the results from this trial we will determine:

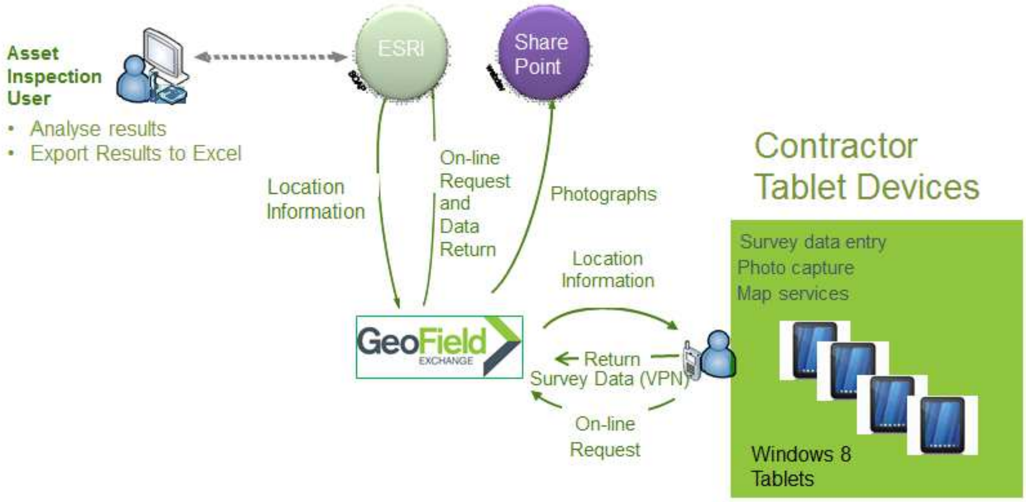
- If this approach is beneficial to assessing smart metering impacts and should be maintained
- Refine our business processes for outage management in a smart environment
- If other back office processes should be evaluated in further trials e.g. customer management platforms

5.3 Mobile Phone Application Prototypes - Cable Head Inspection

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. Presently there is no automated inspection regime or asset register in place. The Cable Head Inspection project focuses on providing a "proof of concept" solution to allow field staff to replace paper-based asset surveys with a mobile alternative. The main objective of this is to record defects and hazards associated with cable heads and rising mains to help identify their associated health index and ensure ESQCR compliance. In addition to this the survey will capture critical medically sensitive customer information, which can then be used to update ADQM. The project commenced in January this year and is progressing well, with Go Live scheduled for the end of May 2014.

The solution will initially be rolled out to IQA (external contractors) 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. A new Geofield Workflow has been developed and deployed onto the contractor devices 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. The ESRI database 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.

Once the form is submitted, a PDF embedded with any pictures taken during the inspection, will be generated and sent to a new SharePoint site. URL links to the form will be available in ESRI.



5.3.1 Project Deliverables

- Create a Geofield Workflow to assist SPEN in carrying out the inspection of all cable heads and internal mains systems within their area.
- Provide a system to collect key asset information and record defects and hazard information.
- Capture images of these assets through the phone camera / cable head application.
- Store the information gathered by mobile devices centrally and securely in a database.
- Create a simple user-friendly survey tool for use on Windows 8 tablet devices.

5.4 Smart Dust

This development project aims to produce a suitable low cost private communications system for currently available Fault Passage Indicator's (FPI's). This is to allow successful remote identification of the fault origin without the requirement for numerous SIM cards and contracts.

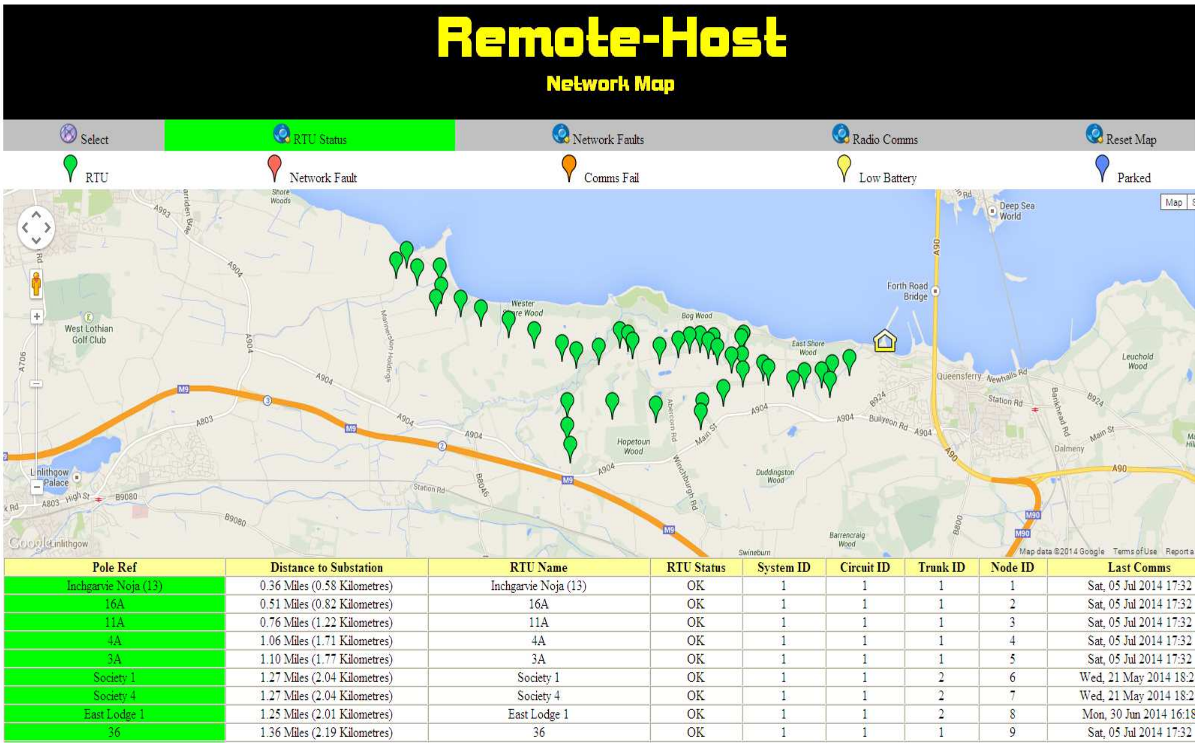
The FPI selected for this development is the Pathfinder 360 Alpha "D" ROSCO, see Figure 2, which is an inductive overhead line FPI that senses electromagnetic field imbalance during specific fault conditions.

Figure 2: Pathfinder 360 Alpha

The FPI instrument continuously monitors the residual current and voltage fields from the overhead line conductors and is triggered when it detects fault current above the current/time threshold curve passing on the overhead line conductors. It will sense both phase-phase and phase-earth faults, either permanent or transient in nature.

The Alpha360 "D" ROSCO has two transistor driven outputs which are utilised by the communications system developed by Willow Technologies Ltd. Either fault passage or a low battery level of the FPI will generate an output alarm. Activation of any FPI output on the network will be communicated back through the VHF communications network to the Gateway.

The Willow Gateway processes the relevant information and communicates it over the UHF GSM network which is presented in real time on Willows web based graphical viewing platform "Remote Host" and can be accessed by any device with access to the internet. Ultimately this information would be presented on ScottishPower's PowerOn but Willow developed this interface to prove functionality of their technology.



Pole Ref	Distance to Substation	RTU Name	RTU Status	System ID	Circuit ID	Trunk ID	Node ID	Last Comms
Inchgarvie Noja (13)	0.36 Miles (0.58 Kilometres)	Inchgarvie Noja (13)	OK	1	1	1	1	Sat, 05 Jul 2014 17:32
16A	0.51 Miles (0.82 Kilometres)	16A	OK	1	1	1	2	Sat, 05 Jul 2014 17:32
11A	0.76 Miles (1.22 Kilometres)	11A	OK	1	1	1	3	Sat, 05 Jul 2014 17:32
4A	1.06 Miles (1.71 Kilometres)	4A	OK	1	1	1	4	Sat, 05 Jul 2014 17:32
3A	1.10 Miles (1.77 Kilometres)	3A	OK	1	1	1	5	Sat, 05 Jul 2014 17:32
Society 1	1.27 Miles (2.04 Kilometres)	Society 1	OK	1	1	2	6	Wed, 21 May 2014 18:2
Society 4	1.27 Miles (2.04 Kilometres)	Society 4	OK	1	1	2	7	Wed, 21 May 2014 18:2
East Lodge 1	1.25 Miles (2.01 Kilometres)	East Lodge 1	OK	1	1	2	8	Mon, 30 Jun 2014 16:18
36	1.36 Miles (2.19 Kilometres)	36	OK	1	1	1	9	Sat, 05 Jul 2014 17:32

Figure 3: Remote Host displaying the South Queensferry installation

A poorly performing circuit on the ScottishPower's Distribution network was identified and offered to the project as a suitable candidate for testing and development of the system.

After factory testing and a demonstration from Willow in November 2013 locations were selected, see Figure 3, a suitable address structure was devised and agreed before 44 FPI's with their associated communications devices and the Gateway were configured in the workshop.

GPS coordinates were provided to Willow for all site locations as Remote Host presents the information on Google Maps.

As with any development project some issues have been identified during the commissioning process which Willow is working to resolve.

Issues include;

- When simulating network activity the gateway has intermittent success if the message is relayed through over 20 nodes.
- The Gateway struggles to process messages >20 nodes on the VHF module while attempting to activate the UHF circuitry.
- The message timeout period may have to be increased beyond the initial 40ms first proposed.
- Downloading log files to laptop, over the air interface from remote nodes, which experience high traffic, can cause some to lock up. This requires a manual power re-cycle to reset.

- Two nodes locked up after initial configuration but before commissioning. These reinitialised after a duplicate device was added, for test purposes, then removed from the network.

The main trunk of this network behaves as expected up to the 20 node point highlighted above.

Though the system is not fully operational it has successfully identified a transient fault which was of sufficient magnitude to cause protection pickup but of insufficient magnitude or duration to cause a trip.

Full testing on the Alpha 360 “D” ROSCO and selected other FPI’s to prove product accuracy in various situations is currently being carried out at the Power Networks Demonstration Centre, PNDC under a separate project but the information will be of value to this development when the communications system is ready to fully implement.

5.5 Offline Planning Tool for Dynamic Thermal Rating (DTR) (IFI 1001)

The connection of low carbon technologies, such as photovoltaics, heat pumps and electric vehicles to the network both now and increasingly in the future is leading to changes in what networks are expected to deal with. The traditional response to these changes would be to trigger significant network reinforcement. However, new solutions are emerging, including new operational regimes (such as demand-side response (DSR), demand-side management (DSM), active network management (ANM)), new design techniques (such as dynamic thermal rating (DTR)) and new technologies (such as voltage regulators, STATCOMS, network automation and energy storage) as alternatives to conventional reinforcement. These new solutions are commonly referred to as Smart Grid technologies.

DTR is a smart grid technology that allows electrical conductors to operate at an increased rating the majority of the time, based on the fact that it is generally the thermal effects that limit the current carrying capability of circuits. Real-time weather measurements are used to calculate conductor thermal ratings. The uplift in rating provided by DTR can be significant. This additional capacity can be used to defer or avoid costly network reinforcement, increase the size and energy yield of distributed generators as well as support the network during outage conditions. However, most DTR research to date has focused on improving the technical solutions. Whilst this is clearly essential to eventual, large scale implementation there are other barriers which must also be overcome. This project addresses several of these other barriers by investigating DTR from a network planning and design perspective.

SPEN has been working with Durham University and Newcastle University to develop network planning, design and operational methods associated with DTR for several years. As part of this PhD project, several methodologies have been developed to allow network planners to quantify the benefits and risks associated with DTR, as illustrated in Figure 4. For example, a wind model is used to identify critical spans on existing overhead lines, assess the energy yield from wind farms and assist in the placement of weather stations and other measurement devices and probabilistic methods has been developed to calculate the additional load that can be connected to the network using DTR and the resulting risk of disconnecting customers. Furthermore, a method has also been developed for assessing the reliability of a DTR network, taking into account the correlation between overhead line ratings and the unreliability and uncertainties associated with the DTR. This work has been recognised as world-leading, with several technical papers being published in leading journals.

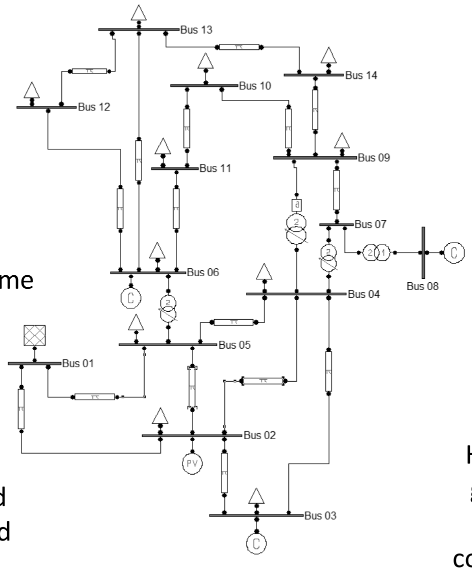
This PhD project is now coming to an end, but it is expected that elements of this work will feed into the proposed industry review of Engineering Recommendation P2/6 (network security) and P27 (overhead line ratings). For ourselves, it is becoming apparent that in order to be able to realise the benefits the smart grid technologies, including DTR, it will be necessary to change the way network performance is assessed and the way that the merit order of network reinforcement solutions are evaluated. This will be taken forward in future work.

Where are the critical spans?

How much load can I connect?

How reliable is the network with Real Time Thermal Ratings (RTTR)?

Where should I build new conductors?



Where should I build weather stations and other sensors?

How much distributed generation can I accommodate? What are the energy yields and constraints?

Figure 4: Quantifying the Benefits and Risks Associated with DTR

5.6 Self-Repair MV Underground Cables

Power cables are central to network operations but they are vulnerable to sheath damage from point of manufacture to installation and operation. During operation underground cables may experience direct sheath damage from nearby building works or utility repairs, see Figure 5. For subsea cables damage may occur including that from the seabed, fishing nets and anchors. If the cable sheath is damaged this may allow water to penetrate the cable which will cause deterioration and failure creating an outage that could not be anticipated or planned for and would be very difficult to detect.

The Cable Care project is developing new self-healing and self-repairing materials that can be applied during cable manufacture. These materials will be used to carry out self-repair of the cable sheath should mechanical damage occur. They will act to prevent water accessing the cable and also prevent any water from moving inside the cable by effective trapping and blocking using the same materials. This is in contrast to existing cable designs that cannot self-repair and have only partial water blocking capability.

Figure 5: MV polymeric cable with typical sheath damage

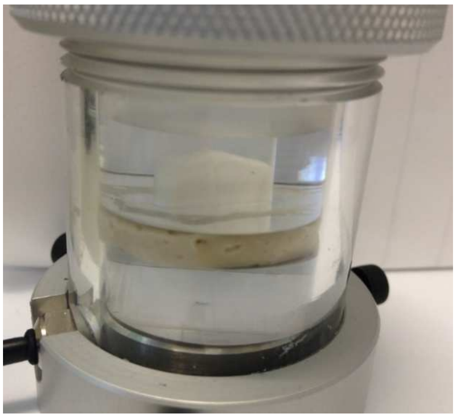


Figure 6: Repair pressure test rig to measure and visualise material response to water

The technical requirements for cable self-repair were established by GnoSys in consultation with SPEN engineers and also in consultation with leading power cable producers to ensure cable manufacturing needs could be met. GnoSys have identified several materials that could potentially meet the needs and they have carried out laboratory assessment of the properties and repair function of the materials in test geometries that simulate a damaged cable – Figure 6 and 7.

The top rated prototype materials include one family that molecularly self-heals itself and another that carries out repair by dilating in the presence of water to repair the sheath and block the movement of water inside the cable.

Over the next 6-12 months GnoSys will be carrying our further measurements of the best candidate materials and assessing their processability and the likely cost of adoption. They will also be holding discussions with cable companies that have an interest in applying the materials.

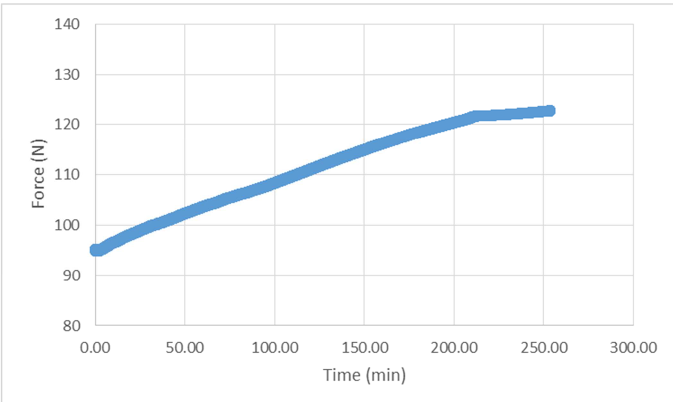


Figure 7: Repair force response curve for a sub sheath repair material exposed to water

5.7 Solid State Voltage Limiter (HTIP Project)

Overvoltage is inherent in the supply of electricity as network operators have to allow for transmission losses and have to be able to respond to periods of high demand. Additionally the continual adoption of distributed generation technologies, such as photovoltaic panels will also add to the voltages on a low voltage network tending towards the higher end of the permitted range. For the customer 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. Currently all the existing solutions for this sector are based on transformers with their corresponding size, weight, high cost and no-load losses. Despite the energy savings being identified by reducing the average voltage from 240V to 220V the uptake of transformer based solutions has been poor due to the cost and size factors.

The Solid State Voltage Limiter project is developing a miniaturised, solid state energy saving solution based on high efficiency silicon-based electronics. The Voltage Limiter will be low cost, highly efficient and compact so it is suitable for unobtrusive installation such as in the meter box or as an energy saving module for electrical equipment and smart meters.

The Voltage Limiter will maintain a stable output voltage regardless of supply fluctuations. The firm developing this product, HTIP Ltd calculate that based on savings of 10-12% and a carbon factor of 0.43 kg of CO_2 per unit of electricity some 200-300 kg carbon could be saved annually per household.

HTIP originally had their technology tested and validated by Cambridge University's Centre for Advanced Photonics and Electronics. The technology won the Shell Springboard award in February 2012, but the company still needed funding support to advance the technology beyond TRL3. After approaching the Energy Innovation Centre, HTIP gained the support of SPEN which helped to capture funding from DECC to be matched by SPEN. The project was initiated to take the technology to the point of manufacturing.

The project has now been running for a year and has completed over half of its milestones. An early prototype has been successfully demonstrated to SPEN and DECC and there is high confidence that the all targets of the original specification will be met. In the next few months the focus will be moving to pre-commercialisation testing and when the final prototype is available, SPEN will support the extensive reliability and efficiency tests which will be carried out using the PNDC testing centre. At the PNDC there will be an opportunity to test the behaviour of the device in various network situations with the use of real network simulation technology.

5.8 Cable Paper Moisture Analyser

Historically power cables were insulated using oil impregnated papers, modern cables use polymeric insulating materials but there are still many paper cables in use on the system. SPEN's cable jointers still work with these cables on a frequent basis especially when faults occur or when alterations to the network are needed. When working with faulted cables there is a real possibility that water has entered the cable and moved along the cable's length. Current practice dictates that cable jointers should use a hot oil bath to determine the presence of water in insulating papers. This system is open to interpretation by the cable jointer and is also imprecise due to the nature of the equipment. Figure 8 below show the problems with the oil bath's resolution. A small change in temperature makes the same moisture content react very differently.

Figure 8: (Left) 135 degrees Celsius. (Right) 115 degrees Celsius.

The Paper Cable Moisture Meter project with EA Technology (EATL) is aimed at creating an easy to use hand held meter that SPEN's jointers could use on site and remove the hot oil bath. By creating a meter the removal of oil baths will create a number of benefits. There will be no health and safety hazard from heating up a bowl of paraffin wax and there will be an improvement in detection of moisture in cables thus reducing future faults.

EATL has recently completed the first stage of this project with promising results. EATL have looked at a number of methods to detect the amount of moisture present in paper samples. They settled upon a method using frequency sweeping, see Figure 9. This method has been shown to be highly repeatable through laboratory experimentation and also lends itself to the creation of a handheld sized appliance.

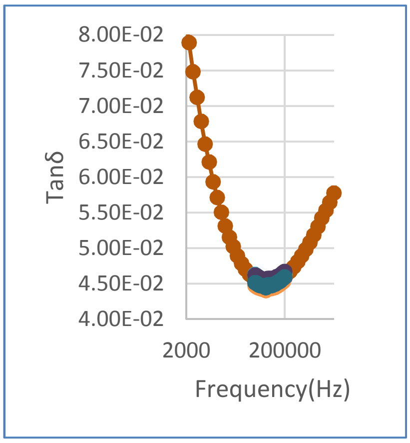


Figure 9: Repeatability measurements for laboratory prototype

SPEN has assisted this project directly by allowing EATL access to their training centre at Hoylake where expert advice was given on jointing techniques, including real life use of hot oil baths. SPEN has also given EATL a number of cable samples, both old and used, and in varying types to test in the laboratory.

EATL has made good progress with stage one and SPEN is looking forward to the completion of the next stage which will investigate the technique in more detail and methods of packaging for commercialisation, see Figure 10.

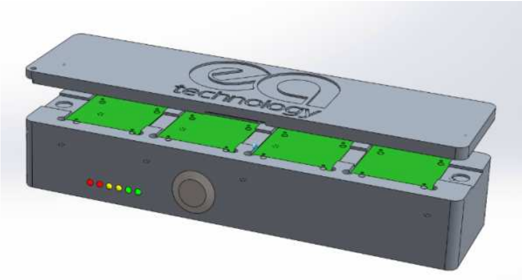


Figure 10: Prototype concept drawing

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, historically, been split against each licence as follows:

Licence Area	Percentage Split Distribution
SP-Distribution	~60%
SP-Manweb	~40%

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 2014 the status of the 47 projects reported as well as those that have stopped is detailed below.

IFI Project Status			
No.	*Phase*	*Definition*	*External Cost*
33	*Live projects*	*Projects in progress*	*Yes (if milestones have been met)*
14	*Completed projects*	*Projects which have completed their trial phase*	*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.

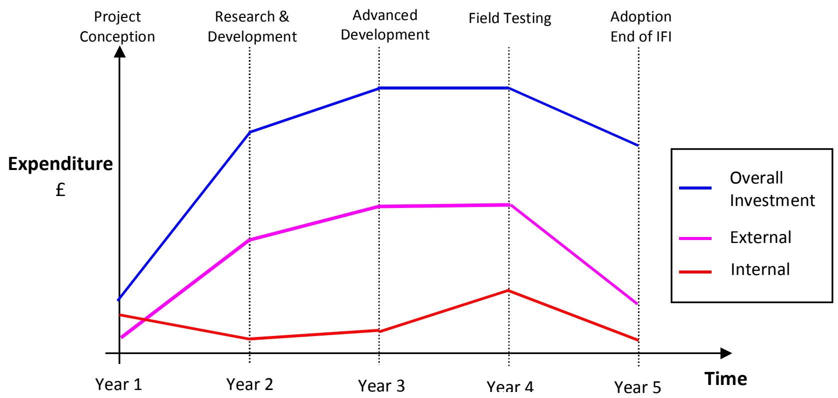


Figure A1: Example Expenditure Profile for an IFI Project

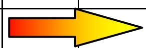
Project Description	Percentage split		£ split			
			SPD		SPM	
	SPD	SPM	External	Internal	External	Internal
IFI 0401 - Strategic Tech Prog	60%	40%	£ 136,490	£ 32,409	£ 90,993	£ 21,606
IFI 0507 Sensor Networks - Smart Dust	60%	40%	£ 3,519	£ 7,878	£ 2,346	£ 5,252
IFI 0509 - Superconducting Fault Current Limiter	60%	40%	£ 3,569	£ 5,880	£ 2,379	£ 3,920
IFI 0515 - Power Network Demo Centre	60%	40%	-£ 138,063	£ 8,327	-£ 92,042	£ 5,551
IFI 0607 LV Network Automation	60%	40%	£ 28,742	£ 6,532	£ 19,161	£ 4,355
IFI 0615 - SP Advanced Research Centre	55%	45%	£ 78,040	£ 2,698	£ 63,851	£ 2,208
IFI 0621-2 LV Sure	60%	40%	£ 6,925	£ 2,944	£ 4,616	£ 1,962
IFI 0621-3 Live Alert	60%	40%	£ 6,925	£ 2,944	£ 4,616	£ 1,962
IFI 0621-4 PURL2	60%	40%	£ 6,925	£ 3,841	£ 4,616	£ 2,561
IFI 0701 ENA Small Value Projects	60%	40%	£ 13,424	£ 2,944	£ 8,949	£ 1,962
IFI 0711 - 3rd Party ROEP Risk Assessment	55%	45%	£ 45,160	£ 8,455	£ 36,949	£ 6,918
IFI 1001 - DTR DURHAM	0%	100%	£ -	£ -	£ 2,108	£ 8,644
IFI 1002 - SUPERGEN HIDEF	60%	40%	£ 1,265	£ 3,392	£ 843	£ 2,261
IFI 1004 - Remote Access to Pole Mounted Auto Reclosers	60%	40%	£ 1,265	£ 6,084	£ 843	£ 4,056
IFI 1007 - Outram Fault Level Monitor	60%	40%	£ 41,391	£ 8,324	£ 27,594	£ 5,549
IFI 1102 - Energy Storage Project	60%	40%	£ 24,599	£ 5,187	£ 16,399	£ 3,458
IFI 1104 - SF GB Electricity Demand Project	60%	40%	£ 9,320	£ 4,738	£ 6,213	£ 3,159
IFI 1107 - Cable Identification Devices	60%	40%	£ 1,265	£ 4,289	£ 843	£ 2,860
IFI 1202 - Nanodielectrics	60%	40%	£ 17,020	£ 6,084	£ 11,347	£ 4,056
IFI 1203 - Psymetrix ACAM Phase 1	0%	100%	£ -	£ -	£ 2,770	£ 9,207
IFI 1205 -Transient Earth Detector	60%	40%	£ 10,813	£ 3,392	£ 7,208	£ 2,261
IFI 1206 - Sudafix Conductive Concrete	50%	50%	£ 5,770	£ 2,827	£ 5,770	£ 2,827
IFI 1207 - Smart 3 Phase Voltage Regulat	60%	40%	£ 17,302	£ 3,785	£ 11,534	£ 2,524
IFI 1209 - Substation Earth Integrity Monitoring System	50%	50%	£ 3,270	£ 2,453	£ 3,270	£ 2,453
IFI 1211 - Smart CCU Development	60%	40%	£ 6,925	£ 56,638	£ 4,616	£ 37,759
IFI 1213 - Phase 3 Transformer Research Consortium	50%	50%	£ 19,804	£ 4,696	£ 19,804	£ 4,696
IFI 1215 - Self Repair MV underground	60%	40%	£ 42,930	£ 3,841	£ 28,620	£ 2,561
IFI 1216 - The Role of the Demand Side	60%	40%	£ 7,220	£ 10,115	£ 4,813	£ 6,743
IFI 1218 - Impact of Domestic Heating	60%	40%	£ 1,265	£ 5,187	£ 843	£ 3,458
IFI 1219 - Substation Efficiency	60%	40%	£ 25,008	£ 5,187	£ 16,672	£ 3,458
IFI 1220 - Smart Grid Forum WS3	60%	40%	£ 1,265	£ 2,944	£ 843	£ 1,962
IFI 1302 - SUSCABLE 2	60%	40%	£ 1,265	£ 3,841	£ 843	£ 2,561
IFI 1304 - Smart Meter Enablement	60%	40%	£ 67,642	£ 9,224	£ 45,094	£ 6,149
IFI 1305 - Low Power Radio Alarm System	60%	40%	£ 61,330	£ 8,313	£ 40,887	£ 5,542
IFI 1307 - Mobile Phone Application Prototypes	60%	40%	£ 166,071	£ 7,995	£ 110,714	£ 5,330
IFI 1308 - HTIP	60%	40%	£ 18,694	£ 4,206	£ 12,462	£ 2,804
IFI 1309 - Smart Grid Forum Work Stream 3	60%	40%	£ 26,987	£ 2,944	£ 17,991	£ 1,962
IFI 1310 - Cable Paper Moisture Analyser	60%	40%	£ 12,724	£ 3,084	£ 8,483	£ 2,056
IFI 1311 - Green Running	60%	40%	£ 21,969	£ 2,944	£ 14,646	£ 1,962
IFI 1312 - V2G	60%	40%	£ 1,265	£ 4,908	£ 843	£ 3,272
IFI 1315 - Ultrapole	60%	40%	£ 15,925	£ 2,944	£ 10,616	£ 1,962
IFI 1316 - Upgrading Legacy GM NCP to Plexman 2	60%	40%	£ 26,824	£ 5,131	£ 17,883	£ 3,421
IFI 1317 - Cable Core Temperature Monitoring	60%	40%	£ 31,645	£ 2,944	£ 21,096	£ 1,962
IFI 1318 - VTOL	60%	40%	£ 6,925	£ 5,750	£ 4,616	£ 3,833

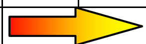
	SPD		SPM	
Totals	External	Internal	External	Internal
	£ 888,616	£ 288,238	£ 625,570	£ 215,025
Ratios	76%	24%	74%	26%

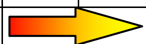
Table A1: Overview of 13/14 projects showing application between licences

Appendix B – Project Reports IFI Projects

April 13 – March 14

Project Title	***IFI 0401 STP 2 – Overhead Lines***			
Description of project	A DNO research and development collaboration hosted by EA Technology			
Expenditure for financial year	Internal £4,486 External £56,871 **Total £61,357**	Expenditure in previous (IFI) financial years	Internal £71,796 External £382,801 **Total £454,597**	
Project Cost	£341,137	Projected 2014/15 costs for SPEN	Internal £10,000 External £50,000 **Total £60,000**	
Technological area and / or issue addressed by project	The Module 2 programme for budget year 2013/14 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			
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 overhead line networks			
Expected Timescale to adoption	Range 1-5 years - dependent on project	Duration of benefit once achieved	Range 3-5 years - dependent on project	
Probability of Success	Range 49-95% - 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	£42,652		
Project Progress March 2014	Only a small number of projects or project stages started in the Module during 13/14 have been completed since the majority are multi-stage projects that span more than one year			
Potential for achieving expected benefits	Collectively, the 13/14 work programme demonstrates the development of innovative products, processes and techniques that improve the management of overhead lines. A full list of projects and deliverables are available from SPEN or EA Technology			
Collaborative Partners	Other DNOs			
R&D Providers	EA Technology			

<table>
<tr><td>Project Title</td><td colspan="9">IFI 0401 STP 3 – Cable Networks</td></tr>
<tr><td>Description of project</td><td colspan="9">A DNO research and development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £14,952
External £56,871
Total £71,823</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £74,533
External £461,576
Total £536,109</td></tr>
<tr><td>Project Cost</td><td colspan="2">£413,360</td><td colspan="3">Projected 2014/15 costs for SPEN</td><td colspan="4">Internal £10,000
External £60,000
Total £70,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">The Module 3 programme for budget year 2013/14 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 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">No</td><td colspan="2">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">• 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 colspan="2">Range 1-2 years - dependent on project</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">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="4">£42,013</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="9">Only a small number of projects or project stages started in the Module during 13/14 have been completed since the majority are multi-stage projects that span more than one year</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="9">Collectively, the 13/14 work programme demonstrates the development of innovative products, processes and techniques that improve the management of cable Networks. A full list of projects and deliverables are available from SPEN or EA Technology</td></tr>
<tr><td>Collaborative Partners</td><td colspan="9">Other DNOs</td></tr>
<tr><td>R&D Providers</td><td colspan="9">EA Technology</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4">IFI 0401 STP 4 – Substations</td></tr>
<tr><td>Description of project</td><td colspan="4">A DNO research and development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £5,981
External £56,871
Total £62,852</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £72,014
External £356,162
Total £428,176</td></tr>
<tr><td>Project Cost</td><td colspan="2">£345,174</td><td>Projected 2014/15 costs for SPEN</td><td>Internal £10,000
External £40,000
Total £50,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The Module 4 programme for budget year 2013/14 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</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">• If successful projects in this Module may increase the performance and reliability of substations</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-4 years - dependent on project</td><td colspan="2">Duration of benefit once achieved</td><td>Range 1-6 years - dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 30-95% - dependent on project</td><td colspan="3">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
</td></tr>
<tr><td>Project NPV</td><td colspan="3">(Present Benefits x Probability of Success) – Present Costs</td><td>£32,721</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="4">Only a small number of projects or project stages started in the Module during 13/14 have been completed since the majority are multi-stage projects that span more than one year</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Collectively, the 13/14 work programme demonstrates the development of innovative products, processes and techniques that improve the management of substations. A full list of projects and deliverables are available from SPEN or EA Technology</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">Other DNOs</td></tr>
<tr><td>R&D Providers</td><td colspan="4">EA Technology</td></tr>
</table>

Project Title	***IFI 0401 STP 5 – Networks for Distributed Energy Resources***								
Description of project	A DNO research and development collaboration hosted by EA Technology								
Expenditure for financial year	Internal £8,971 External £56,871 **Total £65,842**		Expenditure in previous (IFI) financial years			Internal £69,738 External £401,579 **Total £471,317**			
Project Cost	£349,243		Projected 2014/15 costs for SPEN			Internal £10,000 External £50,000 **Total £60,000**			
Technological area and / or issue addressed by project	The Module 5 programme for budget year 2013/14 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								
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 networks for Distributed Energy resources								
Expected Timescale to adoption	Range 1-3 years - dependent on project		Duration of benefit once achieved			Range 2-5 years - dependent on project			
Probability of Success	Range 51-100% - dependent on project	TRL Development (Start – Current)							
		1	2	3	4	5	6	7	8	9
					→ (4 to 5)					
Project NPV	(Present Benefits x Probability of Success) – Present Costs					£28,841			
Project Progress March 2014	Only a small number of projects or project stages started in the Module during 13/14 have been completed since the majority are multi-stage projects that span more than one year								
Potential for achieving expected benefits	Collectively, the 13/14 work programme demonstrates the development of innovative products, processes and techniques that improve the management of overhead lines. A full list of projects and deliverables are available from SPEN or EA Technology								
Collaborative Partners	Other DNOs								
R&D Providers	EA Technology								

<table>
<tr><td>Project Title</td><td colspan="4">IFI 0507 – Sensor Networks (Smart Dust) – Phase 2</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. ScottishPower 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 OH networks.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £13,130
External £5,865
Total £18,995</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £100,611
External £226,017
Total £326,627</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>Phase 1 = £16k
Phase 2 = £191k</td><td>Projected 14/15 costs for SPEN</td><td colspan="2">Internal £15,000
External £19,000
Total £34,000</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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>5 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
</table>

<table>
<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>(Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£554.5k</td></tr>
<tr><td>Project Progress
March 14</td><td colspan="10">Progress in 2013/2014:

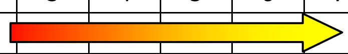
Although there has been good progress, there have also been some significant set-backs.

The Bowden FPI 360 Alpha was provided with incorrect internal jumper settings, which was compounded by the wrong manufacturer’s manual being received. This resulted in 30 FPIs having to be taken down, after having being deployed to the network, and replaced with new correctly configured units.

The auto-configuration function failed to work once the units were enabled. The message length and the transfer to the Gateway appear to be the source of concern.

The field trial successfully detected a transient fault which was confirmed by interrogation of the upstream PMAR. This is the first live fault detection since the system was installed to the South Queensferry Circuit 23. The zone staff were delighted with the accuracy of the system, which localised the faulted section.

Although there remains to be design issues that have to be addressed by Willow before the product can be accepted as a working prototype.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">This new approach will allow control engineer’s 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">Central Networks</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Willow, E.ON Power Technology</td></tr>
</table>

Project Title	***IFI 0509 – Superconducting Fault Current Limiter***		
Description of project	This project aims to design, develop and trial three 12kV Superconducting Fault Current Limiting (SFCL) devices on three different UK networks.		
Expenditure for financial year	Internal £9,801 External £5,948 **Total** **£15,749**	Expenditure in previous (IFI) financial years	Internal £82,046 External £468,245 **Total** **£550,293**
Project Cost (Collaborative + external + SPEN)	**£2,345,967**	Projected 14/15 costs for SPEN	Internal £5,000 External £5,000 **Total** **£10,000**
Technological area and / or issue addressed by project	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.		
Type(s) of innovation involved	Incremental: No	Significant: Yes	Technological substitution: No Radical: No
Expected Benefits of Project	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.		
Expected Timescale to Adoption	3 years	Duration of benefit once achieved	20 years
Probability of Success	25%	TRL Development (Start – Current) 1 2 3 4 5 6 7 8 9 	
Project NPV	(Present Benefits x Probability of Success) – Present Costs	£-267,191 Project NPV is negative due to the low TRL / high costs upon commencement	

Project Progress March 14	In March 2014 a decision was made to close this project once the SFCL is recovered from the test site in Liverpool. There were 3 key reasons behind this decision: **(i) Reliability** Whilst the SFCL was in situ for ~20 months, it has only been operationally available for a little over 12 months. This was largely down to technical issues associated with the cryogenics system. Upon the discovery of a new issue in February 2014 a decision was made to permanently disconnect the SFCL from the network. **(ii) Support** In early 2014 the manufacturer of the SFCL entered into administration creating uncertainty around the availability of any short to long term support for the unit. **(iii) Network** Due to a slower load growth than expected on the 11kV network the fault level at the SFCL's location has not reached a suitable magnitude to trigger the unit when a fault has occurred on the adjacent network. This meant that the even if the SFCL was fully operational it would be extremely unlikely that its performance could be proven in this location. In 2014/15 SPEN will recover the unit from Liverpool and arrange a suitable new use for the SFCL most likely within academia.
Potential for achieving expected benefits	Through the deployment and operation of the SFCL SPEN has gained valuable knowledge and experience that will influence our future strategy for the deployment of fault current limiting technology.
Collaborative Partners	Electricity North West, CE Electric UK, Applied Superconductor Ltd
R&D Providers	Applied Superconductor Ltd

Project Title	***IFI 0515 – Power Network Demonstration Centre (PNDC)***			
Description of project	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. 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.			
Expenditure for financial year	Internal £13,878 External -£230,105 **Total** **-£216,228**	Expenditure in previous (IFI) financial years	Internal £57,917 External £762,958 **Total** **£820,875**	
Project Cost (Collaborative + external + SPEN)	**£7,200,000**	Projected 14/15 costs for SPEN	Internal £30,000 External £35,000 **Total** **£65,000**	
Technological area and / or issue addressed by project	In partnership with collaborators, this project aims to: • 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 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. 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.			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	Yes	Yes	Yes
Expected Benefits of Project	Benefits to DNOs from such a facility include: **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. **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. **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.			
Expected Timescale to adoption	1 Years	Duration of benefit once achieved	20 Years	
Probability of Success	25%	TRL Development (Start – Current) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 (Start 3 – Current 8)		
Project NPV	(Present Benefits x Probability of Success) – Present Costs		£709,171	

Project Progress March 14	**Activity April 2013 - March 2014** • As of March 2014 the construction of the PNDC buildings and network was complete with only a handful of remedial activities required prior to the network coming under the ownership of the University of Strathclyde. • The PNDC was officially opened in May 2013 by Scotlands First Minister, Alex Salmond. • In September 2013 activities commenced on the Core research modules to establish several collaborative network projects to be taken forward in 2014/15.
Potential for achieving expected benefits	**Facility – Operation and SP role** Overall governance will be carried run by the PNDC Directors, Operational and Research (UoS staff). The Core Research Programme, will be planned and approved by the PNDC board which comprises of the PNDC directors, UoS finance director and Tier 1 members. There are three classes of membership: Founder Tier 1, Tier 1 and Tier 2, each having different voting rights on the PNDC board. For SPEN to get maximum value out of the PNDC we will be seeking to use our place on the PNDC board to our maximum advantage in guiding the PNDC core programme to benefit our IFI programme. We also anticipate that SPEN will have various projects that will require the use of the Centre to reduce their time to adoption within SP.
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="4">IFI 0607 – LV Network Automation</td></tr>
<tr><td>Description of project</td><td colspan="4">The aim of a Low Voltage Automation (LVA) project is to provide a trial system on SPEN's LV network, which will prove the benefits of implementing a larger scale LVA system across the LV networks. The trial system will consist of one LVA CCU (modified old CCU) and one phase LVA switch.

There are two major parts that will be validated in the project. The first one is the communication from the control point to the LVA switch. The communication technique will be the Power Line Communication (PLC). The second part is the mechanical behaviour and the control of the Magnetic vacuum Switch from EPS.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £10,887
External £47,903
Total £58,790</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £186,882
External £207,829
Total £394,710</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£257,775</td><td colspan="2">Projected 14/15 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 Low Voltage networks contribute ~11% CI and ~15.5% CML between the SP-D / SP-M networks (taken from 2003/04 NaFIRs report).

• Both proposals aim to produce, install and test prototype systems on a trial network, providing a proof of concept and evaluating performance of the installation on the LV distribution network.
• Application will be to focus on high customer density, worst performing LV 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>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Application of the technology should provide the following benefits:
• Reduction of CMLs on the LV network
• Increased asset life of circuit elements by the reduction of both fault currents and stresses during fault location
• Reduced cost and time of fault location through rapid identification of faults location
• Elimination of repeated intermittent faults</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>50%</td><td colspan="3">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9
(arrow from 5 to 7)</td></tr>
<tr><td>Project NPV</td><td colspan="3">(Present Benefits x Probability of Success) – Present Costs</td><td>£526,7k</td></tr>
<tr><td>Project Progress March 14</td><td colspan="4">The project was closed at 80% completion. Although the project did not achieve all the objectives, there were sufficient learning outcomes to enable an understanding of the requirements for LV control.</td></tr>
</table>

Potential for achieving expected benefits	Having proved the LVA could perform in this environment, coupled with the control and network behaviour data capability, we have now embarked on a continuation IFI project to further develop this prototype into a final product that will enable the Smart Grid concept.
Collaborative Partners	None
R&D Providers	Netcontrol

<table>
<tr><td>Project Title</td><td colspan="4">IFI 0615 – ScottishPower Advanced Research Centre (SPARC)</td></tr>
<tr><td>Description of project</td><td colspan="4">Three work streams have been proposed:

• 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 will be developed within each work stream.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £4,906
External £141,891
Total £146,797</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £47,405
External £727,874
Total £775,279</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£460,083</td><td>Projected 14/15 costs for SP-EN</td><td colspan="2">Internal £10,000
External £89,750
Total £99,750</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">• 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>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">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>3 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>Varies per project</td><td colspan="3">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
(arrow from 4 to 7)</td></tr>
<tr><td>Project NPV</td><td>(Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">TBC
In development for the core projects in each work stream</td></tr>
</table>

Project Progress March 14	**'Investment Strategy' Theme: Smart Power Network Asset Management Strategies and Tools** Completed the development of a method to optimise targeting of investment for asset replacement over a given period of time. A conference paper was presented in March 2014, and a paper has been accepted for the 2014 Cigré session in Paris: • A. Johnson, "A framework for investment planning for asset end of life replacement", *International Conference on Innovation for Secure and Efficient Transmission Grids*, Brussels, March 2014. • A. Johnson, S. Strachan, G. Ault, "A framework for asset replacement and investment planning in power distribution networks" *Accepted for 45th Cigré session, Paris, August 2014*. In addition, a journal paper is expected to be submitted later in 2014. The PhD student conducting this work has now completed her research activities and is now writing up her thesis. **'System Development' Theme: Optimal Distribution Network Architectures** Agreement has been reached with a commercial partner for the algorithms and tools developed as part of this research to be incorporated into their product, enhancing its capabilities to include loss and reliability assessment and optimisation. Work to integrate these capabilities is ongoing, with support from Strathclyde University. **'Asset Technology' Theme: PD Diagnostics in MV Cables** The development of a prototype system for double sided PD monitoring system and signal processing algorithms was previously completed: 1. Hardware and software produced as part of this work has been tested in an operational environment. 2. The PhD student conducting this work has completed the research aspects of his studies and has joined a company working in this technology area. 3. Negotiations with a preferred commercial partner with a view to developing the technology into a product in its own right or as part of a wider monitoring system were unsuccessful as a result of changing priorities within the partner organisation. Other commercialisation opportunities are currently being assessed. 4. Two journal papers have been published, and a further journal paper has been accepted for publication: • F. Peer Mohamed, W.H. Siew, J. Soraghan, S. Strachan and J. McWilliam, Jamie "Partial discharge location in power cables using a double ended method based on time triggering with GPS" *IEEE Transactions on Dielectrics and Electrical Insulation*, Vol. 20, No. 6, Dec. 2013, pp. 2212-2221; ISSN 1070-9878; doi: 10.1109/TDEI.2013.6678872 • F. Peer Mohamed, W.H. Siew, J. Soraghan, S. Strachan and J. McWilliam, "The use of power frequency current transformers as partial discharge sensors for underground cables" *IEEE Transactions on Dielectrics and Electrical Insulation*, Vol. 20, No. 3, June 2013, pp. 814-824; ISSN 1070-9878; doi: 10.1109/TDEI.2013.6518951 • W.H. Siew, F. Peer Mohamed, J. Soraghan, S. Strachan and J. McWilliam, Jamie "Remote monitoring of partial discharge data from insulated power cables" *IET Science, Measurement and Technology*. (In Press)

	'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. • A feasibility study has been undertaken has been undertaken using existing archived data to assess the utility and practicality of anticipating the occurrence of permanent faults through the analysis of transient events and "nuisance" tripping. • On the basis of this study, 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. • Initial work focuses on identifying circuits and time periods of interest for detailed investigation through analysis of central SCADA-driven databases. More detailed data can then be gathered as required from communication-enabled PMARs as they are installed and commissioned in the network. • A conference paper has been submitted to the 2014 *Universities Power Engineering Conference*, and a submission to the *6th Innovative Smart Grid Technologies Conference* (February 2015) is planned.
Project Progress March 14	**Enhanced Weather Modelling for Dynamic Line Rating (DLR)** This PhD project (jointly supported by National Grid) aims to improve the capabilities of Dynamic Thermal Rating of overhead lines through enhancement to the detail and accuracy of the modelling of ambient weather conditions at locations between fixed weather stations. Such improved models will allow DLR to be applied more effectively, and will allow increased line capability without incurring additional risk. • Work to date has involved investigation of methods of meteorological data interpretation, including kriging methods, and spatial and temporal detrending. • The theory and application of existing DLR monitoring systems have been reviewed, and advantages and disadvantages have been identified. A report on findings is currently being finalised. • Current work is investigating and optimising methods for the interpolation of wind direction and solar radiation, and on the forecasting of ambient conditions. **Assessing the Feasibility of Hyperspectral Imaging for the Detection of OHL Corrosion.** This study assessed the feasibility of Hyperspectral Imaging (HSI) for detecting early signs of internal corrosion of OHL conductors from the ground, with the intention of replacing the existing Cormon device designed and built in the 1980s which is no longer manufactured or supported. Upon review of the findings of the study, it was determined that the results obtained from the application of HSI were not strong enough to justify further work in this area. As a result, this research activity has not been taken forward.

Potential for achieving expected benefits	• The **'Smart Power Network Asset Management Strategies and Tools'** PhD project of the Investment Strategy theme developed a methodology involving asset deterioration modelling and optimisation techniques to enable asset managers to establish desirable optima balancing of asset health, risk and investment, providing a more robust scientific basis for justifying asset investment. In addition to optimizing the level of investment required to manage risk satisfactorily, the methodology investigated the identification of assets which provide the best return on investment, in terms of risk management. • 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. • The **'Optimal Distribution Network Architectures'** PhD project of the System Development theme delivered a reconfiguration algorithm capable of minimising network losses, while not compromising network reliability and security. This system actively manages power flow through network reconfiguration within operational, planning and design timescales. This will allow SPEN to implement operationally 'smarter' and more cost effective solutions to minimise active power losses as an alternative to costly network reinforcement. Commercialisation of this work is currently in progress with an industrial partner. • The **'PD Diagnostics in MV Cables'** PhD project of the Asset Technology theme has delivered a cost effective method of detecting partial discharge present in medium voltage cables. This phenomenon is responsible for the degradation of cable insulation and ultimately failure. Using existing protection CTs to also perform a secondary function as PD cable sensors affords asset managers with an unprecedented level of cable PD monitoring capability across the network, without the need to develop or install dedicated PD cable sensors. Commercialisation opportunities are actively being explored. • The '**Enhanced Weather Modelling for Dynamic Line Rating'** PhD project will improve extent to which dynamic, weather-dependent enhanced overhead line ratings can be applied by SPEN to accommodate load growth or generation connections while minimising reinforcement costs. By improving the accuracy of models of weather conditions between weather stations, the level of uncertainty is reduced, and thus greater line ratings can be applied without an increase in associated risk. • Key SPEN personnel are 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) is to ensure that the pipeline of prospective research projects is maintained and that they remain relevant to the strategic objectives of SPEN.
Collaborative Partners	N/A
R&D Providers	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="4">IFI 0621 – 2 LV Sure</td></tr>
<tr><td>Description of project</td><td colspan="4">The development of LV Sure will take the SignalSure concept of circuit restoration and consider whether it could be applied to low voltage distribution networks. The project’s objectives are to:
• Produce functional specification, detailed product development project plan & test plan for the LVSure system
• Production of a prototype LVSure System and laboratory testing of the system
• Installation and testing of prototype on a representative test circuit
• Monitoring, evaluation and reporting of the performance of the trial system against functional specification

Installation and demonstration of a number of prototypes on a selection of LV Networks</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £4,906
External £11,541
Total £16,447</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £10,802
External £47,495
Total £58,297</td></tr>
<tr><td>Project Cost</td><td>£260,980</td><td>Projected 2014/15 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 LV Sure system comprises a source breaker, the Intelligent Fuse Unit (IFU); plus a number of mechanical isolating switches, or Intelligent Link Units (ILUs) installed at strategic positions along the LV circuit.

Isolation of the faulted section and restoration of supply to un-faulted sections of the circuit is fully automated and does not require communication between the devices which comprise the LV Sure system.

When a fault occurs on the LV network the IFU disconnects supply to the entire circuit. The ILUs along the route, sense no voltage and automatically open, in effect sectioning the circuit. Both the IFU and the ILU incorporate sensing circuitry which tests for the presence of a fault on the electrical section downstream of each Unit. The IFU would commence the restoration process by testing downstream and if healthy would restore supply to the first section. Each ILU in turn would initially sense it has an incoming voltage, then test downstream and again, if healthy, restore supply. This would continue until the faulted section was reached when testing would inhibit the ILU from closure. Circuits with an alternative supply from a remote end could complete the restoration process until all sections had supply restored except the faulted section.</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">Successful completion of the project will result in:
• Knowledge of how to reconfigure and redesign LV networks to obtain optimum performance will be developed and transferred to the DNO.
• Avoid potential hazard of operator installing a replacement fuse of a live LV board with a faulted circuit.
• Assuming installation on worst performing (Rogue) LV circuits avoiding CML and CI associated with up to 5 transient interruptions per year per LV circuit would substantially and sustainably improve network performance for worst served customers.
• Reduction in potential risks from loss of traffic controls, street lighting, general lighting in public areas etc.</td></tr>
</table>

<table>
<tr><td>Expected Timescale to adoption</td><td>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 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">£245,517</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="10">The project was closed early following the development and laboratory testing of prototypes. Although results were very encouraging it was decided due to the time frame required to further develop the concept, and likely development of commercially available solutions, the project should be brought to an appropriate conclusion at this junction.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Although the initial prototype unit was developed it was concluded its size and functionality would have to be modified to develop the solution into a viable product. Further work looking at using different types of materials failed to advance the project sufficiently to allow it to continue.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">SSE, Surenet Technology Ltd, Energy Innovation Centre</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Surenet Technology Ltd</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="9">IFI 0621 – 3 Live Alert/Energised Alert</td></tr>
<tr><td>Description of project</td><td colspan="9">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>Expenditure for financial year</td><td colspan="2">Internal £4,906
External £11,541
Total £16,447</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £19,242
External £26,127
Total £45,398</td></tr>
<tr><td>Project Cost</td><td colspan="2">£ 65,815</td><td colspan="3">Projected 2014/15 costs for SPEN</td><td colspan="4">Internal £3,000
External £10,000
Total £13.000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">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="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">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>1 Year</td><td colspan="4">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></td><td colspan="4">→ (4 to 7)</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">-£49,420</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="9">• Stage One of the project, to design and develop the sensing system was completed successfully and met the deliverable set at the start of the project.
• Stage Two, to design and develop a refined was completed successfully and met the deliverable set at the start of the project.
• Stage Three, to manufacture and evaluate 10 energised alerts units is complete
• Stage Four was completed and issues surrounding over sensitivity were identified.
• The project was stalled pending legal authorisation to the extension of the project to solve the issues identified in Stage Four.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="9">The project is on target to achieve the expected benefits.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="9">Northern PowerGrid, Electricity North West, SSE</td></tr>
<tr><td>R&D Providers</td><td colspan="9">Live Alert</td></tr>
</table>

Project Title	***IFI 0621 – 4 PURL2***
Description of project	EA Technology currently offers the PURL instrument to allow condition assessment of wooden poles and while the instrument performs this function well it is slow and complex to use and only makes use of a single measurement technique to make the assessment. Other instruments are currently available, however, these also base the estimate of pole strength on a single measured parameter; a few instruments use two (for example moisture content and fibre strength). A further major disadvantage with many of these instruments is that they physically damage the pole in order to make the measurement, therefore requiring ongoing maintenance e.g. annual Boron treatment. PURL2 will make use of four measured parameters to increase measurement accuracy and reduce uncertainty. The techniques used for all measurements will have no more effect on the surface of the pole than standard climbing spikes so minimising ongoing maintenance requirements. All measurements will also be time and location stamped which, when combined with wired and wireless connectivity, will allow integration into field and office based asset management systems.
Expenditure for financial year	Internal £6,401 External £11,541 **Total £17,942** Expenditure in previous (IFI) financial years: Internal £13,157 External £151,515 **Total £164,672**
Project Cost	£ 284,000 Projected 2014/15 costs for SPEN: Internal £0 External £0 **Total £0**
Technological area and / or issue addressed by project	The new PURL will combine the existing ultrasonic attenuation measurement technique with measurements of ultrasonic time of flight, water content and surface hardness to provide a more accurate and reliable assessment over a wider range of degradation types and environmental conditions. More advanced coupling techniques would be used to speed up and simplify the measurement process compared to the current instrument.
Type(s) of innovation involved	Incremental: No Significant: Yes Technological substitution: No Radical: No
Expected Benefits of Project	PURL 2 will represent a real advance on the current technology available and should result in more efficient, more accurate and less damaging condition assessment of wood poles. The benefits of this should be: • Better use of inspection team resource • More effective identification of failing poles and therefore:- • Reduced failure of wood poles which will result in:- • Reduced CMIs/CLs, which in combination with the above will result in:- reduction in overall cost
Expected Timescale to adoption	1 years Duration of benefit once achieved: 10 years
Probability of Success	50% TRL Development (Start – Current): 1 2 3 4 5 6 7 8 9 (arrow from 3 to 7)
Project NPV	(Present Benefits x Probability of Success) – Present Costs: £738,046

Project Progress March 2014	The project completed stage 1. However different techniques for detecting wood rot in poles were identified outside of this project. Therefore the project sponsors decided to close the project at this stage.
Potential for achieving expected benefits	Project started in September 2011, potential for achieving expected benefits as per above probability of success.
Collaborative Partners	SHEPD, Energy Innovation Centre
R&D Providers	EA Technology Limited

Project Title	***IFI 0701 – ENA IFI Projects***			
Description of project	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.			
Expenditure for financial year	Internal £4,906 External £22,374 **Total £27,280**	Expenditure in previous (IFI) financial years	Internal £27,318 External £73,626 **Total £100,944**	
Project Cost	c£50,000	Projected 2014/15 costs for SPEN	Internal £8,000 External £55,495 **Total £63,495**	
Technological area and / or issue addressed by project	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. **Harmonic Impedance Modelling:** The project addresses the detailed modelling of cable and overhead line components, to develop cable models appropriate for distribution networks **Earthing Project – HV/LV Earthing Transfer:** The aim is to develop new techniques to assess the impact of lower voltage earth electrodes on higher voltage 'hot zones' and to measure the resistance of distribution substation earth systems **Smart Grid Forum Workstream 3 Phase 1 & 2:** Takes the impact of Britain's future energy scenarios into key strategic directions for network development, identifying the needs for network expansion and the opportunities for smart grid techniques to drive cost-efficiency and deliver new services. It considers the enablers for change, including the necessary development of commercial and regulatory frameworks **DC Injection:** Investigation into the corrosion effects of DC on DNO networks with specific emphasis on assessing the impact of DC flows in the neutral conductors and providing evidence that a max of 20 milliamps as per British Standards is suffice.			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	Yes	No	No
Expected Benefits of Project	These projects have the potential to provide a wide range of benefits. In some cases, they will help to understand key asset-related issues and allow designs to be altered to address them. In other cases they will allow us to better understand risks to our network, whether from climate change or changes in demand. The smart metering project is already making a valuable input to the overall smart metering consultations and the development of the national Smart Metering Equipment Technical Specification (SMETS).			
Expected Timescale to adoption	1 - 10 Years	Duration of benefit once achieved	10 – 20 Years	
Probability of Success	25 - 75%	TRL Development (Start – Current) 1 2 3 4 5 6 7 8 9		
Project NPV	(Present Benefits x Probability of Success) – Present Costs	£100,000		

Project Progress March 14	**Harmonic Impedance Modelling** Completed. **Earthing Project – HV/LV Earthing Transfer** Completed. **Smart Grid Forum Workstream 3 Phase 1, 2 & 3** The phase 1 report translates the impact of UK's future energy scenarios into key strategic directions for network development, identifying the needs for network expansion and the opportunities for smart grid techniques to drive cost-efficiency and deliver new services. It considers the enablers for change, including the necessary development of commercial and regulatory frameworks. It focuses on 2020 and 2030, and casts a forward look towards 2050 to consider the enablers for change, including the necessary development of commercial and regulatory frameworks. Phase 2 will develop a technical model and cost benefit analysis network investment tool for a range of typical network types from EHV to LV. The model will be run against synthetic networks at each voltage level under a range of low carbon uptake scenarios. As of March 2013 phase 2 is complete and can now be used for ED1 Business Plans. Work is currently commencing on WS3 Phase 3. Phase 3 deliverables have been agreed. **DC Injection:** Project is underway, project objectives have been raised, project currently progressing through early stages.
Potential for achieving expected benefits	Work on the harmonic impedance modelling (G5/4) will help DNOs understand harmonics issues on distributed networks and produce a revised revision of G5/4. The transfer potential projects will assist with understanding earthing issues in differing situations. The remaining projects are still in progress and it is hoped they will demonstrate the benefits explained.
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.

Project Title	***IFI 0711 – 3rd Party ROEP Risk Assessment***				
Description of project	The development of the so-called 'Stage I' for risk assessment of earthing systems, using a new concept of safety limit curves, where standard fault clearance times are used, was achieved under National Grid research project NSETS180 in collaboration with SPEN, and was completed in Autumn 2006. The Stage I risk assessment enables broad classification of substations into low/high risk categories for Rise of Earth Potential (ROEP). The theoretical studies to develop a Stage II probabilistic-based risk assessment, which includes the use of historical network fault clearance times, are now under development at Cardiff University. In this project, it is proposed to conduct pilot studies, which allow initial implementation of the developed 'Stage I' technique at identified key National Grid substations (4 to 5 sites). This will allow a refined quantification of risk in relation to the ALARP levels. In addition, a user-friendly procedure will be developed to allow easy and quick assessment of sites. The ultimate purpose of the research is to provide better information to engineers making decisions on investment for earthing reinforcement schemes.				
Expenditure for financial year	Internal £ 15,373 External £ 82,108 Total **£ 97,481**	Expenditure in previous (IFI) financial years	Internal £ 46,464 External £ 110,769 Total **£ 157,233**		
Project Cost	Stage 1 - £100,000 Stage 2 - £150,000	Projected 2014/15 costs for SPEN	Internal £ 0 External £ 0 Total **£ 0**		
Technological area and / or issue addressed by project	This software package will allow SPEN to assess current sites to determine whether or not there is a touch/step issues within the substation and a danger of third party exposure to ROEP.				
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical	
	Yes	No	No	No	

<table>
<tr><td>Expected Benefits of Project</td><td colspan="10">There are many sites in Scotland and Manweb where the existing sites do not have earthing that has been installed to the current standard. System fault levels have been increasing due to the significant amounts of renewable generation that has been connected (with bigger schemes in the construction and planning stages). If maximum system fault levels are applied to these sites there is a potential that the touch/step voltage levels will be too high to allow work to commence without further costly mitigation measure being implemented. This tool would allow an assessment to be made of what the probability would be of a life-threatening fault appearing at the substation so that the appropriate corrective action can be taken.

The following variables are used to define the probability function; fault magnitude probability and the probability of an employee being on site when the fault happens. The study also assessed the distribution of touch potentials within the substation to identify hazardous locations.

The user friendly interface package will allow SPEN staff to carry out assessments of earthing systems using statistical fault levels and clearance times values as opposed to worst case.

By being better equipped to assess the potential risk posed by existing substation earthing arrangements appropriate steps can be taken, which could be the avoidance of unnecessary expenditure on inappropriate mitigation measures.

The software analysis will help to justify Third party mitigation measures.</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">4 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">£ 15,562</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="10">The original project has been completed and follow up research works have been commissioned and agreed (April 2012) with Cardiff University to investigate the following:

1. Apply the approach developed in this study to the following situations:
• Potentials exported out with the substation.
• Locations or point within the substation.
2. Update the software for revised IEC/CENELEC standards.

Progress
Llandinam Substation was taken as one of the case studies in this research project. Deterministic and probabilistic techniques were used to assess the risk of rise of earth potential. The study was also used to assess the technical feasibility (with respect to reduction of ROEP) of two overhead line design options which were under consideration for the new Llandinam line.

The research project is now complete.</td></tr>
</table>

Potential for achieving expected benefits	• The probabilistic software has been updated to take into account the revised CENELEC standards. and assessment of the improved probability software tool is in progress. • Risk assessment will continue to be based, on the first pass, on conventional methods. Where a site exceeds the safety criteria, the exercise will progress to Phase 2 where the probabilistic method will be employed to refine the assessment.
Collaborative Partners	National Grid
R&D Providers	Cardiff University High Voltage Energy Systems Research Group.

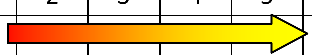
<table>
<tr><td>Project Title</td><td colspan="4">IFI 1001 – Offline Planning Tool for Dynamic Thermal Rating</td></tr>
<tr><td>Description of project</td><td colspan="4">The dynamic thermal rating (DTR) concept is based on the observation that the first limit for the current carrying capacity of a circuit is its temperature, influenced by its ability to dissipate to the environment the heat produced by the joule effect, and by external conditions such as ambient temperature, or wind speed, which are constantly varying. Even though the mechanisms of heat exchange involved are well understood, determination of the correct value of the circuit temperature is non-trivial. For this reason, static ratings based on the worst case scenario are often used.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £8,644
External £2,108
Total £10,753</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £30,574
External £33,579
Total £64,153</td></tr>
<tr><td>Project Cost</td><td colspan="2">£121,500</td><td>Projected 14/15 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 implementation of a DTR system in an electrical network could potentially increases its average rating whilst also reducing the risk of component thermal overload. However, successful implementation requires a number of challenges to be overcome. Not least the measurement, estimation and communication of real time component temperatures and prevailing weather conditions over a wide geographical area containing a significant number of power system components distributed around a complex terrain.

A successful DTR system could be used as a decision support tool for Distribution Network Operators (DNO). This tool could be used both at the planning stage and in real time within potential future active network management philosophies in order to safely increase the utilization of power systems and facilitate distributed generation (DG).</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>
</table>

<table>
<tr><td rowspan="1">Expected Benefits of Project</td><td colspan="10">Durham University is already working with SPEN and Astrium on a TSB project to investigate the use of DTRs for electrical distribution networks in order to accommodate increased levels of DG safely and cost effectively.

The aim of this phase of the work is to carry out further research and development work to build upon the achievements so far, ensure continuity and to avoid the loss of vital knowledge gained by the PhD researchers. The primary deliverable will be an offline tool to:

1. Allow SP planning engineers to evaluate the likely headroom which could be exploited through the adoption of DTR systems over a wide range of existing SP distribution networks.
2. Make use of historical power flow and meteorological data as well as terrain and vegetation information.
3. Estimate the ratings of overhead lines, underground cables and transformers over a wide area of distribution network and present these estimates in the form of a probability distribution function. (In this document ‘Distribution Network’ refers to networks with voltages up to and including 132kV)
4. Carry out thermal estimates for a wide range of types and configurations of overhead lines, underground cables and power transformers.
5. Allow calculations to be made regarding the potential additional energy that could be accommodated by the power system when dynamic ratings are adopted.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>4 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">Projects with various probabilities of success will be considered</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">£58,587</td></tr>
<tr><td>Project Progress March 14</td><td colspan="10">The project is now complete. An assessment tool was developed, building on the state-of-the-art computational fluid dynamic (CFD) modelling and high resolution terrain topology mapping developed previously. The tool uses the traditional distribution network planning methodology (as described within Engineering Recommendation P2/6 - “Security of Supply”), which is based on fixed static ratings for overhead lines, and combines this with enhanced ratings, as calculated using the CFD/terrain topology mapping tools previously developed last year.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The analysis of network security using dynamic ratings for overhead line conductors has provided significant insights in our understanding of the impact of utilising these techniques in real time and power flow analysis. There is real potential for these techniques to release significant network capacity headroom. However, the analysis is complex and further work is required to further validate the results.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Astrium, Durham University</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Durham University</td></tr>
</table>

Project Title	***IFI 1002 – Supergen HiDEF***								
Description of project	The Highly Distributed Power Systems Consortium have developed plans for renewal that will demonstrate a radical vision of a highly distributed energy future that enables all end users to participate in system operation and real time energy markets, and thereby more fully exploits the potential of distributed generation and active load resources to deliver a more sustainable and resilient provision of energy for the future								
Expenditure for financial year	Internal £5,654 External £2,108 **Total £7,762**	Expenditure in previous (IFI) financial years	Internal £24,974 External £102,258 **Total £127,232**						
Project Cost	**£4,492,000**	Projected 14/15 costs for SPEN	Internal £0 External £0 **Total £0**						
Technological area and / or issue addressed by project	This Highly Distributed Energy Future (HiDEF) programme researches the essential elements of a decentralised system that could be implemented over the period 2025 and 2050, but at the same time has been structured to support the evidence base relating to key questions of current concern within the stakeholder community and in this way its relevance extends beyond the limits of its decentralised system vision. In concept, the research vision is one of decentralised resources, control and market participation extending to include end users at system extremities.								
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical					
	Yes	No	No	No					
Expected Benefits of Project	Outputs from the HiDEF workstreams have informed active debates in the industry and enabled the following benefits to be realised: • Models of single and multiple DER (Distributed Energy Resource) units have been developed to assess the thermodynamic analysis, life cycle assessment and environmental cost benefit analysis, providing a quantification of performance • Development of control solutions for single units, cells containing multiple DERs, and multiple cells, with a focus on security and resilience of communications and control systems • Support and investment guidance for future decentralised network operation through the development of MV/LV architectures and planning tools • Design of a distributed market place, enabling the investigation of market based response, trading contracts and products, defining the components essential to market realisation • Inform future policy decisions by reviewing current policy delivery mechanisms in the UK, comparing market structures and examining the potential for alignment with various market aggregations								
Expected Timescale to Adoption	Year 2012 onwards	Duration of benefit once achieved	20 years						
Probability of Success	25%	TRL Development (Start – Current)							
		1	2	3	4	5	6	7	8	9
										
Project NPV	(Present Benefits x Probability of Success) – Present Costs	£78,648							

Project Progress March 2014	The project has completed its final year with many examples of completed models and tools, published results, and impact on industry demonstrations and trials. Efforts have been committed to make results more accessible including a final London workshop, updated web resources, and a series of on-line videos. This project is now closed.
Potential for achieving expected benefits	SP Distribution and SP Manweb networks, and to some extent SP Transmission will benefit from the insight into a power network well into the future and the challenges that it might bring. It is envisaged that this applied research project will be useful for future Price Control discussions, particularly in the areas of smart applications, regulatory and commercial structures. The project is academic in nature but at the same time taking into consideration current developments in areas such as smart meters, demand side management and micro generation among many others. Project progress over the last year has been good, and the completion of tasks and deliverables have been reported at the project management meetings. Case studies undertaken to date have demonstrated some of the benefits of wider adoption.
Collaborative Partners	EPSRC and the following industrialists: Community Energy Scotland, Delta Energy & Environment, Intelligent Power Systems, National Grid, Western Power Distribution, Scottish Power Energy Networks, Scottish and Southern Energy.
R&D Providers	University of Strathclyde supported by: University of Bath, Cardiff University, University of Oxford, Loughborough University, Imperial College London.

<table>
<tr><td>Project Title</td><td colspan="9">IFI 1004 – Remote Access to Pole Mounted Auto Reclosers</td></tr>
<tr><td>Description of project</td><td colspan="9">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 £10,139
External £2,108
Total £12,248</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £39,566
External £38,799
Total £78,364</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">£76,800</td><td colspan="3">Projected 14/15 costs for SPEN</td><td colspan="3">Internal £5,000
External £0
Total £5,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">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="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">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="9">• 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="3">10 years</td></tr>
<tr><td rowspan="2">Probability of Success</td><td rowspan="2">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>Project NPV</td><td colspan="4">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£343,820</td></tr>
</table>

Project Progress March 14	Development of a browser dashboard to give clear and concise summary information from the Envoy devices was delayed until the deployment of Windows 7 across the business. The Internet Explorer (IE) version used by the company would not allow the data to be displayed in the format that it was designed, and requires IE 9. The Envoy units are installed by the zones, with key staff trained to install, commission, and analyse the recovered data.
Potential for achieving expected benefits	The installation of this device to a problematic circuit affected by transient fault interruptions, causing short duration power interruptions to customers. The device reported in real-time identified the affected phase and recorded the fault current interrupted. With this information, the probable location of the fault was deduced. Line crews confirmed the fault location and a subsequent repair has prevented a re-occurrence and has improved the quality of supply to those affected Customers.
Collaborative Partners	None
R&D Providers	Nortech

Project Title	***IFI 1007 – Outram Fault Level Monitor***									
Description of project	The aim of this project is the development of a portable instrument that can successfully measure fault level on a distribution network with repeatability and reliability. The developed instruments will be deployed at various locations where there is uncertainty in fault level in Low Voltage, 11kV, 33kV and 132kV groups on the network.									
Expenditure for financial year	Internal £13,873 External £68,984 **Total £82,858**		Expenditure in previous (IFI) financial years		Internal £47,480 External £131,207 **Total £178,689**					
Project Cost	£121,196		Projected 2014/15 costs for SPEN		Internal £0 External £0 Total **£0**					
Technological area and / or issue addressed by project	It is proposed that the instrument could provide a viable fault level assessment alternative to extensive modelling or at locations where upstream and downstream fault level can vary drastically over a period of time making traditional fault level analysis complex.									
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical						
	Yes	No	No	No						
Expected Benefits of Project	• Accurate fault level profiles for 132kV, 33kV and 11kV distribution sites, showing both downstream and upstream contributions. • The identification and remedy of fault level conditions previously unidentified. • The release of network capacity previously unavailable due to perceived the fault level. • The deferment of investment on healthy equipment / network based on perceived fault level issues. • Validation and improvement of existing network models.									
Expected Timescale to adoption	<2 Years	Duration of benefit once achieved	10 Years							
Probability of Success	75%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
						5 → 9				
Project NPV	(Present Benefits x Probability of Success) – Present Costs		£188,953							
Project Progress March 2014	Over the course of 2013/14 there has been further trialling of the fault level monitor (FLM), the results obtained from each trial have been very satisfactory. As of March 2014 the project is now closed and the widespread application of FLMs has built into SPENs ED1 innovation strategy.									
Potential for achieving expected benefits	As of March 2013 the FLM has more than met the performance criteria set at the start of the project. The limitations of the FLM have been identified and a user guide is nearly complete. Testing has proven that the FLM will typically generate results that compare favourably with models. To achieve the full range of expected benefits the FLM has to be tested and be trialled by other DNOs / TSOs to further enhance its capabilities. Once its performance is accepted it can start to work its way into fault level policies.									

Collaborative Partners	Outram Research Ltd
R&D Providers	Outram Research Ltd

<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="3">Internal £8,644
External £40,998
Total £49,643</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £20,503
External £20,679
Total £41,181</td></tr>
<tr><td>Project Cost</td><td colspan="3">£326,000</td><td colspan="3">Projected 2014/15 costs for SPEN</td><td colspan="3">Internal £5,000
External £5,000
Total £10,000</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="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</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="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>3 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">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 colspan="3">→ (4 to 6)</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">Not known at this stage</td></tr>
</table>

Project Progress March 2014	A comparison of different energy storage operating schemes has been carried out and the resultant decrease in losses, voltage events, and On-Load Tap Changer (OLTC) operations has been assessed. A control methodology for the co-operative operation of the OLTC and ESS to derive maximum benefits on the MV network has been identified. The cost of operating the energy storage scheme has been determined; the cost saving based on increased lifetime for the OLTC and network upgrade deferral (transformer and lines/cables) resulting from reduction in peak power flows has been established.
Potential for achieving expected benefits	This investigation aims to show that the coherent coordination of ESS with OLTCs will deliver technical and financial benefits to DNOs in the UK when used on an MV distribution network with increasing demand requirements brought about by increased electrification.
Collaborative Partners	Electricity North West
R&D Providers	Durham 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 £7,897
External £15,533
Total £23,430</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £9,079
External £13,693
Total £22,772</td></tr>
<tr><td>Project Cost</td><td>£348,895</td><td colspan="2">Projected 2014/15 costs for SPEN</td><td>Internal £2,000
External £0
Total £2,000</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></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">TBC</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="10">The project has made significant progress to date through the publication of several papers on issues associated with GB Electricity Demand and Use of Demand Side Response. The following papers were published:

• Paper 8 – Electricity demand and household consumer issues
• Paper 9 – GB Electricity Demand – 2012 and 2025. Impacts of demand reduction and demand shifting on wholesale prices and carbon emissions. Results of Brattle modelling.
• Paper 10 – The Electricity Demand-Side and Local Energy: how does the electricity system treat ‘local’?
• Paper 11 – How could electricity demand-side innovation serve customers in the longer term? Frontier Economics & Sustainability First.

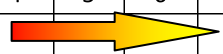
Paper 12 – The household electricity demand-side & the GB electricity markets : realising the resource is complete and will be published towards the end of summer 2014.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The project is on track to realise expected benefits.</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>

Project Title	***IFI 1107 – Cable Identification Devices***
Description of project	SEBA KMT has produced a device that uses DC pulses to positively identify cables either live or dead circuits. Identification is via a visual display which shows the rise and fall in signal strength along the cable length due to the layup of the cores. As DC is used there is no current induction in adjacent cables thus avoiding incorrect identification which other devices can suffer from. This project will be a trial evaluation of the device through field testing with the device being enhanced as appropriate.
Expenditure for financial year	Internal £7,149 External £2,108 **Total £9,257** Expenditure in previous (IFI) financial years: Internal £16,432 External £23,778 **Total £40,210**
Project Cost	£42,000 Projected 2014/15 costs for SPEN: Internal £0 External £0 Total **£0**
Technological area and / or issue addressed by project	Every year there are a number of instances where an incorrect cable is opened in error. This device has the potential to minimise these occurrences.
Type(s) of innovation involved	Incremental: Yes Significant: No Technological substitution: Yes Radical: No
Expected Benefits of Project	• The cable detection device can be used on both live and dead HV and LV circuits and no current is induced in adjacent circuits. • The requirement to excavate an LV cable to the nearest known service location is avoided. • Unnecessary customer interruptions are avoided. • The number of open excavations and the associated risk to staff and public is reduced.
Expected Timescale to adoption	<2 Years Duration of benefit once achieved: 10 Years
Probability of Success	90% TRL Development (Start – Current): 1 2 3 4 5 6 7 8 9
Project NPV	(Present Benefits x Probability of Success) – Present Costs: £1,123,305
Project Progress March 2014	Trialling has not provided the success rate expected and consequently no further development work is proposed. This project will subsequently be closed.
Potential for achieving expected benefits	The project did not realise the expected benefits. The device did not prove suitable for HV cable identification.
Collaborative Partners	None
R&D Providers	SEBA KMT

Project Title	***IFI 1202 – Nanodielectrics***			
Description of project	The aim of this project is to gain an understanding and practical experience of the processing of nanodielectric materials in order to develop a set of materials design and process rules to achieve the reliable production of high performance insulation materials.			
Expenditure for financial year	Internal £10,139 External £28,367 **Total £38,507**	Expenditure in previous (IFI) financial years	Internal £15,693 External £33,868 **Total £49,561**	
Project Cost	£104,980	Projected 2014/15 costs for SPEN	Internal £0 External £0 Total **£0**	
Technological area and / or issue addressed by project	The understanding gained by this project and the materials design rules developed will feed into HV equipment design to achieve new high performance equipment with significantly improved voltage and power ratings and potentially much smaller size for the same rating. Although targeted at HVDC applications, the knowledge gained within the project will also be relevant to HVAC applications.			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	Yes	Yes	Yes
Expected Benefits of Project	• Increased continuous, switching and emergency current ratings. • Higher power density equipment or smaller footprint assets. • Longer insulation lifetime and insulation more tolerant to overloads. • Enhanced flexibility in network operation. • Greater resistance to power electronics system harmonics particularly in systems containing HVDC technologies. • Lower capital costs for civil works. • Higher retained asset value and operational efficiency.			
Expected Timescale to adoption	<3 Years	Duration of benefit once achieved	10 Years	
Probability of Success	35%	TRL Development (Start – Current): 1, 2, 3, 4, 5, 6, 7, 8, 9 (4 → 5)		
Project NPV	(Present Benefits x Probability of Success) – Present Costs	Not known at this stage		
Project Progress March 2014	The project started on 1 June 2012. Good progress has been made in the selection of nanomaterials and investigating their processing with two new epoxy resins considered suitable for HVDC applications. The choice of resin is complete having good characteristics and storage stability with nanomaterials. The primary nanoparticles have been selected from many that were assessed and new mixing methods have been applied that produce much better dispersion than experienced before and reported in the literature to date. The work on nanomaterial surface treatments remains to be completed due to delays in appointments at the University of Warwick and this has required a 6 month extension of the project which has been formally requested of the TSB. Electrical measurements have confirmed excellent space charge charging and dissipation behaviour and very good current-voltage behaviour at short polarisation times. A good start has been made in measuring mechanical and thermal properties and in anticipating microcomposite formulations for component casting. The casting of trial components using reduced volume process methods has been demonstrated and			

	the selection of trial insulators for testing along with the testing programme has been determined. The requirements for industrial scaling of the processes for batch processing have been examined and process scaling trials will be initiated when final formulations are agreed. The case study to assess life cycle performance had also been agreed and this will be started on switchgear barrier bushings. The project was reported at two international conferences and one UK conference attracting significant attention. This project has been reassigned as a NIA Transmission project and is also included in the 2013/14 NIA annual report. All future costs will be booked against the NIA project. As of March 2014 this IFI project was closed.
Potential for achieving expected benefits	GnoSys Global Ltd, University of Southampton, ALSTOM Grid Research & Technology Centre, with collaborative involvement of other research centres such as National Physical Laboratory, the University of Warwick, and Imperial College London.
Collaborative Partners	NGC, SSE
R&D Providers	GnoSys UK, University of Southampton and Alstom Corporate Research & Technology Centre, University of Warwick and National Physical Laboratory

<table>
<tr><td>Project Title</td><td colspan="9">IFI 1203 – Psymetrix ACAM Phase 1</td></tr>
<tr><td>Description of project</td><td colspan="9">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="2">Internal £9,207
External £2,770
Total £11,977</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £51,912
External £149,517
Total £201,428</td></tr>
<tr><td>Project Cost</td><td colspan="2">£320,655</td><td colspan="3">Projected 2014/15 costs for SPEN</td><td colspan="4">Internal £8,000
External £48,000
Total £56,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">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="2">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">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="9">• 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>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">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></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">£187,974</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="9">• Since the installations were completed in the summer of 2013 there have been several technical issues with the availability of the PMUs and the 3G communication network. Unfortunately this has not enabled the proposed analysis to take place utilising simultaneous data from 5 PMUs / sites.
• Diagnosis of the PMUs and communications channels has now been completed, with repairs scheduled to take place in July 2014.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="9">The projects potential to deliver the expected benefits has not been diminished, but it has been delayed by the technical issues faced on Anglesey.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="9">Psymetrix</td></tr>
<tr><td>R&D Providers</td><td colspan="9">Psymetrix</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4">IFI 1205 – Transient Earth Detector</td></tr>
<tr><td>Description of project</td><td colspan="4">The Transient Earth Detector (TED) is a device for detecting and locating insulation breakdown faults on wood pole overhead lines. It comprises two parts: a passive low-cost Detector that clips around the earth wire on earthed poles, and a battery-powered hand held Reader that is carried by a linesman that can be used to interrogate the Detector to see if it has witnessed one or more fault occurrences.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £5,654
External £18,021
Total £23,675</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £4,451
External £15,039
Total £19,490</td></tr>
<tr><td>Project Cost</td><td>£207,000</td><td colspan="2">Projected 2014/15 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">Most faults that result in the overhead line protection tripping will occur on earthed poles where there is a clear return path for the fault current. Such faults include cracked insulators, damaged bushing or arcing horns, faulty surge arresters, internal breakdown within transformers, flashovers etc. By their nature, these faults are often intermittent and occur during adverse weather conditions/unsociable hours which means they are difficult and costly to locate. In addition, the reoccurring sequence of supply interruptions leads to significant annoyance to customers.</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">The Reader, when placed near the Detector, allows the contents of the Detector's counter to be displayed and, if required, re-set. By fitting a Detector to each earthed pole (either routinely as part of a foot patrol, or specifically in the case of known troublesome lines) defective poles will be readily identifiable from the ground after a fault event, even whilst the line is energised.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="3">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
</td></tr>
<tr><td>Project NPV</td><td colspan="3">(Present Benefits x Probability of Success) – Present Costs</td><td>£11,745</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="4">Several meetings during early 2012 been held between EA Technology, SPEN and the EIC to develop the specification ideal product format for the technology to give maximum benefit for minimum cost to the customer.

Although the result of the above was successful in terms of identifying a very efficient design solution. The resultant format represented a very low cost solution as compared to the original project proposal which did NOT represent a viable commercial business case for EA Technology to develop and market a product. The project has therefore been closed.</td></tr>
</table>

Potential for achieving expected benefits	Project feasibility meetings have confirmed the need for the device, although the originally proposed format (a low cost pole mounted device without fault time stamping supported by a sophisticated hand held reader) is not the best configuration for field benefit. A revised technical approach has been agreed, with some additional functionality in the pole mounted device to time stamp faults, which enables the technology to be used without the need for a hand held scanner.
Collaborative Partners	None
R&D Providers	EA Technology Ltd

<table>
<tr><td>Project Title</td><td colspan="9">IFI 1206 – Sudafix Conductive Concrete</td></tr>
<tr><td>Description of project</td><td colspan="9">Traditional earthing methods are susceptible to theft, and earthing can be difficult in rocky areas in certain soil conditions. To overcome this challenge FM Sudafix designs and supplies industry leading earthing systems utilizing Conducrete. The Conducrete product has been successfully applied in a number of industry sectors (e.g. telecoms, rail, trams), but not as yet with DNOs.

This project will assess the earthing performance and anti-theft capability of Conducrete in power networks.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £5,654
External £11,541
Total £17,195</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £3,383
External £36,090
Total £39,473</td></tr>
<tr><td>Project Cost</td><td colspan="3">£55,062</td><td colspan="3">Projected 2014/15 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">The project will undertake earthing resistivity tests to validate the claims of Conducrete resistive properties, thermal shock test to demonstrate that the products electrical performance is satisfactory both during normal load and repeated fault conditions and mechanical impact tests to determine Conducrete's anti-theft capability.</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">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="9">• The successful project would enable a DNO to fully take on board the use of Conducrete in design and installation activities.
• The use of Conducrete makes it easier to achieve target earth resistances.
• Reduced need for boreholes to solve earthing problems and reduced earth trenching requirements to meet earth resistance specifications.
• The use of Conducrete to reduce the risk of copper theft
• The pressure for new transformer sites to occupy a smaller and smaller land footprint places challenges on earthing in some soil situations and so Conducrete could be very useful in these circumstances.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">25 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">£24,734</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="9">• The final project report was delivered on 01-09-2013.
• This project is now closed</td></tr>
</table>

Potential for achieving expected benefits	The thermal shock and mechanical impact tests have been completed with the results being positive. Early resistivity results indicate that significant improvement in resistivity can be achieved.
Collaborative Partners	SSE, Energy Innovation Centre
R&D Providers	FM Sudafix Ltd

<table>
<tr><td>Project Title</td><td colspan="4">IFI 1207 – Smart 3 Phase Voltage Regulator</td></tr>
<tr><td>Description of project</td><td colspan="4">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>Internal £6,309
External £28,836
Total £35,145</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £4,095
External £21,342
Total £25,437</td></tr>
<tr><td>Project Cost</td><td>£225,000</td><td>Projected 2014/15 costs for SPEN</td><td colspan="2">Internal £5,000
External £24,000
Total £29,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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>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 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>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>10%</td><td colspan="3">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9</td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">£76,055</td></tr>
</table>

Project Progress March 2014	The initial stages of the project had been successfully however the company was placed in Administration in March 2014. As a result the project was placed on hold and to date no further work has been carried out on it. Various options are being investigated to continue the project or end it.
Potential for achieving expected benefits	The first stage of the project identified the limitations of the initial GenDrive approach which would have had limited ability to achieve the benefits sought. However a second design has been created that exceeds these. There is a good level of optimism that this project will deliver the benefits sought.
Collaborative Partners	None
R&D Providers	Gendrive Ltd, (supported by EA Technology)

<table>
<tr><td>Project Title</td><td colspan="10">IFI 1209 – Substation Earth Integrity Monitoring System</td></tr>
<tr><td>Description of project</td><td colspan="10">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 £4,906
External £6,541
Total £11,447</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £15,387
External £141,470
Total £156,857</td></tr>
<tr><td>Project Cost</td><td colspan="3">£189,347</td><td colspan="3">Projected 2014/15 costs for SPEN</td><td colspan="4">Internal £40,000
External £246,965
Total £286,976</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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 ScottishPower substations.</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">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>1 Year</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">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="4">→ (5 to 8)</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£71,378</td></tr>
</table>

Project Progress March 2014	**RFID Tags and SWR** • In the light of early successes with the RFID testing the project plan has been reworked in order to concentrate all engineering resources into the RFID technology only. • A suitable substation site requires to be identified to trial the developed system **Cresatech CuTS Prototype Unit** • Scottish & Southern Energy joined the project at the site trials stage of the project • Strong and consistent results achieved at SPEN sites in Wales and in the USA • Digitisation of much of the system, enabling filtering and other capabilities has been further developed • Requirement to split larger substation earthing infrastructures into zones to ensure that compromising of the earthing integrity is detected by a CuTS monitoring unit has been completed • Communication requirements have been developed • A wider pilot phase is under consideration
Potential for achieving expected benefits	Given the success of the RFID testing and substation trials of the Cresatech CuTS prototype unit the potential for achieving expected benefits is considered to be high.
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="12">IFI 1211 – Smart CCU Development</td></tr>
<tr><td>Description of project</td><td colspan="12">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="3">Internal £94,396
External £11,541
Total £105,937</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £64,625
External £85,015
Total £149,641</td></tr>
<tr><td>Project Cost</td><td colspan="3">£88,000</td><td colspan="4">Projected 2014/15 costs for SPEN</td><td colspan="5">Internal £15,000
External £0
Total £15,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">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="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">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="12">• 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 colspan="3"><1 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" colspan="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></td><td></td><td colspan="2">→</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="7">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">Not determined at this stage</td></tr>
</table>

Project Progress March 2014	Significant development work has been carried out on this project. Awaiting installation at St Andrews substation for final field trials. The project is reliant upon the installation of an 86870-5-104 comms link to complete the project. The project is on target for completion in 2014.
Potential for achieving expected benefits	The potential for achieving expected benefits is considered to be high
Collaborative Partners	SmartGridNetworks
R&D Providers	SmartGridNetworks

<table>
<tr><td>Project Title</td><td colspan="9">IFI 1213 – Phase 3 Transformer Research Consortium</td></tr>
<tr><td>Description of project</td><td colspan="9">The University of Manchester has undertaken research into alternative oils as potential replacement for traditional mineral ones for power transformer application. A subsequent Phase 3 to this research work is proposed that will extend into transformer insulation systems, not excluding alternative liquids, but focus more on the common problems faced by electrical power utilities such as ageing, dissolved gas analysis (DGA) and partial discharge (PD), inhibited and non-inhibited mineral oils and thermal performance assessment of power transformers.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £9,392
External £39,608
Total £49,000</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £5,519
External £1,693
Total £7,212</td></tr>
<tr><td>Project Cost</td><td colspan="3">£172,500</td><td colspan="2">Projected 2014/15 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">The project aims to consider 1) Ageing - Rate of ageing and end of life predictions 2) On-line DGA Devices - Evaluating the performance of devices under fault conditions 3) DGA versus PD - Understanding the relationship between DGA and PD; 4) PD of Aged Insulation Systems - Quantify the impact on PD activity of ageing by-products; and 5) Thermal Performance Assessment.</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">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="9">• Inform transformer asset decision making regarding maintenance, condition monitoring and specification.
• Improved knowledge sharing and communications within the UK transformer community.
• The research findings could lead to improvements to existing transformer equipment, designs or processes.
• Through a better understanding of the transformer ageing process, within an ageing asset population, timely corrective action can be taken to avert potential safety issues arising.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>4 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">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 colspan="2">4 → 5</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">£1,067,034</td></tr>
</table>

Project Progress March 2014	**Work Package 1** • Methodology of data presentation and analysis on transformer oil database was developed. • Population trend analysis on transformer oil database from SPEN, NG and UKPN has been completed. Acidity shows the clearest ageing trend compared with other parameters like moisture and breakdown voltage. • An early peak of acidity at age of around 20-25 years was identified, which was proved to be an UK national wide feature. • A Head Space-Gas Chromatograph Mass Spectrometry based technique was developed to measure Methanol in oil, which is expected as a novel paper ageing indicator. **Work Package 2** • Partial discharge (PD) behaviours of various oils including a conventional mineral oil Gemini X, a new Gas-to-Liquid transformer oil Diala S4, a synthetic ester transformer oil Midel 7131, were documented using IEC 61294 electrode configuration. • Effects of oil conditions on PD behaviours were investigated. PDIV was less affected by oil condition compared with PD patterns at overstressed voltages. In addition, PD number was found to be more sensitive to oil condition than maximum PD amplitude. • In general, MIDEL 7131 has higher PD magnitude and larger PD number than other two oils. • Effect of electrode configuration on PDIV was studied. PDIV in quasi-uniform (plane-needle-plane) field is much higher than that in divergent field (needle-plane) . **Work Package 3** • DGA test system using Kelman Transfix DGA device has been set up. • DGA test systems using Calisto-2 DGA device has been set up. • DGA test platform using multiple-DGA devices is being developed. **Work Package 4** • Literature review of transformer thermal performance using modelling and experimental approaches was completed. • A small-scale thermal test rig, which enables studying various cooling structures, is being developed. This project has been reassigned as a NIA Transmission project and is also included in the 2013/14 NIA annual report. All future costs will be booked against the NIA project. As of March 2014 this IFI project was closed.
Potential for achieving expected benefits	All the indications show that the project is on track to realise the expected benefits
Collaborative Partners	Alstom Grid, National Grid, Scottish Power, UK Power Network, M&I Materials, Electricity North West, Weidmann
R&D Providers	University of Manchester

Project Title	***IFI 1215 – Self Repair MV Underground Cables***									
Description of project	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.									
Expenditure for financial year	Internal £6,401 External £71,549 **Total £77,951**	Expenditure in previous (IFI) financial years	Internal £4,807 External £34,959 **Total £39,766**							
Project Cost	£224,350	Projected 2014/15 costs for SPEN	Internal £7,000 External £47,477 Total **£54,477**							
Technological area and / or issue addressed by project	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.									
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical						
	No	Yes	No	No						
Expected Benefits of Project	• 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									
Expected Timescale to adoption	4 Years	Duration of benefit once achieved	20 Years							
Probability of Success	25%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
				3 → 4						
Project NPV	(Present Benefits x Probability of Success) – Present Costs	£15,340								

Project Progress March 2014	• 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 will look at the merging of two different repair technology classes to gain the best possible self-repairing mechanisms.
Potential for achieving expected benefits	Stage one of this project has been completed to date and has delivered some significant findings. The view thus far is positive.
Collaborative Partners	SSE, Energy Innovation Centre
R&D Providers	Gnosys Ltd

<table>
<tr><td>Project Title</td><td colspan="4">IFI 1216 – The Role of the Demand Side in Delivering Effective Smart Grids</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 £16,858
External £12,033
Total £28,891</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £8,878
External £11,693
Total £20,571</td></tr>
<tr><td>Project Cost</td><td>£19,925</td><td>Projected 2014/15 costs for SPEN</td><td colspan="2">Internal £1,000
External £0
Total £1,000</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>
<tr><td>Expected Benefits of Project</td><td colspan="4">• 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>
</table>

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Expected Timescale to adoption	<2 Years	Duration of benefit once achieved				10 Years				
Probability of Success	50%	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 2014	During the reporting period two meetings have taken place with the UK project partners of the project whereby updates have been provided on the activities of the wider project and learning gained from each area to date. A number of discussions have taken place on activity and experience from each of the UK partners that include both DNOs, Suppliers and Welsh Assembly Government representatives. Several Stakeholder surveys and workshops were also held to inform on UK domestic customers appetite for engagement in demand response activities and what is required to change their behaviour.									
Potential for achieving expected benefits	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.									
Collaborative Partners	EON, ENW and NG									
R&D Providers	EA Technology									

Project Title	***IFI 1218 – Impact of Residential Heating and Building Standards on Demand Profiles***								
Description of project	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.								
Expenditure for financial year	Internal £8,644 External £2,108 **Total £10,753**		Expenditure in previous (IFI) financial years		Internal £11,927 External £1,693 **Total £13,620**				
Project Cost	£96,000		Projected 2014/15 costs for SPEN		Internal £8,640 External £49,800 Total £58,440				
Technological area and / or issue addressed by project	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.								
Type(s) of innovation involved	Incremental		Significant		Technological substitution		Radical		
	No		No		Yes		No		
Expected Benefits of Project	• 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								
Expected Timescale to adoption	3 Years		Duration of benefit once achieved		15 Years				
Probability of Success	50%	TRL Development (Start – Current)							
		1	2	3	4	5	6	7	8	9
							6 → 7			
Project NPV	(Present Benefits x Probability of Success) – Present Costs				£84,113				

Project Progress March 2014	• 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 • Ravenscraig low carbon homes are being monitored • Additional installation planned for CHP heating high rise site in Glasgow • Profiles captured and ADMD values have been quantified • Tool developed to calculate ADMD value based on data captured • Future work will focus on finalising project outcomes using captured data
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="8">IFI 1219 – Substation Efficiency</td></tr>
<tr><td>Description of project</td><td colspan="8">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. Energy efficiency has been lower priority in the past; however, 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 underheating, lack of control, lighting defects and the need to install ventilation. This is leading 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 £8,644
External £41,681
Total £50,325</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £20,471
External £49,608
Total £70,079</td></tr>
<tr><td>Project Cost</td><td colspan="2">£139,800</td><td colspan="3">Projected 2014/15 costs for SPEN</td><td colspan="3">Internal £12,582
External £71,880
Total £84,462</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="8">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="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="8">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 colspan="2"><2 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="3">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="7">TRL Development (Start – Current)</td></tr>
<tr><td>1 2 3 4 5 6</td><td>7</td><td>8</td><td>9</td><td colspan="3"></td></tr>
<tr><td colspan="7">7 → 8</td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£850,809</td></tr>
</table>

Project Progress March 2014	• 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 • 10 substations selected to receive installation of metering to capture electrical demands • Work started on installing improved heaters and control to these substations • Future work focussed on assessing outcomes of substation improvements and potential benefits if rolled out further
Potential for achieving expected benefits	High
Collaborative Partners	None
R&D Providers	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="9">IFI 1220 – Smart Grid Forum WS3 Phase 3</td></tr>
<tr><td>Description of project</td><td colspan="9">Production of a techno-economic model to assess Smart Grid investments in support of the delivery of the UK's Low Carbon Transition Plan. This project supports Workstream 3 activities under the Smart Grid Forum.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £4,906
External £2,108
Total £7,014</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £4,095
External £58,386
Total £62,481</td></tr>
<tr><td>Project Cost</td><td colspan="3">£649,420</td><td colspan="3">Projected 2014/15 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">Technical modelling and development of a cost benefit analysis network investment tool for a range of typical network types from EHV to LV. Model to be run against synthetic networks at each voltage level under a range of low carbon uptake scenarios.</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">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="9">The project will develop a range of typical network types from EHV to LV that can provide a modelling framework for the majority of GB network topologies. That:
• Are able to characterise the national targets/national levels of uptake of Low Carbon Technologies, DG, etc. on a regional or sub-regional basis and aggregates point loads up to the required level.
• Quantifies, in terms of cost and headroom released, the range 'smart grid' mitigating solutions identified in the WS3 Phase 1 report. Including the identification of relevant LCN Fund projects and their delivery timescales.
• Combines these measures together in a manner that is consistent with that being undertaken for Ofgem under WS2.
• This project will give a more granular output, which could be used by individual DNOs to inform ED1 business plans.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td colspan="4">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">£14,590</td></tr>
</table>

Project Progress March 2014	This project has produced the TRANSFORM Model - a techno-economic model to assess Smart Grid investments in support of the delivery of the UK's Low Carbon Transition Plan. During "Phase 3" of the project, the model has been peer reviewed by leading consultancies and the GB Network Operator community. The specific focus of this phase of the work was to assess whether there are 'Least Regrets' investments or other actions that should be made in the RIIO-ED1 period in anticipation of achieving efficient deployments in ED2, noting the lead times involved. http://www.energynetworks.org/electricity/smart-grid-portal/decc/ofgem-smart-grid-forum/work-stream-3.html As of March 2014 the WS3 activities under IFI 1220 and IFI 1309 were completed.
Potential for achieving expected benefits	The assessment highlighted the following findings: • The analysis continues to show a strong cost benefit in adopting a smart investment strategy over a purely conventional investment strategy for all the DECC scenarios considered to 2050; this benefit is of the order of 25-30% of total investment costs to 2050; • The conclusions are not sensitive to the availability of any one individual smart solution; the model continues to show that a mix of smart and conventional solutions is likely to provide the optimum investment strategy for GB; • The model can therefore be expected to provide helpful guidance for the estimated investment trajectory whilst not being prescriptive of specific smart solutions; • The model now includes Tipping Point analysis that provides early warning to DNOs for the anticipated preparation timescales and the severity of likely business impacts of specific smart solutions on a distribution company's processes and systems; • Incorporating the impact of Tipping Points on smart solutions, where the increasing scale of deployment offers the opportunity for procurement efficiencies, gives a further predicted investment benefit of around £1billion in Totex to 2050; • An important conclusion from the revised model, that now includes closer analysis of enabler costs, is that a "Full" top down investment strategy no longer shows a financial benefit over an incremental investment strategy
Collaborative Partners	WPD, SSE, UKPN, SP, ENW, NPG, NG, Inexus GL Noble Denton, Element Energy, Frontier Economics, Chiltern Power
R&D Providers	EA Technology

Project Title	***IFI 1302 – SUSCABLE 2***									
Description of project	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.									
Expenditure for financial year	Internal £6,401 External £2,108 **Total £8,510**	Expenditure in previous (IFI) financial years		Internal £0 External £0 **Total £0**						
Project Cost	£143,333	Projected 2013/14 costs for SPEN		Internal £10,000 External £53,333 Total **£63,333**						
Technological area and / or issue addressed by project	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).									
Type(s) of innovation involved	Incremental	Significant		Technological substitution		Radical				
	No	Yes		No		No				
Expected Benefits of Project	• 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									
Expected Timescale to adoption	<2 Years	Duration of benefit once achieved		10 Years						
Probability of Success	35%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
						5 → 6				
Project NPV	(Present Benefits x Probability of Success) – Present Costs			£71,499						

Project Progress March 2013	The project has not formally started due to delays in establishing contractual agreements with a new additional partner. These have now been resolved and it is expected that the project will begin in June 2014.
Potential for achieving expected benefits	To be determined
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

Project Title	***IFI 1304 – Smart Meter Enablement***
Description of project	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.
Expenditure for financial year	Internal £15,373 External £112,736 **Total £128,109** Expenditure in previous (IFI) financial years: Internal £5,519 External £1,693 **Total £7,212**
Project Cost	£383,000 Projected 2014/15 costs for SPEN: Internal £6,062 External £214,849 Total **£220,911**
Technological area and / or issue addressed by project	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
Type(s) of innovation involved	Incremental: No Significant: No Technological substitution: Yes Radical: No
Expected Benefits of Project	• Readiness for the implementation of smart meters and accession to new Smart Energy Code • Ability to innovatively use smart meter data
Expected Timescale to adoption	<2 Years Duration of benefit once achieved: 10 Years
Probability of Success	50% TRL Development (Start – Current): 1 2 3 4 5 6 7 8 9
Project NPV	N/A at this trial stage
Project Progress March 2014	• 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
Potential for achieving expected benefits	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.
Collaborative Partners	Kyria, potentially GE, AMT-Sybex other DNO.
R&D Providers	Kyria, potentially GE and AMT-Sybex.

<table>
<tr><td>Project Title</td><td colspan="9">IFI 1305 – Low Power Radio Alarm System</td></tr>
<tr><td>Description of project</td><td colspan="9">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 £13,855
External £102,217
Total £116,072</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £8,114
External £8,559
Total £16,673</td></tr>
<tr><td>Project Cost</td><td colspan="3">£104,277</td><td colspan="3">Projected 2014/15 costs for SPEN</td><td colspan="3">Internal £2,000
External £0
Total £2,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">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="2">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">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="9">• Development of a low power radio
• Development of an interface into an NMS100 NCP RTU</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1.5 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></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">-£15,760</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="9">Prototypes have been delivered and a workshop trial has been conducted. Now awaiting a site trial. The target date for completion is 2014.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="9">The potential for achieving expected benefits is considered to be high.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="9">Smart Grid Networks</td></tr>
<tr><td>R&D Providers</td><td colspan="9">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 £13,324 External £276,784 **Total £290,109**	Expenditure in previous (IFI) financial years	Internal £0 External £0 **Total £0**
Project Cost	£360,936	Projected 2014/15 costs for SPEN	Internal £35,000 External £115,000 Total **£150,000**

<table>
<tr><td rowspan="1">Technological area and / or issue addressed by project</td><td colspan="9">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>Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>No</td><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">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="4">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="2">5 → 6</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">N/A at this stage</td></tr>
</table>

Project Progress March 2014	**Incident Dispatch & Status Management (IDSM)** • Application completing development and subject to User Acceptance Testing (UAT) • Initial concept demonstrated and tested with pilot users **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	Based on the work carried out to date the potential for achieving expected benefits is considered to be good.
Collaborative Partners	**Incident Dispatch & Status Management (IDSM)** IRW **Cable Head Register and Service Position Inspection Application (CHR & SPIA)** IQA
R&D Providers	Sigma Seven

Project Title	***IFI 1308 – HTIP***									
Description of project	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.									
Expenditure for financial year	Internal £7,011 External £31,156 **Total £38,167**		Expenditure in previous (IFI) financial years		Internal £0 External £0 **Total £0**					
Project Cost	£76,516		Projected 2014/15 costs for SPEN		Internal £7,300 External £48,733 Total **£56,033**					
Technological area and / or issue addressed by project	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.									
Type(s) of innovation involved	Incremental		Significant		Technological substitution		Radical			
	No		Yes		No		No			
Expected Benefits of Project	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.									
Expected Timescale to adoption	2 Years	Duration of benefit once achieved		20 Years						
Probability of Success	50%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
				→ (3 to 8)						
Project NPV	(Present Benefits x Probability of Success) – Present Costs					£340,000				

Project Progress March 2014	The project had identified 20 milestones, 9 of which have been completed. From initial kick off meetings, the project has reviewed components, completed power circuit testing, specified software and completed the software development. Full product tests and pre-commercialisation have started.
Potential for achieving expected benefits	• Successful demonstrations of a prototype unit to DECC and SPEN have supported the case that this project has the great potential to deliver a working unit. • Issues raised earlier in the project such as closed loop control, load current issues and noise have all been addressed.
Collaborative Partners	SPEN, DECC, Energy Innovation Centre
R&D Providers	HTIP Ltd

<table>
<tr><td>Project Title</td><td colspan="11">IFI 1309 – Smart Grid Forum WS3 TRANSFORM Model</td></tr>
<tr><td>Description of project</td><td colspan="11">This project follows on from IFI1220 and develops the economic aspects of the TRANSFORM model to be more in line with economic assessment methods recommended by Ofgem. The cost-benefit analysis methodology, including the CBA engine, will be modified in order to align with Ofgem recommendations for CBA analysis. Where it is not practical to do this within the model itself, methods will be developed to carry out these methods with post-processing externally to the model.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £4,906
External £44,978
Total £49,884</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">£649,420</td><td colspan="4">Projected 2014/15 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="11">Technical modelling and development of a cost benefit analysis network investment tool for a range of typical network types from EHV to LV. Model to be run against synthetic networks at each voltage level under a range of low carbon uptake scenarios.</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">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="11">The project will develop a range of typical network types from EHV to LV that can provide a modelling framework for the majority of GB network topologies. That:
• Are able to characterise the national targets/national levels of uptake of Low Carbon Technologies, DG, etc. on a regional or sub-regional basis and aggregates point loads up to the required level.
• Quantifies, in terms of cost and headroom released, the range ‘smart grid’ mitigating solutions identified in the WS3 Phase 1 report. Including the identification of relevant LCN Fund projects and their delivery timescales.
• Combines these measures together in a manner that is consistent with that being undertaken for Ofgem under WS2.
• This project will give a more granular output, which could be used by individual DNOs to inform ED1 business plans.</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">15 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3" colspan="2">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="5">£14,590</td></tr>
</table>

Project Progress March 2014	• Six areas were identified for change within the model. The following items have been changed within the model: • Extending the CBA period from 40 to 45 years • Moving the price base one year forward to 2013 • Moving the base year three years forward to 2015 • Changing depreciation for conventional solutions to 45 years • Adjusting non capacity benefits (losses and interruptions) to come on at the end of year 1 • Changing the discount rate to reduce to 3% from 3.5% after 30 years This project is now complete.
Potential for achieving expected benefits	Following the completion and successful delivery of the Smart Grid Forum Work Stream 3 Phase 3 programme of work, EA Technology was approached by Ofgem to discuss whether the model complies with their most recent guidance for conducting Cost Benefit Analysis (CBA) calculations (finalised April 2013). This discussion revealed a number of areas where the Transform Model®1 differs from current Ofgem requirements. In some areas these differences are relatively minor and easy to adjust, whilst in some areas the changes are quite involved and in one or two instances it is suggested that it is not suitable to make the changes within the model as this would be detrimental to the functionality of the model. In these instances it is suggested the DNOs make further calculations outside of the Transform Model®.
Collaborative Partners	WPD, SSE, UKPN, SP, ENW, NPG, NG, Inexus GL Noble Denton, Element Energy, Frontier Economics, Chiltern Power
R&D Providers	EA Technology

<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 £5,140
External £21,207
Total £26,347</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td>£231,450</td><td colspan="2">Projected 2014/15 costs for SPEN</td><td>Internal £5,000
External £48,000
Total £53,000</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">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="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£505,000</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="10">The project has successfully completed the first two stages 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.</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>

Project Title	***IFI 1311 – Green Running***										
Description of project	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										
Expenditure for financial year	Internal £4,906 External £36,615 **Total £41,521**		Expenditure in previous (IFI) financial years			Internal £0 External £0 **Total £0**					
Project Cost	£163,000		Projected 2014/15 costs for SPEN			Internal £5,000 External £32,534 Total **£37,534**					
Technological area and / or issue addressed by project	Load and DG detection, being able to identify types of load on a network from their harmonic signatures.										
Type(s) of innovation involved	Incremental	Significant		Technological substitution			Radical				
	No	No		Yes			No				
Expected Benefits of Project	Load and DG detection, being able to identify types of load on a network from their signatures.										
Expected Timescale to adoption	3 Years	Duration of benefit once achieved			20 Years						
Probability of Success	25%	TRL Development (Start – Current)									
		1	2	3	4	5	6	7	8	9	
						5 → 6					
Project NPV	(Present Benefits x Probability of Success) – Present Costs				£1.8m						
Project Progress March 2013	The prototype system has been installed in a number of substations and has provided some promising results. Full details will come with post analysis of the data gathered from these sites.										
Potential for achieving expected benefits	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.										
Collaborative Partners	SSEPD, Energy Innovation Centre										
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 £8,180 External £2,108 **Total £10,288**	Expenditure in previous (IFI) financial years	Internal £0 External £0 **Total £0**						
Project Cost	£813,000	Projected 2014/15 costs for SPEN	Internal £30,000 External £203,000 Total **£233,000**						
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 2014	The batteries required for testing have been procured. All parties are now in place to begin the first phase laboratory trials to prove the technology. Significant work / time has been spent to get the legal documents signed between all parties (DNOs, multiple suppliers and academic bodies). This has taken significantly longer than originally anticipated. Despite the time spent on the legal side the project is still progressing as intended. The laboratory at the University of Southampton has been set up and is expected to begin performing test schedules on the different battery packs in June 2014. The project management is controlled by Future Transport Systems and work is progressing well with all the required suppliers on board to build the individual parts to create the communications / integration / control system.								

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.
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 £4,906
External £26,541
Total £31,447</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td>£75,000</td><td>Projected 2014/15 costs for SPEN</td><td colspan="2">Internal £5,000
External £0
Total £5,000</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>
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<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">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 colspan="4">→ (2 to 5)</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">£802,753</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="10">The project started in April 2013. Initial kick off meeting completed. Supply of test material established and test equipment ordered.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Project started in April 2013, potential for achieving expected benefits as per above probability of success.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">SSE, UK Power Networks, Electricity Northwest, Northern PowerGrid</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Acuity Products Ltd</td></tr>
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<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 £8,552
External £44,707
Total £53,259</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td>£33,166</td><td colspan="2">Projected 2014/15 costs for SPEN</td><td>Internal £2,000
External £0
Total £2,000</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>

Probability of Success	50%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
							→	→		

Project NPV	(Present Benefits x Probability of Success) – Present Costs	£2,796,290

Project Progress March 2014	A prototype has been delivered and a workshop trial is underway. The target for completing the project is 2014
Potential for achieving expected benefits	The potential for achieving expected benefits remains high
Collaborative Partners	None
R&D Providers	Smart Grid Networks Limited

Project Title	***IFI 1317 – Cable Core Temperature Monitoring***											
Description of project	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".											
Expenditure for financial year	Internal £4,906 External £52,741 **Total £57,647**			Expenditure in previous (IFI) financial years			Internal £0 External £0 **Total £0**					
Project Cost	£206,000			Projected 2014/15 costs for SPEN			Internal £5,000 External £0 Total **£5,000**					
Technological area and / or issue addressed by project	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%).											
Type(s) of innovation involved	Incremental		Significant		Technological substitution			Radical				
	No		No		Yes			No				
Expected Benefits of Project	• 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.											
Expected Timescale to adoption	3 Years		Duration of benefit once achieved				25 Years					
Probability of Success	10%	TRL Development (Start – Current)										
		1	2	3	4	5	6	7	8	9		
				3 → 5								
Project NPV	(Present Benefits x Probability of Success) – Present Costs						£194,965					
Project Progress March 2014	The project started in January 2014. Stage 1 the analytical and experimental proof of principle has been completed. The direct temperature measurement technique has been adopted as the favoured method.											

Potential for achieving expected benefits	Stage 1 work 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 measures 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="4">IFI 1318 – VTOL</td></tr>
<tr><td>Description of project</td><td colspan="4">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 £9,583
External £11,541
Total £21,124</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td>£416,000</td><td>Projected 2014/15 costs for SPEN</td><td colspan="2">Internal £7,900
External £56,333
Total £64,233</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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>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>
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<tr><td>Expected Benefits of Project</td><td colspan="11">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="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£624,442</td></tr>
<tr><td>Project Progress March 2014</td><td colspan="10">Project kick off meeting held in March. Stage 1 to commence at the start of April</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>
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