Innovation Funding Incentive
Annual Report

3rd September 2013

IFI Projects
April 12 – March 13

For SP Distribution Ltd, SP Manweb plc and SP Transmission Ltd

Foreword

During 2012/13 SP Energy Networks (SPEN) has continued to strengthen its Distribution innovation activities and, in response to Ofgem's innovation stimulus measures proposed under RIIO T1, we have been identifying further potential Transmission innovation projects in anticipation of the Network Innovation Allowance (NIA) and Network Innovation Competition (NIC). Our RIIO ED1 Business Plan for 2015 – 2023 reflect the outcomes of innovation and our belief in the power of innovation to deliver tangible and meaningful benefits for our customers, indeed our RIIO ED1 plans include £100M benefit to our customers from the adoption of innovation.

During the reporting year 2012/13, we authorised 16 new IFI projects to increase our balanced portfolio to fifty projects that embraced the range of Technology Readiness Levels from concept through to trial and demonstration. Once again we have achieved significant leverage of R&D spend through collaboration and, alongside these projects, we have further progressed Low Carbon Network Funded (LCNF) projects at both Tier 1 and 2 level. For all projects we will maintain our focus to ensure early adoption and commercialisation, as appropriate, to ultimately realise customer benefits.

SPEN has continued its strategic deployment of wide ranging IFI projects including new and existing projects with academic and industrial partners. Of particular note are two earthing integrity projects that were initiated in response to the incidence of high copper theft experienced, not only within the electricity supply industry but the UK as a whole. One of these projects was the recipient of the UK Energy Innovation Award in the field of Asset Security Innovation.

SPEN has been actively engaged in the development of the world-class Power Networks Demonstration Centre (PNDC) at Cumbernauld, adjacent to our existing training centre. It was officially opened by the First Minister of Scotland, Alex Salmond in May 2013. In anticipation of the centre being open for business we have invested significant effort during 2012/13 to identify and develop suitable projects for network trials at the centre.

We recognise that innovation will be a key enabler to ensuring that SPEN's network is 'low carbon ready' in response to the higher 2020 carbon reduction targets set for Scotland and Wales. We welcome the opportunity this presents to play a major part in the UK's low carbon transition.

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 / transmission 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.

With the extension of IFI to the transmission licences, agreement at the ENA R&D Working Group was given to the creation of a common Good Practice Guide (GPG) considering IFI for electricity distribution, transmission and gas transmission networks; Version 2 of Engineering Recommendation G85 issued in December 07.

2. SP Energy Networks Structure

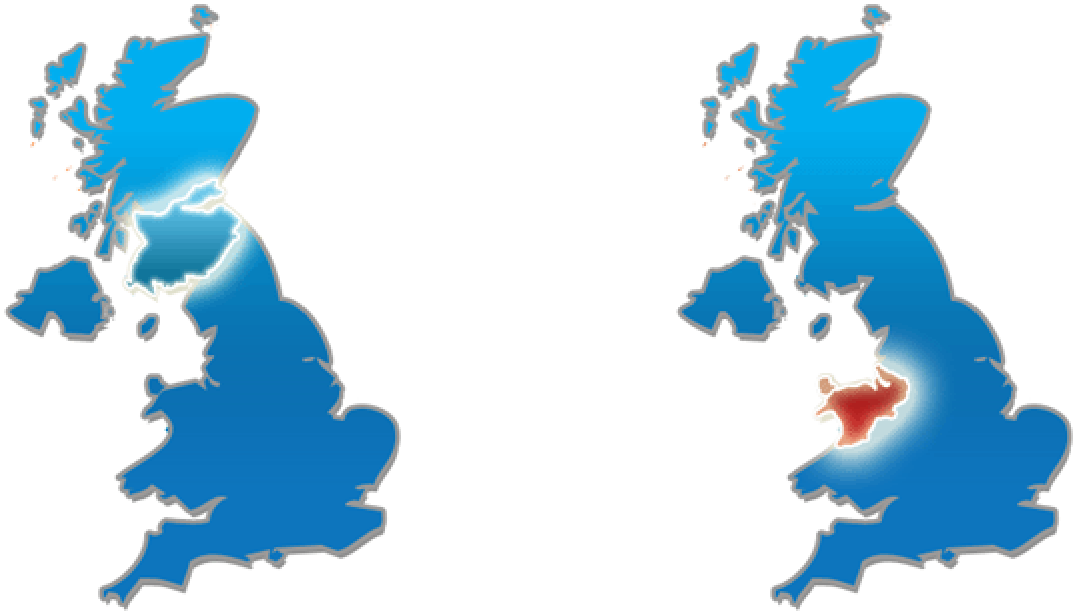
SP Energy Networks (SPEN) is the part of ScottishPower UK Ltd, which owns and operates the electricity transmission and distribution network of southern Scotland and the electricity distribution network of Merseyside and North Wales. Day-to-day operation of our network, approaching 112,000 km, is conducted by SP Energy Networks, 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 Ltd, referred to as SP-D in this report
- SP Manweb plc, referred to as SP-M in this report
- SP Transmission Ltd, referred to as SP-T in this report



(a) (b)

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

3. Overview

3.1 IFI Overview

A total of 50 IFI projects are being reported by SP Energy Networks on behalf of the three ScottishPower Network licence areas for the period 1st April 12 – 31st March 13.

At time of writing SPEN has a total of c.£6m authorised IFI projects, representing a levered portfolio of over £21m. The projects cover a breadth of R&D providers from academia, to consultants, to manufacturers with projects ranging in investment from £4k to £250k 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 2012/13 every £1 of SP IFI money invested in a project was levered by c.£4 from other sources:

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	Yearly Programme Leverage
2004/05 (Early Start)	£223k	12	c. £1.5m
2005/06	£546k	36	c. £3m
2006/07	£1,282k	41	c. £5m
2007/08	£1,793k	50	c. £7m
2008/09	£1,978k	38	c. £9m
2009/10	£1,462k	35	c. £7m
2010/11	£1,621k	27	c. £8m
2011/12	£1,975k	40	c. £11m
2012/13	£2,582k	50	c.£10m

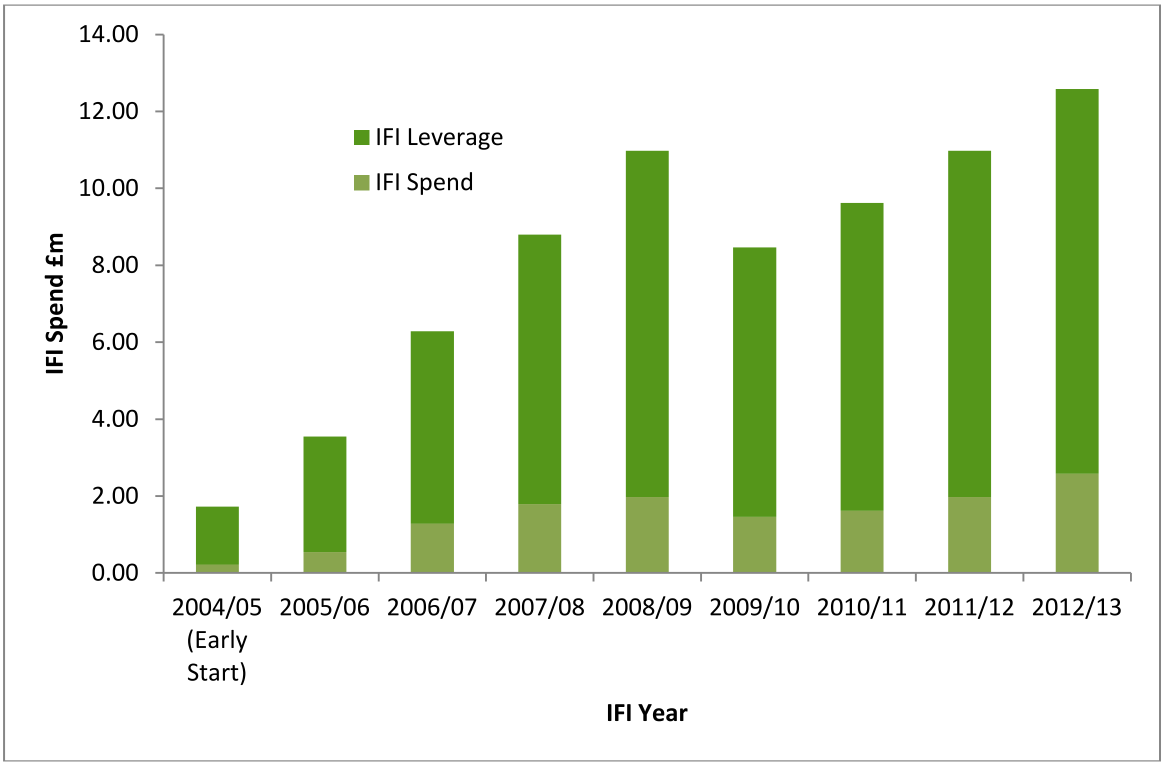


Figure 2 IFI Spend

4. Summary Tables

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

IFI Summary - SP Distribution Ltd Licence Area 12/13	
SP Distribution Ltd Network Revenue	£365,040,000
IFI Allowance	£1,825,200
Unused IFI Carry Forward to 2012/13	£830,000
Number of Active IFI Projects	41
Summary of benefits anticipated from IFI projects 2012/13	[1]
External expenditure [2012/13] on IFI projects	£929,876
Internal expenditure [2012/13] on IFI projects	£246,572
Total expenditure [2012/13] on IFI projects	**£1,176,448**

IFI Summary - SP Manweb plc Licence Area 12/13	
SP Manweb plc Distribution Network Revenue	£349,800,000
IFI Allowance	£1,749,000
Unused IFI Carry Forward to 2012/13	£750,000
Number of Active IFI Projects	44
Summary of benefits anticipated from IFI projects 2012/13	[1]
External expenditure [2012/13] on IFI projects	£788,634
Internal expenditure [2012/13] on IFI projects	£201,400
Total expenditure [2012/13] on IFI projects	**£990,034**

IFI Summary - SP Transmission Ltd Licence Area 12/13	
SP Transmission Ltd Distribution Network Revenue	£223,620,000
IFI Allowance	£1,118,100
Unused IFI Carry Forward to 2012/13	£501,200
Number of Active IFI Projects	16
Summary of benefits anticipated from IFI projects 2012/13	[1]
External expenditure [2012/13] on IFI projects	£365,024
Internal expenditure [2012/13] on IFI projects	£50,464
Total expenditure [2012/13] on IFI projects	**£415,488**

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

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[1] Summary of benefits are available in Section 6 “Highlights from 12/13”

5. Achievements for 2012/13

At the end of 2012/13 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:
    - 50 live projects
    - 16 new projects were authorised during the 2012/13
    - Of the 50 projects, 14 are now complete and either awaiting adoption or formal closure
- Over £10m of leverage obtained

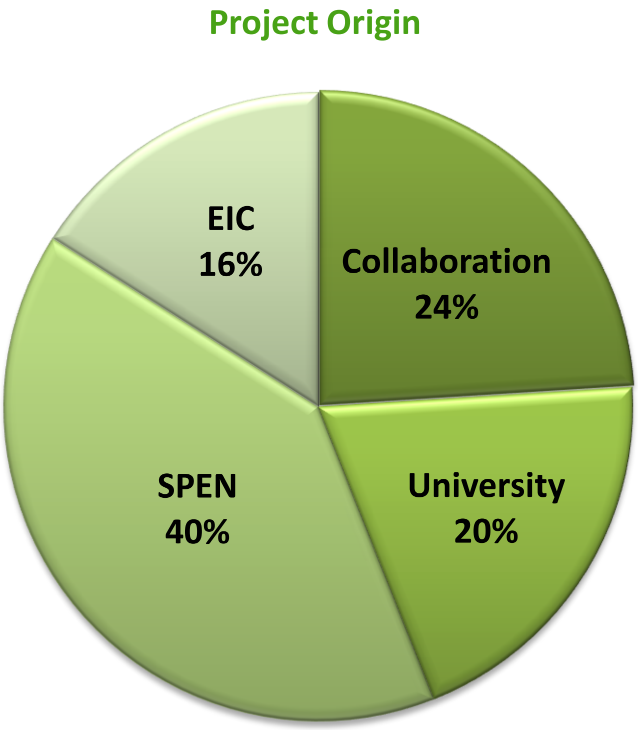
5.1 Development of Partnerships

The current programme consists of the following collaborative projects:

- DNO specific – 26 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.
- 3rd year of participation in the Electrical Power and Research Institute which has been strategically positioned to engage with our western link HVDC project.

5.2 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.



6. Highlights from 12/13

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.

6.1 Remote UHF Monitoring of a Power Transformer with PD Location

A continuous ultra-high frequency (UHF) partial discharge (PD) monitoring system supplied by Qualitrol-DMS has been installed on the SGT 2A power transformer at Clyde North windfarm substation. As part of this project, a trial installation of an on-line system for remote location of PD sources inside the transformer is taking place. Design and supply of the PD location system was subcontracted to the University of Strathclyde by Qualitrol-DMS at the request of SPEN. The PD location system uses a high sampling rate front end unit together with time-of-flight methods with the aim of locating any significant PD activity discovered inside the tank. The additional information provided by a PD location system will support decision making with regard to plant health and remedial action, since knowledge of PD location permits better judgement of defect severity and the potential for on-site repair.

The transformer is equipped with six UHF sensors, pictured below. Four of these are 'window' sensors mounted on specially adapted hatch plates on top of the tank. Sensors of this type have previously been used successfully in transformer tests in collaboration with SPEN. The remaining two sensors are of an oil valve probe type, designed and supplied by Qualitrol-DMS. These are fitted to the upper and lower oil ports on the end of the transformer opposite to the cooler.

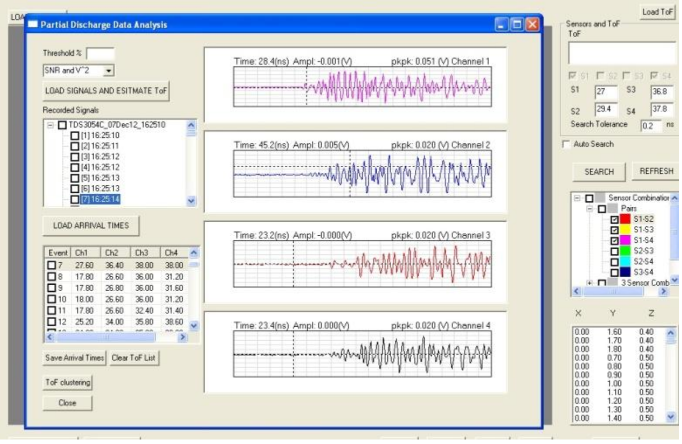
SGT 2A at Clyde North windfarm

View along the line of four UHF window sensors on top of the tank.

The lower of the two oil valve UHF probes.

The system supplied by Strathclyde was adapted from technology previously developed in partnership with DMS through a Knowledge Transfer Partnership project. The implementation at Clyde North uses a stand-alone data-logging software package to control a Tektronix oscilloscope installed adjacent to the transformer, sharing the temperature controlled cubicle with the commercial PD monitor, as shown below. The host PC in the control room communicates with the oscilloscope via optical fibre Ethernet. The PD location system was commissioned on 7th December 2012, at which time some moderate PD activity was observed. Some of the UHF signals captured at this time are visible on the oscilloscope display and on the data analysis software screenshot below.

Equipment cubicle adjacent to the transformer. UHF cables enter at the bottom. Four of them feed into the oscilloscope before connection to the Qualitrol PD monitor.



Threshold %

SNR and V^2

Event	Ch1	Ch2	Ch3	Ch4
☐ 7	27.60	36.40	38.00	38.00
☐ 8	17.80	26.60	36.00	31.20
☐ 9	17.80	26.80	36.00	31.60
☐ 10	18.00	26.60	36.00	31.20
☐ 11	17.80	26.60	32.40	31.40
☐ 12	25.20	34.00	35.80	38.60

Time: 28.4(ns) Ampl: -0.001(V) pkpk: 0.051 (V) Channel 1

Time: 45.2(ns) Ampl: 0.005(V) pkpk: 0.020 (V) Channel 2

Time: 23.2(ns) Ampl: -0.000(V) pkpk: 0.020 (V) Channel 3

Time: 23.4(ns) Ampl: 0.000(V) pkpk: 0.020 (V) Channel 4

☑ S1 ☐ S2 ☐ S3 ☑ S4

S1: 27
S2: 29.4
S3: 36.8
S4: 37.8
Search Tolerance: 0.2 ns

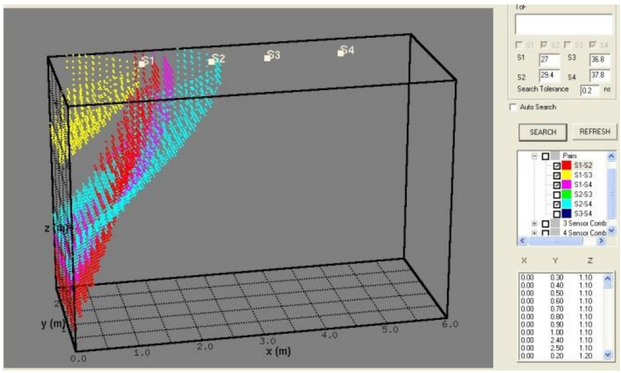
☐ Auto Search

☑ S1-S2
☑ S1-S3
☑ S1-S4
☐ S2-S3
☐ S2-S4
☐ S3-S4

X	Y	Z
0.00	1.60	0.40
0.00	1.70	0.40
0.00	1.80	0.40
0.00	0.70	0.50
0.00	0.80	0.50
0.00	0.90	0.50
0.00	1.00	0.50
0.00	1.10	0.50
0.00	1.20	0.50
0.00	1.30	0.50
0.00	1.40	0.50

Screenshot of the data analysis software showing a set of four UHF signals captured by the PD location system. Each trace corresponds to 100 ns of signal data and their relative arrival times provide the information needed to locate the point of origin inside the tank.

The observed PD activity was intermittent, in the sense that it was continually active for some tens of minutes and would then disappear for a period. Initial analysis of the arrival times at the 4 sensors on top of the tank is illustrated below. This suggests their origin to be at the tap-changer end of the tank. A possible explanation of their intermittency could therefore be related to tap position. However, this is only a preliminary suggestion that requires further investigation. The positioning of 4 sensors in a line along the top of the tank by the manufacturer is not ideal for PD location (poor resolution results from sensors in the same geometrical plane). Hence, the use of the lower oil valve sensor has potential to give a better estimation of PD location. Furthermore, we are awaiting basic dimensions of the internal transformer structure from the manufacturer. These are used to represent the core and windings with the PD location transformer model in order to improve the estimation of PD position by taking into account the fact that the internal metalwork blocks 'line of sight' signal propagation.

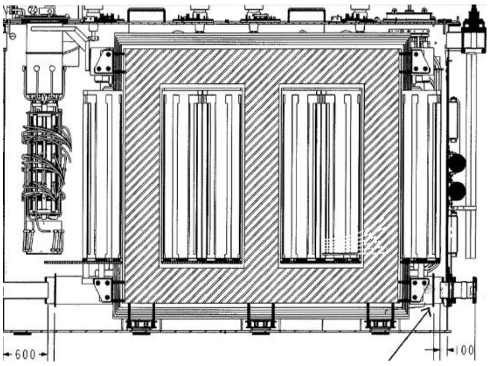


S1 27
S2 29.4
S3 36.8
S4 37.8
Search Tolerance 0.2 ns

☑ 🟥 S1-S2
☑ 🟨 S1-S3
☑ 🟪 S1-S4
☐ 🟩 S2-S3
☑ 🟦 S2-S4
☐ 🟦 S3-S4

X	Y	Z
0.00	0.30	1.10
0.00	0.40	1.10
0.00	0.50	1.10
0.00	0.60	1.10
0.00	0.70	1.10
0.00	0.80	1.10
0.00	0.90	1.10
0.00	1.00	1.10
0.00	2.40	1.10
0.00	2.50	1.10
0.00	0.20	1.20

Preliminary PD location based on the sensors S1-S4 along the top of the tank. Intersection of the planes of coloured points corresponds to the signal origin.



Side view of the internal structure, in which the tap changer mechanism can be seen to the left of the core/winding assembly.

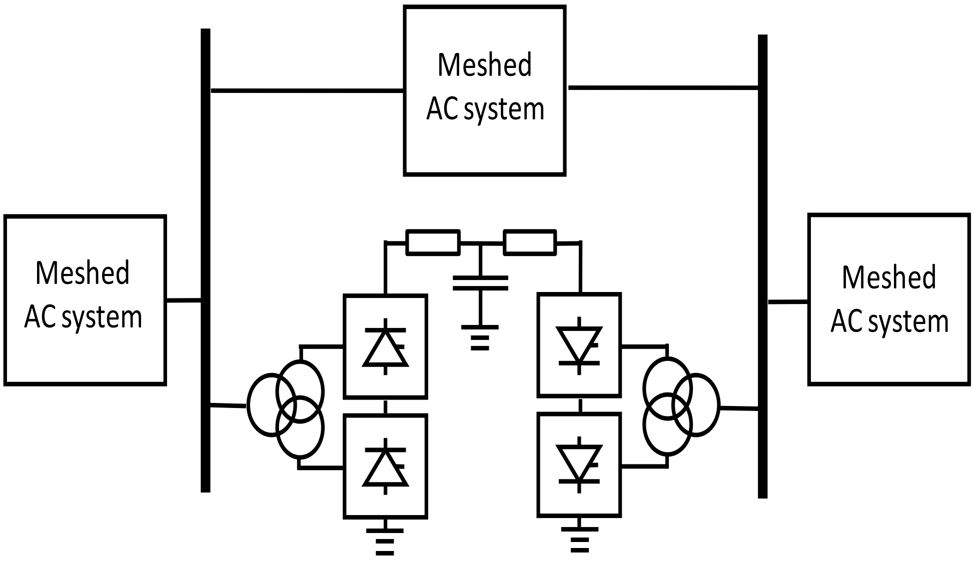
Remote access to the monitoring system is at present restricted to SPEN for reasons of network security. UHF signals had only been recorded by the PD location system within a window of five days during January 2013. These signals were identical in nature to the ones observed at installation in December 2012. However, the reason for the apparent 'silence' between 7th December and 21st January is not clear. Analysis and reporting of experience so far is being carried out in collaboration with Qualitrol-DMS in order to evaluate the data gathered and the extent of correlation with any environmental or operational parameters such as load, temperature, tap setting, etc. More regular remote logging-in by SPEN staff has been agreed to check for PD inception as the ambient temperature rises towards the summer.

6.2 EPRI Supplemental Project - Integrating HVDC into AC Grid

EPRI ELECTRIC POWER RESEARCH INSTITUTE 2011 Research Portfolio

With the increasing focus on HVDC technology SPEN has been able to benefit from the research work undertaken by the Electric Power Research Institute (EPRI) in this area.

Planning studies are being conducted to evaluate impact of the HVDC connections on AC Grid under this EPRI supplemental project. As shown in the following figure a DC interconnection may be embedded in a meshed AC network which will provide many advantages to the combined AC/DC network in terms of not only controlled power flows on the dc line but also increase in power transfer capability of the parallel ac ties and overall system performance improvements.



"Point-to-point"

The following topics are being researched under this project:

2012 Efforts

- Power flow control optimization
- Power oscillation damping methods
- Wide area control systems

An EPRI technical update (Product ID 1024321) – Advanced Power Flow Methods for Power Flow Control Optimization, Power Oscillation Damping Methods, and Wide Area Control System Methods – was published at the end of 2012.

2013 Efforts

- Special protection & control schemes
- Trans requirements for wind integration

- Coordination of dc control with ac network controls

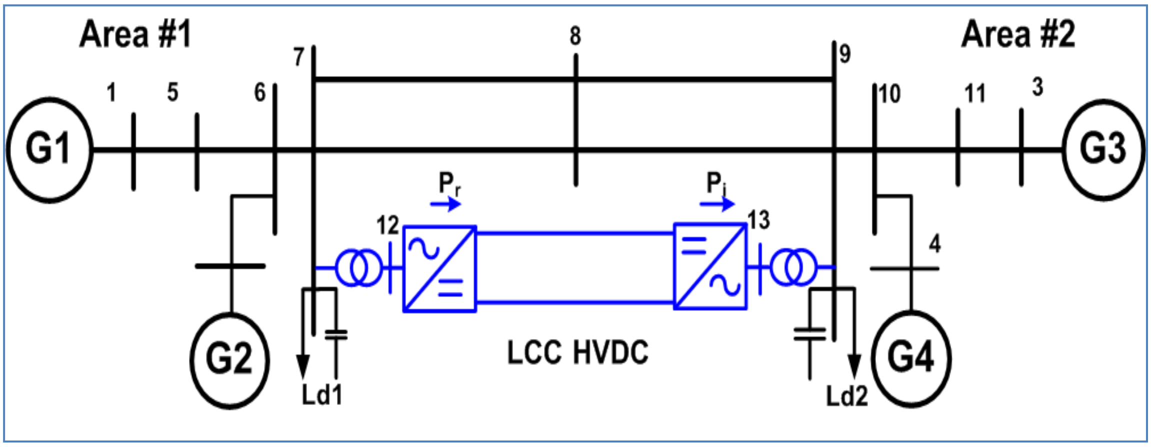
Future year Efforts

- Transmission loss optimization
- Transient stability improvements & fault recovery
- Sub-synchronous resonance damping enhancement
- HVDC models

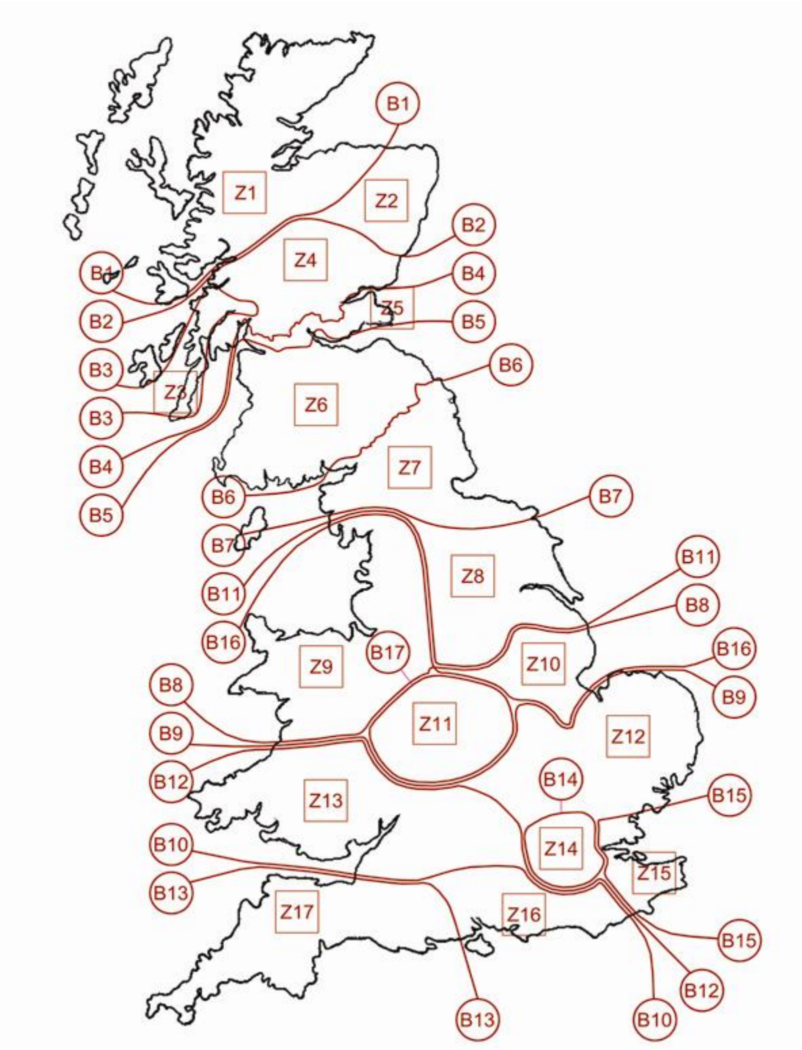
Under EPRI Base funded project fundamental concepts are being developed which are applied to Great Britain Network under the Supplemental project working closely with Scottish Power and National Grid and thus leveraging the results from the Base funded project.

Test Systems

The following small test system was used for concept development which resembles a reduced network of Scottish Power and National Grid with AC and proposed Western HVDC interconnections.



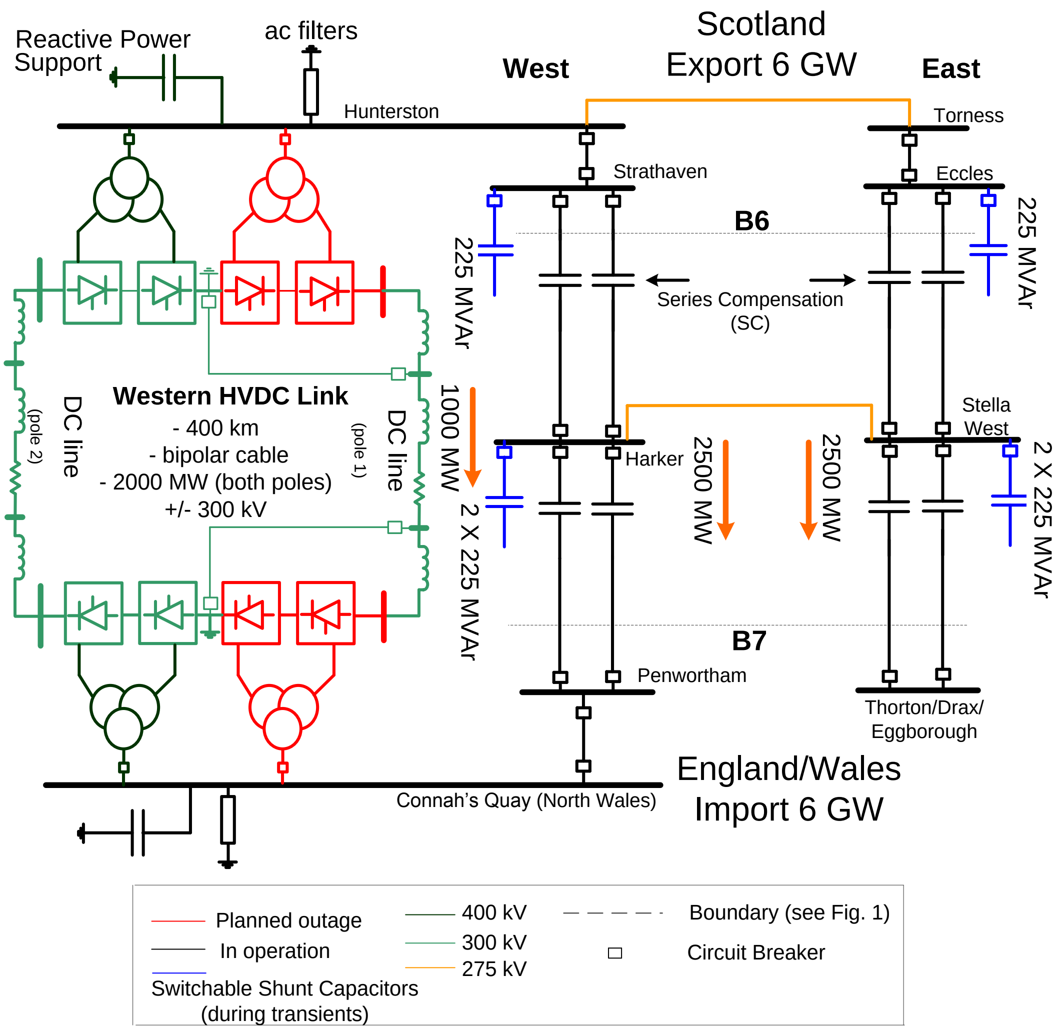
A detailed Great Britain Network model as shown overleaf was used to apply the concepts that were developed using the small test system.



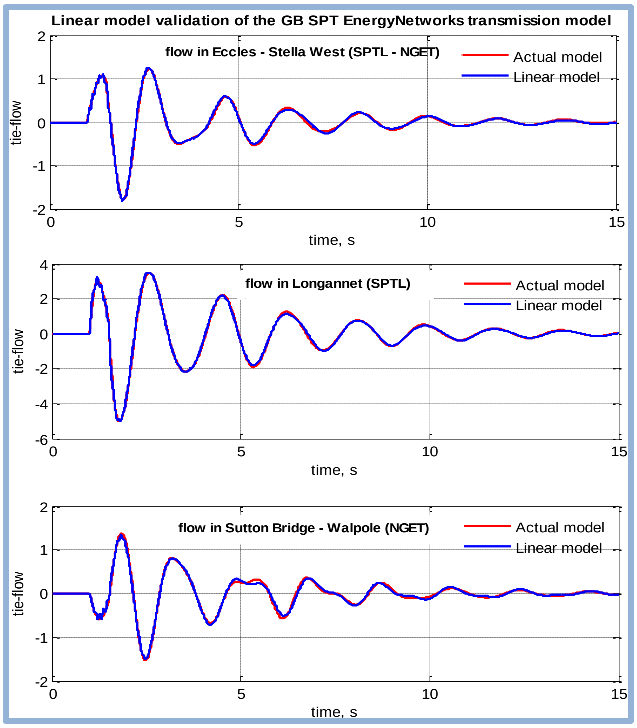
Great Britain Network Model in DIgSILENT Power Factory Software

Load flow & stability studies are being conducted using DIgSILENT Power Factory software. HVDC and other equipment models are being developed as needed.

- GB network is split into three regions and uses three voltage levels of 400 kV, 275 kV and 132 kV
- Model consists of 206 machines, 1,850 lines, 2,850 bus bars, 2,125 transformers, 180 shunts and 657 loads, 58 SVCs. Dynamic models (AVRs, GOVs, PSSs) are all included. 105 onshore wind farms are considered in operation (3.7 GW output).
- Two loading scenarios - a nominal loading case with a 4.4 GW transfer and a higher transfer 6.0 GW are considered.



Dynamic Characteristics of the GB SPT EnergyNetworks Model



A comparison of a state space (linearised) model and actual (non-linear) model is shown in the following figure. The identified state space model was validated by applying a pulse disturbance and comparing its dynamic response against that of the actual (non-linear) system.

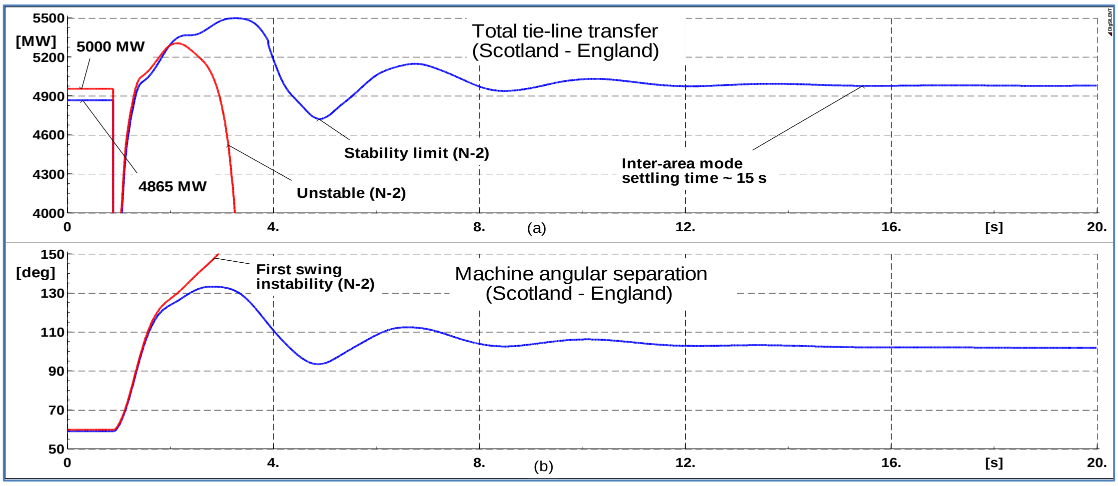
Modal frequency, *f*, damping ratio, ζ, and settling time of the critical inter-area modes considering the higher transfer condition

Inter-area mode	frequency *f*, Hz	Damping ratio ζ, %	Settling time, s
1	0.55	0.0758	15.3
2	0.78	0.0745	11.0

- Modal analysis engine in DIgSILENT **failed** to compute the eigen-values of the *GB SPT EnergyNetworks* model. Also, DIgSILENT **cannot** directly provide linear state-space model.
- System identification technique was applied to the GB system model to estimate (identify) the linearized state-space model. A linear model with 40 states was obtained.
- Two inter-area modes were captured with frequency of 0.55 Hz and settling time of around 15 s, and a second with frequency 0.78 Hz and a settling time of 11 s.

Dynamic Response of the *GB SPT Energy Networks* Model in Power Factory

- **Event:** 3-phase short-circuit fault on two 400 kV bus bars (close to Harker) cleared after 90 ms by tripping the two tie-lines interconnecting Strathaven and Penwortham.
- **Case 1**: 5000 MW (AC tie-lines), 1000 MW (HVDC). Under this heavy loading condition, the system response to the above-mentioned fault is seen to be first swing instability (red trace).
- **Case 2**: 4865 MW (AC tie-lines), 1000 MW (HVDC). Under this loading condition, the system response seems to be stable (blue trace). Power oscillations are found to be settled in around 15 s.



6.3 Low Carbon Spatial Energy Forecasting Tool

Figure 3 Individual Address's Modelled: Domestic. Commercial and Industrial

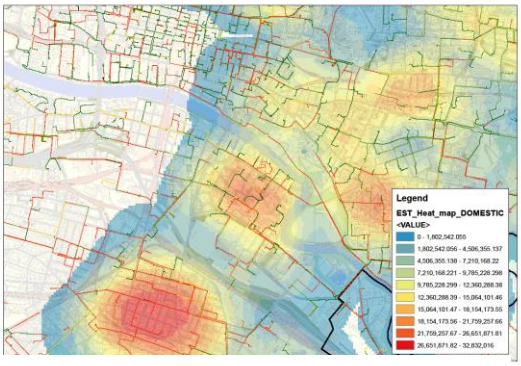


Figure 4 Energy Heat Map Overlaid over existing 11kV infrastructure

The **Spatial Energy Forecasting Tool project** was a proposal to develop a specialised GIS based spatial energy/load forecasting toolkit within the ESRI GIS asset database already installed in SP Energy Networks (SPEN). The main focus of this project was to develop models of existing and 'new-development' energy density & peak load (heat and electric) using standard DNO & industry (including BRE for housing) modelling metrics. The requirement for this facility is driven by the growing need for low carbon stakeholder discussion between energy companies with **'Smart Grid'** obligations and the growing **'Smart Cities'** aspirations. The modelling was completed through a 'per address' energy estimation methodology (**Figure 3**) across the full city landscape. Resultant energy levels are then collated into 'Heat Maps' to provide existing and forecast energy information for the city low carbon energy debate and project development. The extremely successful outcome of this project has delivered a GIS based spatial 'Energy' planning tool that provides adaptive energy density, peak load, CO_2 and low carbon picture for existing buildings and major new developments across the City. This valuable energy picture is then overlaid across our existing GIS infrastructure database (**Figure 4**) alongside layers of City planning and other useful information (**Figure 5**).

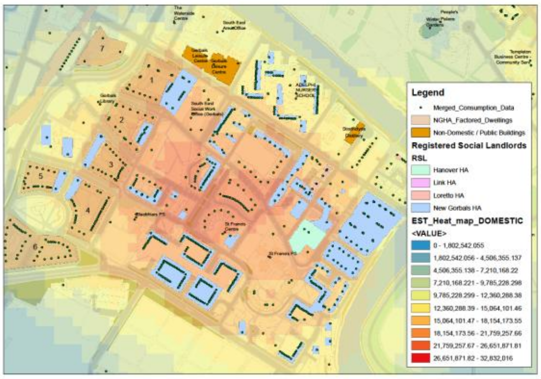


Figure 5 Energy Heat Map with Other useful City low Carbon GIS Information

Along with the core energy planning focus ESRI UK also delivered other useful low carbon GIS 'Toolkits' built using the 'Model Builder' programmable format consisting of,

- **Commercial Energy Demand Model** – City level modelling of Commercial Building Energy Density on a building by building basis
- **Domestic Energy Demand Model** – City level modelling of Domestic Building Energy Density on a building by building basis
- **Future Energy Demand Model** – Modelled potential future Developments Building Energy Density
- **Solar PV & Thermal Model** – Modelled potential of Photovoltaic or Solar thermal on a building by building basis

- **Combined Heat & Power Opportunity Model** – Aggregates individual buildings energy density into predefined CHP opportunity analysis
- **Urban wind Opportunity Model** – Looked at City wide opportunity for wind generation location mainly through analysis of constrains

Expertise and knowledge transfer was carried out between ESRI and the cities team on the Low Carbon geospatial data models through two days of workshop. Proof of concept analysis of these models was then carried out over a three month period whilst adapting and integrating them into a real project environment. This project technique has not only delivered the models that will be invaluable within our stakeholder role but also considerably enhanced our own teams understanding of GIS spatial analysis.

Very early in the delivery of the project the team gained successful participation within a large scale multi city and multi partner European project that will fully utilise and grow these Low Carbon spatial energy modelling tools and techniques. In participation with our Glasgow partners, consisting of Glasgow City Council and Strathclyde University the Cities team will ensure the successful delivery of the European FP7 Step Up project; Enhancement of the City 'Sustainable Energy Action Plan', and will receive funding from Europe of £200k to complete this.

This IFI project has already had hugely successful outcomes for the development potential of the Cities team within SPEN. Delivery of these low carbon models and data analysis techniques has far exceeded original project expectation. Firm plans are already well established for future enhancement and use of these spatial analysis techniques in SPEN. The GIS models and expertise delivered by this project will clearly enhance SPEN's ability to manage our growing low carbon cities based external Stakeholder engagement. Alongside this continuing development of internal uses of this analysis will help SPEN deliver 'smart grid' ready business processes. Some examples of the potential uses of these GIS spatial analysis techniques within the existing SPEN data environment are included for interest in **Figure 6 & 7**.

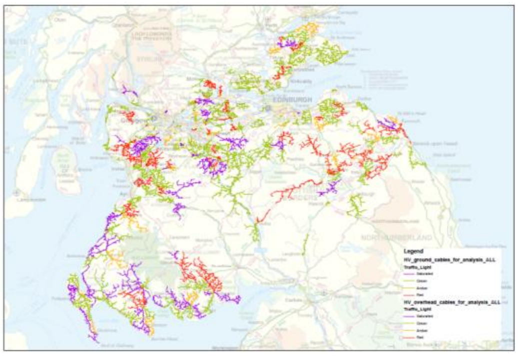


Figure 6 RAG voltage level rating of existing modelled 11kV O/H generator circuits for constraint analysis

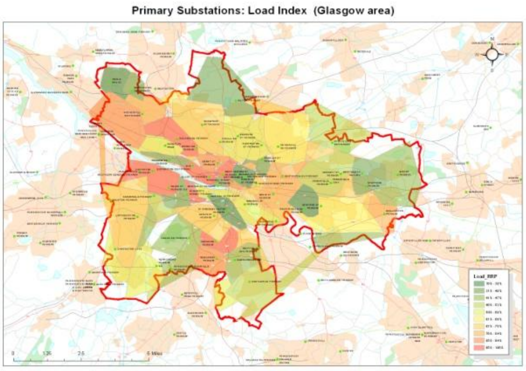


Figure 7 'Convex hull' analysis of 11kV cable extent and influence per primary with 'heat map' analysis based on primary capacity load Index

6.4 PURL2

Rot hidden within wooden poles is an ongoing problem within the industry with implications for both network safety and reliability. Common practise is to hammer test the pole. This is a simple and quick method of determining the internal condition of a pole and involves hitting the pole with a hammer and listening to the sound. Unfortunately, this requires a high degree of operator skill which the electricity companies have become reluctant to support. Different operators will often provide differing results for the same pole, and because the inspectors tend to err on the side of safety there is the danger that poles can be changed unnecessarily.

EA Technology currently offers the PURL instrument which makes use of the attenuation of an ultrasonic signal to determine the presence and extent of rot. It is non-intrusive and does not affect the integrity of the pole. Using the PURL the electricity companies have been able to reduce replacement costs significantly and produce condition data suitable for determining health indices. However, use of the PURL still requires comprehensive staff training to produce consistent results (albeit less than the hammer test) and it is time consuming to perform the test.

The original PURL system consisted of one transmitter, and one receiver. The transmitter required screwing into the pole, and the user moved around the pole with the receiver. The PURL2 system uses a belt of 8 sensors which is fixed to the pole. For small to medium sized poles, the user can press the transmitter against the pole at each measurement point. For larger poles it will still be necessary to screw the transmitter to the pole. The prototype sensor system can be seen fitted to a pole in **Figure 8**.

The increase in number of sensors has resulted in an increase in the accuracy of the system due to the higher number of independent measurements.

Figure 8 - Band of sensors fitted to pole

In addition to improving the measurement procedure, EA Technology has researched additional measurement parameters which will compliment the ultrasonic attenuation measurements used previously. The ultrasonic time of flight is recorded, and gives greater confidence when compared with the ultrasonic attenuation. The pole surface hardness is measured, as the outer 22.5% of the pole diameter contributes to approximately 50% of the overall strength of the pole. Finally, the pole moisture content is estimated, and the moisture content reading is then used to compensate for each of the other measurements.

All of the readings are then combined to generate an estimation of the cross section of the pole. From this cross section, the residual strength value for the pole can be calculated and used to assess whether the pole will need replacing. **Figure 9** shows a cross section of a pole tested in the lab, with the computed cross section estimation visible in **Figure 10**.

Figure 9 - Cross section of pole sample

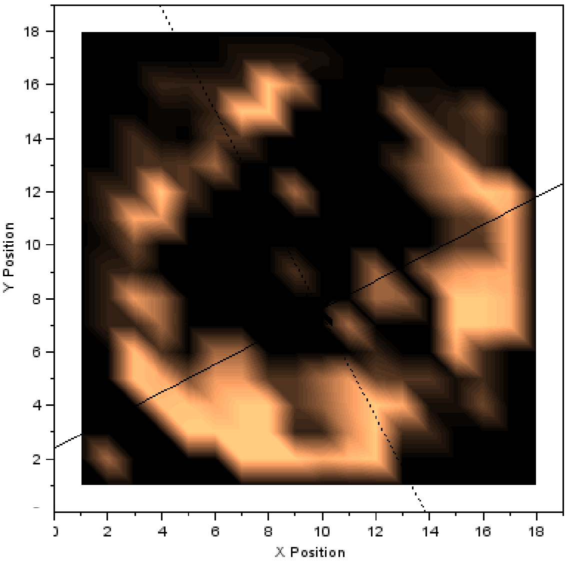


Figure 10 - Computed cross section estimation

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.

6.5 LVSure

Current LV network protection is based on fuses with construction based on simple principles developed more than a century ago. This simple device in its current role does not allow for circuits to be reenergised or reenergised remotely, as once the fault is cleared the fuse element is permanently damaged. As a consequence any fuse operation causes long outages as the faulty fuse has to be localised and replaced. In most cases, however, are temporary faults, where human intervention would be not required if the fuse had an option to reset its state from “off” to “on”.

The original LVSure concept involved semiconductor Electronic Fuse Unit and Intelligent Link Units. The system would be able to clear the fault and restore power to healthy sections of the LV network, decreasing the amount of customers without supply.

The first stage of the project revealed that a semiconductor device would be highly impractical as an electronic fuse due to its size and heat dissipation.

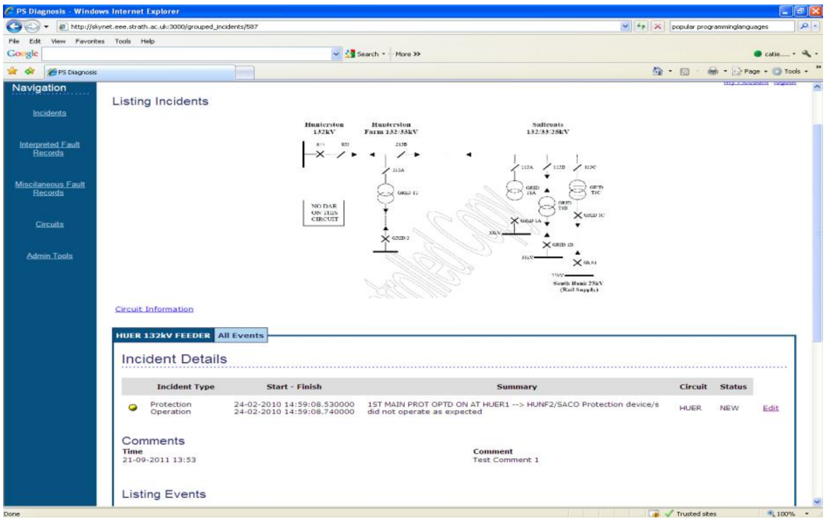
During consequent project stages EA Technology along with SPEN and SSE proposed a novel resettable solution that will provide operation less fuse. It is anticipated that the device will be left in a fuse board and will be able to operate hundreds times clearing fault currents.

The currently built prototype is able to hold currents of 400A. Due to utilisation of the newest technology in material science, it was possible to decrease significantly the size of the unit. Current work is focused on further size optimisation with target size similar to BS88-V fuse holder.

The original semiconductor unit is shown below on the right and new approach on the left. Both are prototypes.

6.6 SPARC Project Summary

6.6.1 Automated analysis of SCADA data and digital fault records for analysis of power system protection performance



Listing Incidents

Incident Details

	Incident Type	Start - Finish	Summary	Circuit	Status	
●	Protection Operation	24-02-2010 14:59:08.530000 24-02-2010 14:59:08.740000	1ST MAIN PROT OPTD ON AT HUER1 --> HUNF2/SACO Protection device/s did not operate as expected	HUER	NEW	Edit

Comments

Time	Comment
21-09-2011 13:53	Test Comment 1

Listing Events

Scottish Power Energy Networks (SPEN) collect, store and manually analyse a high volume of operational data from various sources in the network (e.g. digital fault recorders, PI, SCADA from the PSAlerts database, and travelling-wave fault locators) and are keen to exploit the value of this data through advanced data analysis techniques.

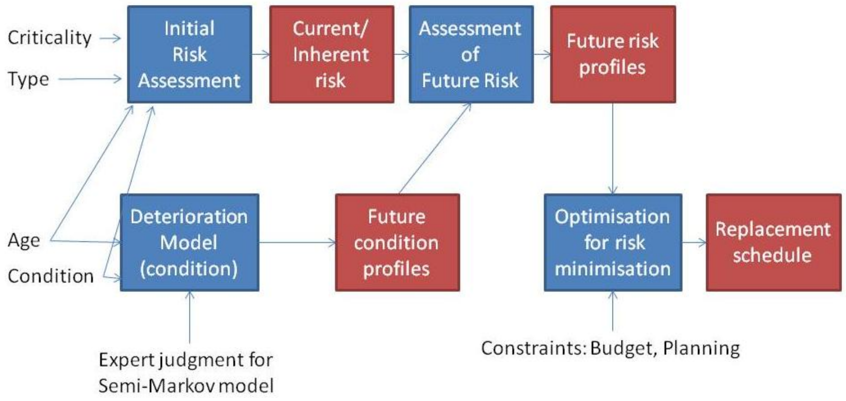
SCADA data is used to identify when and where on the network a protection operation has occurred (i.e. incident occurrence) which then enables identification of relevant DFR and TWFL records for more focused analysis of the incident and assessment/validation of the protection performance.

Previous research projects conducted by the University of Strathclyde in collaboration with SPEN protection experts have produced working data analysis techniques specifically designed to accommodate limited data relating to network and scheme connectivity. The availability of circuit and protection scheme topology data (i.e. maintained in the 'Protection Database') has resulted in a new automated approach to protection operation validation, but still uses the previous SCADA based approach to this analysis.

This project has developed, implemented and tested a prototype Post-Fault Analysis Suite capable of automating the existing holistic approach to the post fault analysis of SCADA and DFR data, providing continual online operation and automated analysis report generation. In doing so, the system provides engineers with appropriate and useful diagnostic information relating to protection performance and its response to incident events.

In addition, the PhD student conducting this work was recruited by SPEN and is currently progressing, and expanding upon, their previous work in this area within SPEN. This project has resulted in successful knowledge and technology exchange through the development of a useful decision support tool and the subsequent recruitment of the individual responsible for its development.

6.6.2 Smart Power Network Asset Management Strategies and Tools

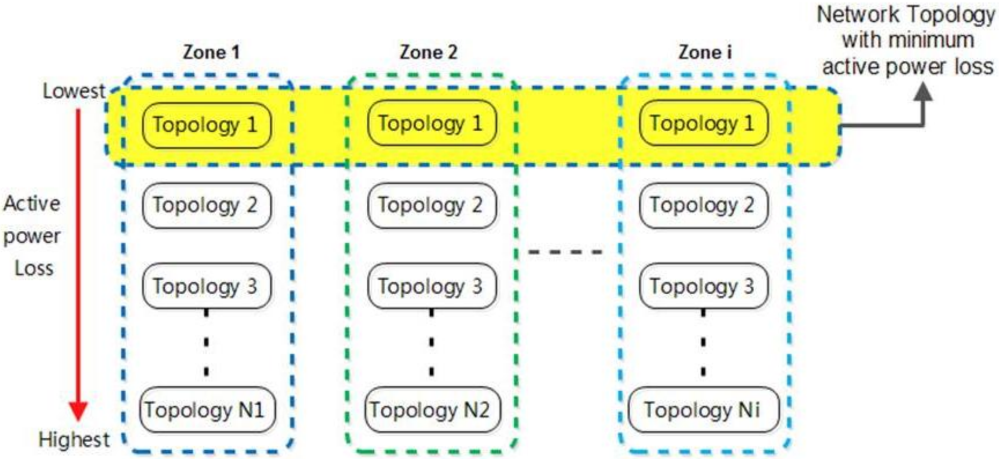


The primary focus of this research will be on the development of a methodology capable of quantifying asset health and risk on an individual asset by asset basis, normalizing and aggregating health and risk measures across groups of assets of similar and different type. This requires an understanding of how asset degradation models should be developed and applied in the assessment of asset health, and the development of asset risk profiles to subsequently inform investment planning. Probabilistic asset degradation models may be developed to estimate the anticipated rate of deterioration and remaining useful life, based on current and historical condition monitoring or inspection data and/or expert insight. Many network assets are first generation and so failure data can be limited, relying extensively on the intimate knowledge of plant experts to assess asset condition. This research will develop asset degradation models using expert judgment and experience in conjunction with available asset data.

A key challenge of this research will be to develop methods capable of handling qualitative and quantitative data/information acquired from expert judgment and CM equipment provided from disparate sources and varying in quality, coverage, consistency and volume. This requires uncertainties associated with missing and variable data/information to be properly accommodated.

The methodology also supports the development of targeted investment plans (for non-load related asset replacement) across an asset base of different asset types. Sensitivity analysis, using optimisation techniques to assess the impact of variations in asset investment on future asset condition (health) and risk profiles, will enable asset managers to establish desirable optima balancing of asset health, risk and investment, providing a more robust scientific basis for the justification of asset investment. In addition to optimizing the level of investment required to manage risk satisfactorily, the methodology will also attempt to identify which assets provide the best return on investment, in terms of managing overall asset risk.

6.6.3 Optimal Distribution Network Architectures

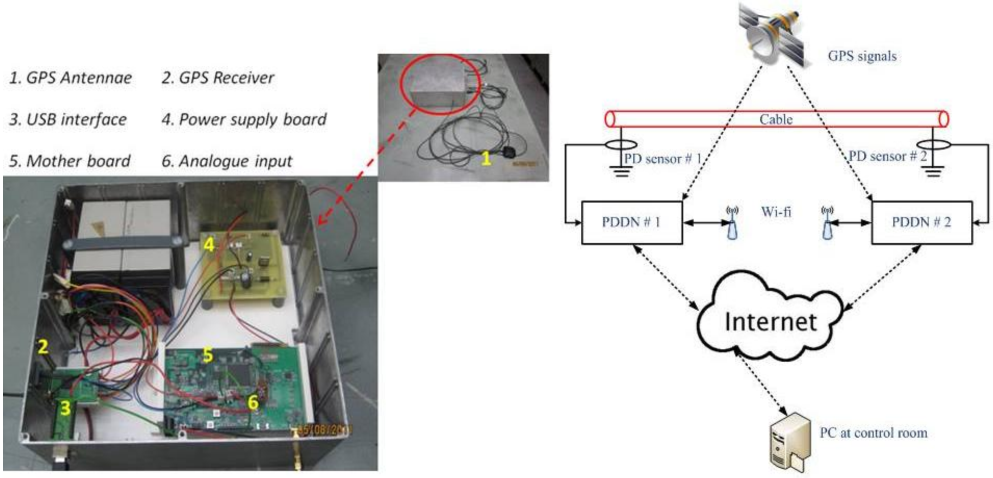


The project has focused on network reconfiguration for the minimisation of distribution losses. This has involved research into methods for optimising network performance based on the joint consideration of technical and commercial costs / benefits associated with loss reduction, while respecting system reliability requirements.

The project has resulted in the development of an 11kV network model for algorithm testing and system studies, a network loss and reliability optimisation algorithm capable of resolving conflicts associated with minimising network losses and maximising reliability in line with Regulator's quality of supply incentive.

This project delivered a prototype tool that provides advice on operational states, i.e. mainly, the location of normally open points that provide the best overall compromise between considerations of losses and reliability. Further work will be conducted to determine how this tool can be integrated into existing systems and processed and applied in operational and planning contexts.

6.6.4 PD Diagnostics in Underground Cables



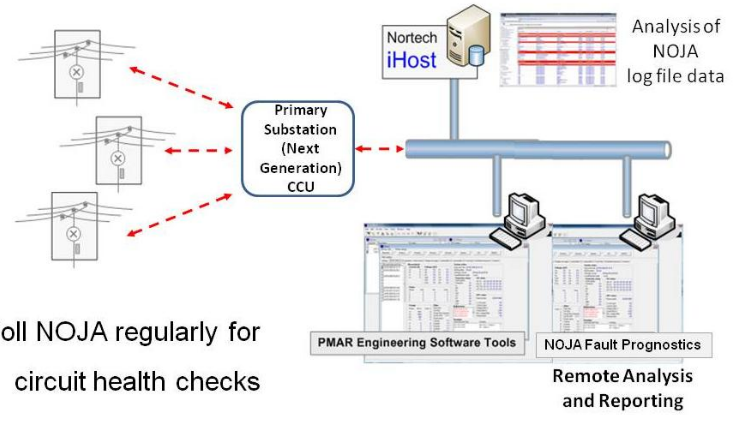
As underground cable networks for power transmission and distribution approach the end of their designed life there may be a need for a condition based maintenance strategy involving on-line monitoring, detection and location of partial discharge sites, which are the result of ageing and which can compromise the cable insulation condition.

Partial discharges offer early symptoms of insulation degradation that can ultimately lead to the complete breakdown of the insulation system. Conventional monitoring requires off-line measurement where the cable must be isolated from the HV network; however, the threat of cable replacements approaching a cliff edge, may require the use of on-line condition monitoring and PD detection methods.

High frequency current transformers (HFCTs) clamped around the earth strap of a cable are most widely used to detect partial discharges. This type of measurement requires the earth trap of the cable to be insulated from the switchgear earth in the substation. These HFCT sensors can also be installed across the phase conductors of the cable, but this retrofit is invasive and requires a circuit outage, involving the additional cost of a dedicated PD sensor. In addition, PD cable condition monitoring often requires constant access to the substation which is not always possible. This project investigates the technical feasibility of using existing pre-installed protection and measurement (power frequency) CTs for detecting PD signals.

This project investigated the technical feasibility of using existing, pre-installed protection and measurement CTs as surrogate PD sensors for the detection of cable PD signals. Signal processing and data analysis algorithms were applied and developed to facilitate the detection and ultimately the location of cable PD sources. This project involved simulations and experimental effort to assess the frequency response of such CTs, which informed the subsequent development of a double ended PD mapping system using time domain reflectometry (TDR) for on-line PD location.

6.6.5 Develop an intelligent decision support system for overhead line fault prognosis utilising available Pole Mounted Auto-Reclosers (PMAR) data



PMARs manage faults on the overhead 11kV network. Recent developments in this equipment have introduced micro-processor technology that now enables the logging of loading data, fault event data and transient activity, referred to as ‘pick-up activity’.

At present this data is used to assist engineers with reactive fault management and post fault investigation into anomalous network behaviour and causes of transient activity leading to both semi-permanent (intermittent) and permanent network faults. At present the transformation of data into meaningful information relating to network behaviour and causes of fault activity is extremely time consuming for automation engineers and asset managers.

Accessed on-line and remotely, using prototype equipment developed for the LCNF Project, this data has the potential to provide engineers with an indication of how the overhead line network behaves and potentially degrades in real time. In addition, through the application of suitable data analysis techniques to the available 'pick-up' data captured from PMARs, statistical trends that may derived, and deterioration and fault classification models developed to predict the type, severity, rate and likelihood of particular faults developing. Being able to predict and classify future fault activity could be used to guide operational staff to identify the cause of the intermittent fault and take appropriate preventative action to avoid continued disruption to customer supplies and ultimately prevent it evolving into a permanent fault resulting in an outage. This system aims to ultimately improve network performance, detect a failing asset, improve customer service and avoid regulatory penalties arising from unplanned network interruptions.

This project will assess the feasibility of data mining techniques to identify 'interesting' data patterns and trends that are indicative of anomalous circuit activity, and where possible identify distinct modes of network behaviour representative of specific network defects responsible for nuisance tripping of customer supplies that risk evolving into more serious permanent faults if left undetected and unattended to (e.g. cracked insulators). Should this approach prove viable, a decision support system capable of a decision support software tool designed to assist engineers in the prognosis of distribution network faults.

6.6.6 PV penetration study and developed software tool

This study established a generic methodology for assessing threshold levels for PV generating capacity connecting to the LV network, indicating where voltage quality and phase imbalance issues become problematic for the LV network. Building on this research, a prototype software tool was developed in conjunction with SPEN Manweb, to assess threshold levels for PV generating capacity connecting to the LV network, indicating where voltage quality and phase imbalance issues become problematic for the LV network. This tool is currently being used by Manweb staff in the decision making process affecting the connection of new PV generation at LV.

6.7 Superconducting Fault Current Limiter Trial at Ainsworth Lane 11kV Substation

In 2006 United Utilities, ScottishPower and CE Electric UK formed a consortium to undertake trials of three (1 per DNO) Superconducting Fault Current Limiters (SFCLs) to be supplied by Applied Superconductor Limited (ASL) based in Blyth, Northumberland. The first of these was installed at Bamber Bridge near Preston in October 2009 and removed in March 2010 following a successful trial. The second and third units were installed in 2012 at Ainsworth Lane in Knowsley near Liverpool and in Scunthorpe and both are in service currently (June 2013). The Ainsworth Lane unit was installed in February 2012 and made live initially in August. Problems with the cryogenic cooling system, which prevents the liquid nitrogen in the unit from boiling off, were finally solved by replacing both of the two coldheads mounted on the SFCL lid – these had suffered from a manufacturing defect. The unit was re-energised in November and has been operational since then.

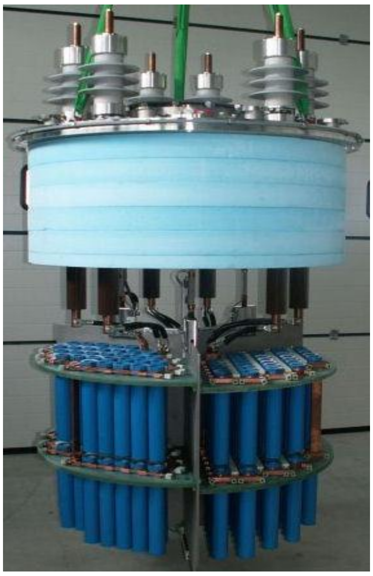


Figure 11

The SFCL is of the resistive type, in which superconducting components (**Figure 11**) connected in series form the main circuit conductors of each phase. These are immersed in liquid nitrogen in a vacuum insulated vessel. During normal operation, the resistance of each phase conductor is nearly zero. When a fault occurs, the resistance rises almost instantly to several ohms, dramatically reducing the fault current. A series circuit-breaker, installed in the cubicle containing the SFCL, is tripped by a differential voltage protection scheme developed by ASL, to prevent overheating of the superconducting parts.

Figure 12

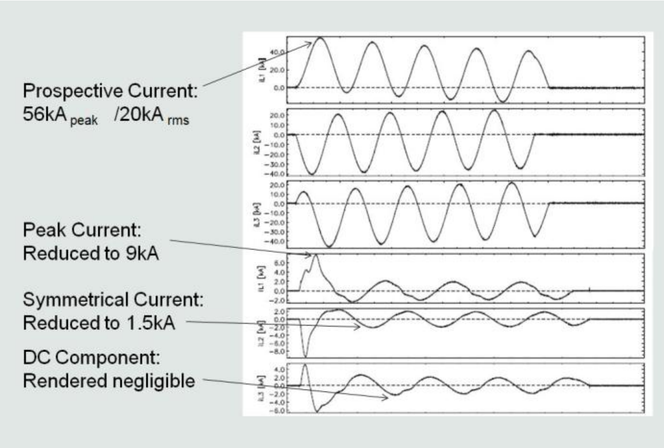


Figure 13

The SFCL underwent short circuit and high voltage tests at IPH in Berlin in December 2010. **Figure 12** shows the unit under short-circuit test and **Figure 13** shows the current limiting effect in action.

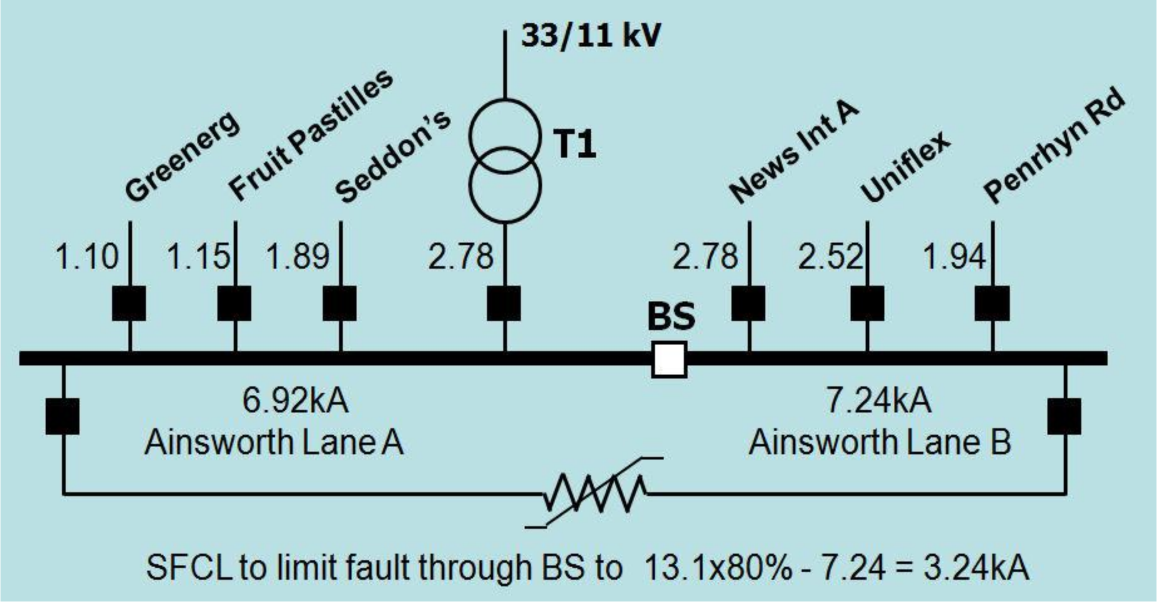
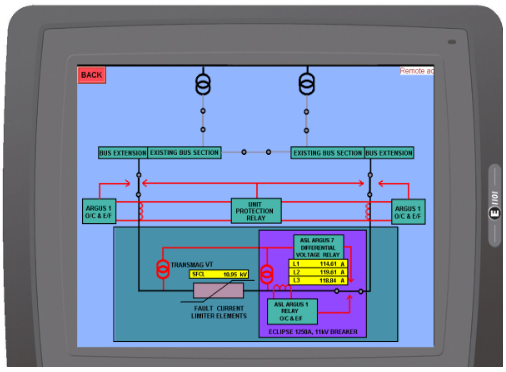


Figure 14

Ainsworth Lane 11kV substation was chosen as the trial site because it is planned to add a 33/11kV transformer and this will cause the fault level here to exceed 250MVA. The SFCL is connected to link the two busbars of the 11kV switchboard (F**igure 14**) and was designed to limit the fault level to 80% of 250MVA by reducing the fault contribution from the unfaulted side (the device is bi-directional) to less than 3.24kA rms symmetrical. The SFCL installed at Ainsworth Lane is shown in F**igure 15**. The enclosure on the left hand side contains water chillers and the enclosure on the right contains the SFCL, the series circuit breaker, two helium compressors and the vacuum vessel containing the superconducting circuits. **Figure 16** shows a screen shot from the remote monitoring system which provides detailed information on the condition of the SFCL and its associated equipment.

Figure 15



SFCL 10.95 kV

L1 114.61 A

L2 119.61 A

L3 118.84 A

Figure 16

6.8 Power Line Carrier on Interconnected Networks

Communications for SmartMetering deployment in the UK will utilise various routes to send data back to the Data Collection Centre (DCC). One method which has been trialled on radial networks is “Prime” Power Line Carrier (PLC), however it has not been tried on interconnected networks which are frequently utilised in the UK. This trial was to evaluate the performance of the Prime PLC technology on a typical interconnected network.

The objectives of the project trial were:

- To evaluate the performance of LV PLC signalling systems within GB LV-interconnected urban environment
- To demonstrate no interruption to supplies during installation of LV-PLC data concentrator at distribution substation(s)
- Demonstrate the collection of routine data (as a proxy for revenue meter data) from PLC devices
- Demonstrate the ability to collect non-routine data (voltage, current, power quality, interruption messages) at each data concentrator and to dispatch operational message to/from a remote control system.

10 Prime PLC SmartMeters were deployed across 3 differing LV network types, i) overhead radial, ii) underground radial and underground interconnected, to see the performance of PLC data communication across the 3 network arrangement types. Also 4 substation data concentrators were installed to receive communications from the PLC meters and relay-on the data to a data server. The communications of the data transmission was monitored over several discrete periods.

Below is a network diagram showing one of the trials sites, with two interconnected substations at Gayton Lane and Kingsway Gayton with the data concentrators installed and the “red dots” identifying the Prime PLC SmartMeters installed out on the LV network.

Performance evaluation of LV signalling system

The principle of operation of the Prime PLC SmartMeters, is that they can operate in a direct transmission of data mode, or operate as a repeater for the transmission of data signals from other Prime PLC SmartMeters. Due to the limited density of meters installed the multiple repeating of signals from other meters is limited, however from the results table below it can be seen that even with limited 'signal repeater' availability there was a high success rate for data transactions.

Table 1	**Short Cycle data transactions**			**Long Cycle data transactions**		
	Test Duration	Transactions	Successful	Test Duration	Transactions	Successful
China Farm Lane (2 meters)	64 hrs	7674	99.9%	31hrs	3708	99.6%
Upton Grange (4 meters)	64 hrs	15152	90.3%	31hrs	5716	91.9%
Kingsway Gayton (4 meters)	61hrs	-	95.58%	189hrs	-	96.9%

Installation of data concentrator equipment in substations without interruption of supplies

Four data concentrators were installed, one in a pole mounted situation and the other three in ground mounted substations. For all installations as fused isolator was installed between the data concentrator unit and the live LV connections for future isolation. This enabled the equipment to be installed and connected to the isolator with the connections to the live LV apparatus to be made using (standard) company live working safety procedures. There were no interruptions to customer supplies for any of the installations.

Demonstrate the collection of routine meter data from PLC devices

It can be seen from Table 1 that the instant Energy Read (Short Cycle) data transmissions were successful considering the small number of meters used in the trial site.

Demonstrate the ability to collect non-routine data (e.g. network data)

It can be seen from Table 1 that the load profile Read (long Cycle) data transmissions were also successful considering the small number of meters used in the trial site.

There are further potential benefits of this trial in utilising the Prime PLC data signalling system to retrieve network data and control devices embedded in the LV network were existing communications may be unable to do so, e.g. underground apparatus.

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 SP Energy Networks operate distribution and transmission licenses for the SP-D, SP-M and SP-T areas, successful developments relating to distribution and/or transmission assets undertaken in one part of the business will equally apply to the other. In line with this, costs have been split against each licence based on the turnover and hence size of each network area.

Cost Breakdown between Licence Areas

Licence Area	Annual Turnover (12/13)	Percentage Split Distribution	Percentage Split Transmission
SP-Distribution	£365.04 million	~60%	NA
SP-Manweb	£349.80 million	~40%	~15%
SP-Transmission	£223.62 million	NA	~85%

Projects identified as only applying to one licence, or ones that apply in favour of one, two or all three 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 SP's 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 2013 the status of the 50 projects reported as well as those that have stopped is detailed below.

IFI Project Status			
No.	*Phase*	*Definition*	*External Cost*
7	*Proposals in development*	*Agreeing scope / objectives, setting up contracts, etc.*	*None Direct (small external £ associated with management cost)*
33	*Live projects*	*Projects in progress*	*Yes (if milestones have been met)*
10	*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** – SP Energy Networks' 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 SP Energy Networks 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.

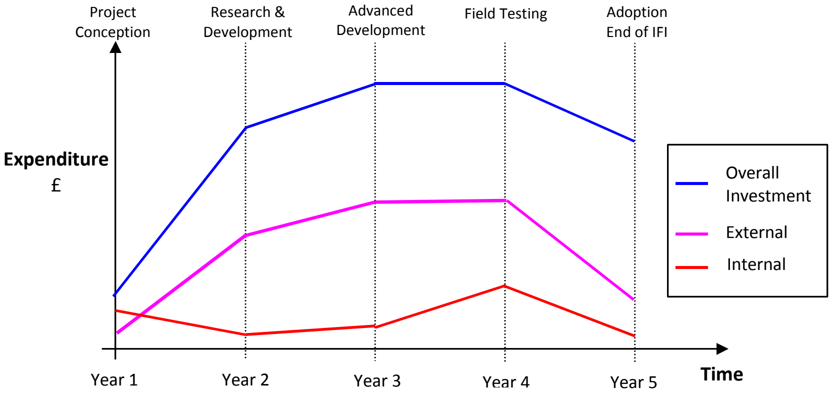


Figure A1: Example Expenditure Profile for an IFI Project

Table A1 is ordered chronologically.

Project Description	Percentage split			£ split					
				SPD		SPM		SPT	
	SPD	SPM	SPT	External	Internal	External	Internal	External	Internal
IFI 0401 - Strategic Tech Prog	55%	35%	10%	£ 122,130	£ 28,589	£ 77,719	£ 18,193	£ 22,205	£ 5,198
IFI 0507 Sensor Networks - Smart Dust	60%	40%	0%	£ 11,240	£ 6,174	£ 7,493	£ 4,116	£ -	£ -
IFI 0509 - Superconducting Fault Current Limiter	60%	40%	0%	£ 9,311	£ 11,514	£ 6,208	£ 7,676	£ -	£ -
IFI 0515 - Power Network Demo Centre	60%	40%	0%	£ 199,463	£ 2,080	£ 132,976	£ 1,387	£ -	£ -
IFI 0526 - PD MONITORING	60%	40%	0%	£ 24,941	£ 2,611	£ 16,627	£ 1,741	£ -	£ -
IFI 0607 LV Network Automation	60%	40%	0%	£ 1,016	£ 6,755	£ 677	£ 4,503	£ -	£ -
IFI 0615 - SP Advanced Research Centre	30%	20%	50%	£ 17,333	£ 1,984	£ 11,556	£ 1,323	£ 28,889	£ 3,307
IFI 0621-1 FMC Tech	30%	20%	50%	£ 2,568	£ 1,015	£ 1,712	£ 677	£ 4,280	£ 1,691
IFI 0621-2 LV Sure	60%	40%	0%	£ 20,964	£ 2,030	£ 13,976	£ 1,353	£ -	£ -
IFI 0621-3 Live Alert	55%	35%	10%	£ 4,708	£ 1,861	£ 2,996	£ 1,184	£ 856	£ 338
IFI 0621-4 PURL2	60%	40%	0%	£ 5,598	£ 2,397	£ 3,732	£ 1,598	£ -	£ -
IFI 0701 ENA Small Value Projects	60%	40%	0%	£ 2,016	£ 2,030	£ 1,344	£ 1,353	£ -	£ -
IFI 0711 - 3rd Party ROEP Risk Assessment	30%	20%	50%	£ 6,508	£ 2,168	£ 4,339	£ 1,446	£ 10,846	£ 3,614
IFI 0714- COLLAPSE PREDICTION CPR-D RELAY	0%	0%	100%	£ -	£ -	£ -	£ -	£ 38,713	£ 3,383
IFI 0801 - IEC 61850 Applications in SPT	0%	0%	100%	£ -	£ -	£ -	£ -	£ 14,242	£ 3,383
IFI 1001 - DTR DURHAM	0%	20%	80%	£ -	£ -	£ 2,339	£ 1,389	£ 9,354	£ 5,554
IFI 1002 - SUPERGEN HIDEF	60%	40%	0%	£ 49,016	£ 2,884	£ 32,677	£ 1,923	£ -	£ -
IFI 1004 - Remote Access to Pole Mounted Auto Reclosers	60%	40%	0%	£ 1,016	£ 14,813	£ 677	£ 9,875	£ -	£ -
IFI 1005 - zMap - GIS Imp	60%	40%	0%	£ 2,772	£ 2,030	£ 1,848	£ 1,353	£ -	£ -
IFI 1007 - Outram Fault Level Monitor	60%	40%	0%	£ 16,386	£ 10,147	£ 10,924	£ 6,765	£ -	£ -
IFI 1101 - EPRI	30%	20%	50%	£ 42,201	£ 1,418	£ 28,134	£ 945	£ 70,335	£ 2,363
IFI 1102 - Energy Storage Project	60%	40%	0%	£ 12,296	£ 3,739	£ 8,197	£ 2,492	£ -	£ -
IFI 1103 - PD Monitoring in Supergrid Transformers	0%	0%	100%	£ -	£ -	£ -	£ -	£ 98,498	£ 7,670
IFI 1104 - SF GB Electricity Demand Project	60%	40%	0%	£ 8,216	£ 5,447	£ 5,477	£ 3,632	£ -	£ -
IFI 1107 - Cable Identification Devices	60%	40%	0%	£ 14,155	£ 4,038	£ 9,437	£ 2,692	£ -	£ -
IFI 1108 - ESRI Powerfactory	60%	40%	0%	£ 49,532	£ 4,549	£ 33,022	£ 3,033	£ -	£ -
IFI 1202 - Nanodielectrics	60%	40%	0%	£ 20,209	£ 4,166	£ 13,473	£ 2,777	£ -	£ -
IFI 1203 - Psymetrix ACAM Phase 1	0%	100%	0%	£ -	£ -	£ 149,331	£ 34,585	£ -	£ -
IFI 1204 - LV Jumpers with integral CB	60%	40%	0%	£ 2,853	£ 5,175	£ 1,902	£ 3,450	£ -	£ -
IFI 1205 -Transient Earth Detector	60%	40%	0%	£ 9,024	£ 2,670	£ 6,016	£ 1,780	£ -	£ -
IFI 1206 - Sudafix Conductive Concrete	35%	35%	30%	£ 12,632	£ 1,184	£ 12,632	£ 1,184	£ 10,827	£ 1,015
IFI 1207 - Smart 3 Phase Voltage Regulat	60%	40%	0%	£ 12,805	£ 2,457	£ 8,537	£ 1,638	£ -	£ -
IFI 1208 - Energy & Carbon Master Planning	60%	40%	0%	£ 52,174	£ 11,100	£ 34,783	£ 7,400	£ -	£ -
IFI 1209 - Substation Earth Integrity Monitoring System	35%	35%	30%	£ 49,450	£ 2,789	£ 49,450	£ 2,789	£ 42,385	£ 2,391
IFI 1210 - Transmission SSR & Harmonics	0%	0%	100%	£ -	£ -	£ -	£ -	£ 11,393	£ 4,807
IFI 1211 - Smart CCU Development	60%	40%	0%	£ 51,009	£ 38,775	£ 34,006	£ 25,850	£ -	£ -
IFI 1212 - Voltage Regulating Secondary Transformer	60%	40%	0%	£ 1,016	£ 8,047	£ 677	£ 5,365	£ -	£ -
IFI 1213 - Phase 3 Transformer Research Consortium	35%	35%	30%	£ 592	£ 1,932	£ 592	£ 1,932	£ 508	£ 1,656
IFI 1214 - DNO Trial of Power Line Carrier	60%	40%	0%	£ 7,190	£ 9,720	£ 4,793	£ 6,480	£ -	£ -
IFI 1215 - Self Repair MV underground	60%	40%	0%	£ 20,976	£ 2,884	£ 13,984	£ 1,923	£ -	£ -
IFI 1216 - The Role of the Demand Side	60%	40%	0%	£ 7,016	£ 5,327	£ 4,677	£ 3,551	£ -	£ -
IFI 1218 - Impact of Domestic Heating	60%	40%	0%	£ 1,016	£ 7,156	£ 677	£ 4,771	£ -	£ -
IFI 1219 - Substation Efficiency	60%	40%	0%	£ 29,765	£ 12,283	£ 19,843	£ 8,189	£ -	£ -
IFI 1220 - Smart Grid Forum WS3	60%	40%	0%	£ 22,616	£ 2,457	£ 15,077	£ 1,638	£ -	£ -
IFI 1301 - Enhanced Weather Modelling for Dynamic Line Rating	0%	0%	100%	£ -	£ -	£ -	£ -	£ 1,693	£ 4,095
IFI 1304 - Smart Meter Enablement	60%	40%	0%	£ 1,016	£ 3,311	£ 677	£ 2,208	£ -	£ -
IFI 1305 - Low Power Radio Alarm System	60%	40%	0%	£ 5,136	£ 4,868	£ 3,424	£ 3,246	£ -	£ -

	SPD		SPM		SPT	
Totals	External	Internal	External	Internal	External	Internal
	£ 929,876	£ 246,572	£ 788,634	£ 201,400	£ 365,024	£ 50,464
Ratios	79%	21%	80%	20%	88%	12%

Table A1: Overview of 12/13 projects showing application between licences

Appendix B – Project Reports IFI Projects

April 12 – March 13

<table>
<tr><td>Project Title</td><td colspan="10">***IFI 0401 STP 2 Overhead Lines***</td></tr>
<tr><td>Description of project</td><td colspan="10">A DNO research and development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £12,995
External £57,247
Total £70,242</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £58,801
External £325,554
Total £384,355</td></tr>
<tr><td>Project Cost</td><td>£341,137</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="5">Internal £10,000
External £50,000
Total £60,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The Module 2 programme for budget year 2012/13 aimed to improve operational performance, maximise potential benefits, improve financial performance, and minimise risk associated with overhead lines. A full list of projects and deliverables are available from SPEN or EA Technology</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• If successful projects in this Module may increase the performance and reliability of overhead line networks</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-5 years - dependent on project</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">Range 3-5 years - dependent on project</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">Range 49-95% - dependent on project</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">→</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£42,652</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">Only a small number of projects or project stages started in the Module during 12/13 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="10">Collectively, the 12/13 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</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Other DNOs</td></tr>
<tr><td>R&D Providers</td><td colspan="10">EA Technology</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 0401 STP 3 Cable Networks</i></td></tr>
<tr><td>Description of project</td><td colspan="10">A DNO research and development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £12,995
External £69,008
Total £82,003</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £61,538
External £392,568
Total £454,106</td></tr>
<tr><td>Project Cost</td><td colspan="2">£413,360</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="5">Internal £10,000
External £60,000
Total £70,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The Module 3 programme for budget year 2012/13 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="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• If successful projects in this Module may increase the performance and reliability of cable networks</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Range 1-2 years - dependent on project</td><td colspan="4">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>→</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">£42,013</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">Only a small number of projects or project stages started in the Module during 12/13 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="10">Collectively, the 12/13 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="10">Other DNOs</td></tr>
<tr><td>R&D Providers</td><td colspan="10">EA Technology</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="9"><i>IFI 0401 STP 4 Substations</i></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="3">Internal £12,995
External £50,124
Total £63,119</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £59,019
External £306,038
Total £365,057</td></tr>
<tr><td>Project Cost</td><td colspan="3">£345,174</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="3">Internal £10,000
External £40,000
Total £50,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">The Module 4 programme for budget year 2012/13 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 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 substations</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-4 years - dependent on project</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">Range 1-6 years - dependent on project</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">Range 30-95% - dependent on project</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="2">→</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£32,721</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="9">Only a small number of projects or project stages started in the Module during 12/13 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 12/13 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="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="10"><i>IFI 0401 STP 5 Networks for Distributed Energy Resources</i></td></tr>
<tr><td>Description of project</td><td colspan="10">A DNO research and development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £12,995
External £45,676
Total £58,671</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £56,743
External £355,903
Total £412,646</td></tr>
<tr><td>Project Cost</td><td>£349,243</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="5">Internal £10,000
External £50,000
Total £60,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The Module 5 programme for budget year 2012/13 aimed to improve operational performance, maximise potential benefits, improve financial performance, and minimise risk associated with networks for distributed energy resources. A full list of projects and deliverables are available from SPEN or EA Technology</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• If successful projects in this Module may increase the performance and reliability of networks for Distributed Energy resources</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-3 years - dependent on project</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">Range 2-5 years - dependent on project</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">Range 51-100% - dependent on project</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>━</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">£28,841</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">Only a small number of projects or project stages started in the Module during 12/13 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="10">Collectively, the 12/13 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</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Other DNOs</td></tr>
<tr><td>R&D Providers</td><td colspan="10">EA Technology</td></tr>
</table>

Project Title	***IFI 0507 - Sensor Networks (Smart Dust) – Phase 2***
Description of project	"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.

Expenditure for financial year	Internal	£10,289	Expenditure in previous (IFI) financial years	Internal	£90,322
	External	£18,733		External	£207,284
	Total	**£29,022**		**Total**	**£297,605**
Project Cost (Collaborative + external + SPEN)	Phase 1 = £16k Phase 2 = £191k		Projected 13/14 costs for SPEN	Internal	£15,000
				External	£19,000
				Total	**£34,000**

Technological area and / or issue addressed by project	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 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-D 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 SP 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).

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

Expected Benefits of Project	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

Expected Timescale to adoption	5 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	£554.5k
Project Progress March 13	Progress in 2012/2013: Phase B has now started and final adjustments are being made to the devices to enable the construction of field ready trial devices. It has taken Willow Technology longer than expected to manufacture the devices for the field trials. The predominant issue has been a new requirement to configure the Gateway to be compatible with not only O2, but, also Orange & Vodafone.	
Potential for achieving expected benefits	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 Customer-Minutes-Lost 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.	
Collaborative Partners	Central Networks	
R&D Providers	Willow, E.ON Power Technology	

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.

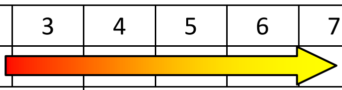
Expenditure for financial year	Internal External **Total**	£19,190 £15,519 **£34,708**	Expenditure in previous (IFI) financial years	Internal External **Total**	£62,856 £452,726 **£515,585**
Project Cost (Collaborative + external + SPEN)	**£2,345,967**		Projected 13/14 costs for SPEN	Internal External **Total**	£6,000 £12,000 **£18,000**

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	Significant	Technological substitution	Radical
	No	Yes	No	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.

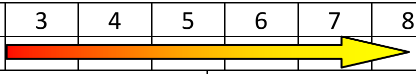
Expected Timescale to Adoption	3 years	Duration of benefit once achieved	20 years

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 13	The SFCL was installed in February 2012 and made live initially in August. Problems with the cryogenic cooling system, which prevents the liquid nitrogen in the unit from boiling off, were finally solved by replacing both of the two coldheads mounted on the SFCL lid – these had suffered from a manufacturing defect. The unit was re-energised in November and has been operational since then.
Potential for achieving expected benefits	Learning from this project will be able to help SPEN make strategic decisions on the future of fault level management
Collaborative Partners	Electricity North West, CE Electric UK, Applied Superconductor Ltd
R&D Providers	Applied Superconductor Ltd

<table>
<tr><td>Project Title</td><td colspan="9">***IFI 0515 - Power Network Demonstration Centre (PNDC)***</td></tr>
<tr><td>Description of project</td><td colspan="9">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.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £3,467
External £332,439
Total £335,906</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £54,450
External £430,519
Total £484,969</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">**£7,200,000**</td><td colspan="3">Projected 13/14 costs for SPEN</td><td colspan="3">Internal £10,000
External £30,000
Total £40,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">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 both marine and distribution 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">Yes</td><td colspan="3">Yes</td><td colspan="2">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£709,171</td></tr>
</table>

Project Progress March 13	**Activity April 2012 - March 2013** • There has been some delay in the commissioning and handover of the network. • The main components; supply substation, isolation transformer, motor generation set, overhead lines, underground cables and substations have been installed and part commissioned with final energisation expected to be during the summer. • The opening ceremony is expected to be in mid May and will be open by Scotlands First Minister, Alex Salmond.
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="10">***IFI 0526 - PD Monitoring of Cables (11 & 33kV)***</td></tr>
<tr><td>Description of project</td><td colspan="10">Partial discharge (PD) monitoring technology is a tool often used for identifying HV cable sections that are at risk of failing in the near future. There are two distinct methods of testing for PD:
• Long term monitoring to identify the degradation of the cable which signals the increase in risk of failure; and
• PD mapping which pinpoints the location of any discharge along the route of the cable.
Developing the technology to apply these methods gives a network operator the evidence required to assist in targeting investment / cable replacement, with a net improvement in network performance.

This project will develop a portable PD monitoring product that can be moved around the network, as tool in the prioritisation in cable replacement.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £4,352
External £41,568
Total **£45,920**</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £27,863
External £134,173
Total **£162,035**</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">£160,000</td><td colspan="3">Projected 13/14 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total **£0**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">This project will develop partial discharge monitoring hardware which will initially be tested on the SP 11kV network with the following aims:
• To develop a suitable portable monitoring solution with the ability to identify any cable sections which are emitting a level of discharge, which could lead to faults in the short term. The portable monitor will allow SP to test for a period of a few minutes to many weeks.
• Following initial testing in 10 primary substations, partial discharge mapping of those cable sections, which are registering the highest level of discharge, will be undertaken.
• Based on the PD maps obtained, any areas of concentrated PD activity, which are identified as critical, will be subject to review and selected cable sections will be replaced. The cable/joints removed will then be tested to validate PD test results.
It is planned that the test results will be collated in a database, which, in conjunction with results from the testing carried out by other UK DNOs, will allow for advancements in the knowledge rules for future PD testing technology.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Developing PD monitoring techniques and understanding of PD activity with respect to cable degradation will assist with cable replacement decision-making. It will also aid justification and prioritising of capital spend.
• Anticipated key benefits will be in the area of CML and CI improvements and cost savings through targeted cable section replacement programmes.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1-2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">5 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="5">⟶</td><td></td></tr>
</table>

Project NPV	(Present Benefits x Probability of Success) – Present Costs	£108,661
Project Progress March 13	The OLPD test and monitoring survey covered a selection of cable circuits with 39x 33kV circuits tested with 12 of these 39 from the SPEN 2002-2008 Worst Performing Circuits List for 33kV Circuits (these 12 represented around 10% of the total list of 122x 33kV circuits) and 25x 11kV circuits. Unfortunately, due to there being unsuitable 'plumbed' lead terminations onto the PILC cable terminations for most of the 11kV worst performing circuits visited, it was only possible to test two of these worst performing 11kV circuits in the project. In order to provide some data on a representative population of 11kV cables during the test project, OLPD tests were made on other 11kV cables that had suitable cable terminations in some of the substations surveyed. Alongside the OLPD testing and monitoring technology, the project allowed HVPD to trial a 4-Phase Condition Based Management (CBM) Plan with SPEN. This incorporates OLPD screening, testing and extended monitoring of the 11kV and 33kV cable circuits. The data generated from this combined approach is then used to produce a v1 condition-based 'OLPD League Table' for both the 11kV and 33kV circuits tested to provide the basis for quantified identification of 'weak spots' and incipient faults on the underground cable networks caused by partial discharge activity, providing the basis for a quantitative, condition-based management (CBM) process. This project has now been stopped with a decision to be made on the viability of PD mapping.	
Potential for achieving expected benefits	The main issue around gaining access to either the individual cable cores or the earth strap from the cable has to be addressed. Within SPEN we're looking at using protection CTs as the sensor and also looking into different methods of 'de-plumbing' older cables without causing more damage to the cable. As well as picking up on deteriorating health of cables, the PD monitoring system has also highlighted possible issues within cable end boxes and these are currently being investigated.	
Collaborative Partners	N/A	
R&D Providers	HVPD (Formally IPEC HV)	

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 0607 - LV Network Automation</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The aim of a Low Voltage Automation (LVA) project is to provide a trial system on Scottish Power Energy Networks (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.
It is 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 colspan="3">Internal £11,259
External £1,693
Total £12,951</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £175,623
External £206,136
Total £381,759</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">£257,775</td><td colspan="4">Projected 13/14 costs for SP-EN</td><td colspan="3">Internal £15,000
External £95,000
Total £110,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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 colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="2">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">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="5">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="3">→</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">£526,7k</td></tr>
</table>

Project Progress March 13	Design issues associated with the physical design of the vacuum switch unit 3D printing has delayed further testing. In addition FAT testing in January was not fully completed as accurate analogue values could not be recovered via PLC to the LVA controller due to insufficient primary current on the test network, and incorrect CT ratios provided by Netcontrol.
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"><i>IFI 0615 - ScottishPower Advanced Research Centre (SPARC)</i></td></tr>
<tr><td>Description of project</td><td colspan="4">Three workstreams have been proposed:
• <i>Asset Engineering</i>: Field based activities, concentrating on the technologies used to gather and interpret data then control and manage individual assets.
• <i>Asset Strategy</i>: Office, desktop, PC based analytical activities including the analysis of data, concentrating on underlying trends of asset populations (from asset ageing to network performance).
• <i>System Development</i>: 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 workstream.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £6,614
External £57,778
Total £64,392</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £40,791
External £670,096
Total £710,886</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£460,083</td><td colspan="2">Projected 13/14 costs for SP-EN</td><td>Internal £10,000
External £160,000
Total £170,000</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
→</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 workstream</td></tr>
</table>

Project Progress
March 13

'Investment Strategy' Theme: Automated analysis of SCADA data and digital fault records for analysis of power system protection performance

- Completed the develop, implement and test a prototype Post-Fault Protection Performance Analysis Suite:
    1. The prototype is currently within the final testing stage with testing conducted on an ongoing basis. The storms of January 2012 have become the final case studies and the preliminary results produced by the prototype are currently available for validation.
    2. Updates carried out to web-front end to improve performance and carry out general view improvements.
    3. Writing and drafting of journal paper for submission in March/April 2012.

In addition, the PhD student conducting this work was recruited by SP and is currently progressing, and expanding upon, her previous work in this area within SP.

'Investment Strategy' Theme: Smart Power Network Asset Management Strategies and Tools

- Develop a method to optimise targeting of investment for asset replacement over a given period of time.
    1. Developing a method to optimise targeting of investment for asset replacement over a given period of time. Investigated suitable optimisation techniques that can be used to establish desirable optima balancing of the objectives of minimising asset base risk, for given constraints (e.g. asset investment, etc.). This optimised targeted investment plan will identify specific assets for replacement to maintain a 'satisfactory' level of overall risk associated with the asset base (including assets of different type, and accommodating practical planning constraints).
    2. Select, apply and evaluate suitable optimisation technique to specified assets.
    3. Developing and testing 'proof of concept' application of selected optimisation and deterioration models for asset investment planning. This involves development of spreadsheet tools to test the 'proof of concept'. While this will not deliver a working prototype tool at this stage, it will deliver a methodology that will form the basis for the future development of an asset investment planning software tool.
    4. Conference papers published at UPEC and the IET/IAM Asset Management Conferences 2012:
        - A. Johnson, S. Strachan, G. Ault, "A Methodology for Risk Based Asset Replacement and Investment Planning," *Universities' Power Engineering Conference (UPEC), Proceedings of 2011 46th International,* pp. 1-5, 2011.
        - A. Johnson, S. Strachan, G. Ault, "A framework for asset replacement and investment planning in power distribution networks," *Asset Management Conference 2012, IET and IAM*, pp. 1-5, 2012.

'System Development' Theme: Optimal Distribution Network Architectures

- Completed the development of algorithm and tool for network reconfiguration for loss and reliability optimisation prototype, which has attracted interest from another commercial partner.

Project Progress March 13	**'Asset Technology' Theme: PD Diagnostics in MV Cables** Completed the development of a prototype system for double sided PD monitoring system and signal processing algorithms: 1. Firmware developed for the double sided PD monitoring system previously developed has been improved to increase the accuracy of PD location and has been verified in laboratory tests. 2. Laboratory test have proved successful. Further site trials within Primary substations and on wind farm circuits are scheduled to test and validate the system in the field is required. 3. Negotiations have started with a commercial partner, which it is hoped will push the project beyond the proof of concept stage and highlight its practical value either as a technology in its own right or as a component of a commercial monitoring system capable of being utilised in a number of industrial applications and areas and providing direct business benefit to SP. 4. A total of 13 conference and colloquium papers have been published in association with this work. One journal has been accepted for publication and two are currently under review. **'Asset Technology' Theme: Develop an intelligent decision support system for overhead line fault prognosis utilising available Pole Mounted Auto-Reclosers (PMAR) data.** This research will assess 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). Should this approach prove viable, a decision support system will be designed to assist engineers in the prognosis of distribution network faults and reduce nuisance tripping and CMLS, CIs. **Anglesey PV Penetration Study and developed software tool** for assessing voltage limits: The study established a generic methodology for assessing threshold levels for PV generating capacity connecting to the LV network, indicating where voltage quality and phase imbalance issues become problematic for the LV network. Building on this research, a prototype software tool was developed in conjunction with SPEN Manweb, to assess threshold levels for PV generating capacity connecting to the LV network, indicating where voltage quality and phase imbalance issues become problematic for the LV network. This tool is currently being used by Manweb staff in the decision making process affecting the connection of new PV generation at LV. **Assessing the Feasibility of Hyperspectral Imaging for the Detection of OHL Corrosion. T**he Cormon device used for OHL corrosion detection was designed and built in the 1980s and is no longer manufactured or supported. Its continued usage is strictly time limited. The ideal approach would be one in which the conductors could be inspected from the ground, eliminating the need for power outages and the requirement for operators to climb the pylons. This study will assess the feasibility of Hyperspectral Imaging (HSI), and potentially other imaging technologies, can be used to detect early signs of internal corrosion from the ground.

Potential for achieving expected benefits	• The **‘Automated analysis of SCADA data and digital fault records for analysis of power system protection performance’** PhD project of the Investment Strategy theme has delivered significant enhancements to the PEDA system developed from previous research conducted by the University of Strathclyde in collaboration with SPEN protection engineers. This system is now active in SP and is supported by the post-doc responsible for its development (now a member of SP staff). SP have benefited from the integration of this decision support tool and also from technology transfer through the recruitment of the individual responsible for its development.. • The **‘Smart Power Network Asset Management Strategies and Tools’** PhD project of the Investment Strategy theme will develop 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 will also attempt to identify which assets 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 opportunities are actively being explored . • 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. • 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="12"><i>IFI 0621-1 Monitoring Solution for overhead networks</i></td></tr>
<tr><td>Description of project</td><td colspan="12">FMC-Tech has developed a new system for on line measurement of conductor temperature and load, using a modified conductor mounted Fault Passage Indicator (FPI) together with a software system running a thermal model of the overhead line asset.
As a result this system enables both dynamic line rating and the location of faults in a single device.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £3,383
External £8,559
Total £11,942</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £19,197
External £59,711
Total £78,908</td></tr>
<tr><td>Project Cost</td><td colspan="3">£273,320</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The technological areas are twofold, firstly the conductor mounted FPI:
• Detects the passage of fault current on distribution networks, recording accurate current waveform data
The dynamic rating monitoring solution can be applied:
• In the management of heavily loaded circuits
Delivering potential connection solutions for DG, particularly wind where increased wind speed results in higher export, but also greater cooling of the overhead line and therefore providing an increased conductor rating.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">Successful completion of the project will result in:
• A new data source platform that is a fundamental base for strategic and operational activity to improve network efficiency.
• Load information available to utility personnel on line conditions prior to system maintenance.
• System will reduce the duration of power outages and allow for distributed generation from renewable energy sources i.e. wind farms.
• Will meet the increasingly stricter outage criteria from the regulator (i.e. future proof the networks, leading to reduction in regulator penalties and power outages.</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">5 years (per unit)</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3" colspan="3">0%</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="7">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£429,197</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="12">• No progress on the project during the period</td></tr>
</table>

Potential for achieving expected benefits	FMC Tech were purchased by GE in July 2011. No external activity or costs have been incurred during this reporting period. The forecast technical performance of the final stage of project now that it is under the control of GE is now such that it falls short of the DNOs needs, for a number of reasons including most importantly the anticipated weight of the device. At the time of writing the project is being formally closed, and will no longer proceed to stage 4 of the project, and agreement has now been given by all parties for closure to take place.
Collaborative Partners	ENW, Scottish Power, SSE, FMC Tech, Energy Innovation Centre
R&D Providers	FMC Tech (now part of GE)

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0621-2 LV Sure</i></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 £3,383
External £34,939
Total £38,322</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £7,419
External £12,556
Total £19,974</td></tr>
<tr><td>Project Cost</td><td>£260,980</td><td>Projected 2013/14 costs for SPEN</td><td colspan="2">Internal £4,000
External £26,380
Total £30,380</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The LVSure 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 LVSure 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 2013</td><td colspan="10">• Tests on modern FCL (Fault Current Limiter)
• Research of suitable materials and experimentation on small samples
• Build of full size prototype
• Further size optimisation to fit standard fuse board
• Thermal tests of the new solution

As a result a suitable contactor and FCL material were identified. It was found that proposed FCL technology may be too slow to perform as a protection device. This is the subject of the current research.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Previous work indicated that semiconductor technology is not suitable to be applied in fault current limiters due to extensive heat dissipation. Therefore another solution including contactor and new technology fault current limiter was proposed. Due to novel nature of the proposed solution a short research phase 2a and 2b was proposed to investigate this approach. The results of the mock up in stage 2a were very encouraging with basic proof of principal demonstrated</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="10"><i>IFI 0621-3 Live Alert – Energised Alert</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The Energised Alert is a high voltage detection device, currently capable of detecting voltages of above 2kV. The project’s objectives are to:
• To extend the voltage sensing range downwards from 2000 Volts
• To undertake a full market appraisal
• To undertake full evaluation of technology whilst in operation
This project aims to take the Energised Alert from TRL 4 to 8.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £3,383
External £8,559
Total £11,942</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £15,859
External £17,568
Total £33,456</td></tr>
<tr><td>Project Cost</td><td colspan="3">£ 65,815</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £3,000
External £7,000
Total £10.000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The Energised Alert senses any increase in electrical potential, above a predetermined threshold, of devices to which it is attached. Once triggered it is linked to an audible alarm, allowing the recognition and management of this potentially deadly hazard in a controlled manner. Its use will, therefore protect the operator, other employees and any members of the public in the vicinity from casual, but more importantly, avoidable electrocution.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">Successful development of the Energised Alert would:
• Help prevent electrocution accidents and fatalities
• Ensure ‘live line’ maintenance can be carried out in a safe manner
• Allow operators to proactively respond to incidents on their network</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 Year</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">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="4">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">-£49,420</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">• 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 4 was completed and issues surrounding over sensitivity were indentified. Work has been ongoing surrounding this and solutions identified. Early in 13/14 testing will be carried out to validate the solutions with project completion in sight.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The project is on target to achieve the expected benefits.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Northern PowerGrid, Electricity North West, SSE</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Live Alert</td></tr>
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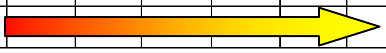
<table>
<tr><td>Project Title</td><td colspan="9"><i>IFI 0621- 4 PURL2</i></td></tr>
<tr><td>Description of project</td><td colspan="9">EA Technology currently offers the PURL instrument to allow condition assessment of wooden poles and while the instrument performs this function well it is slow and 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.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £3,995
External £9,329
Total £13,325</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £9,162
External £142,186
Total £151,347</td></tr>
<tr><td>Project Cost</td><td colspan="2">£ 284,000</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £2,000
External £10,000
Total £12,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">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.</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">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</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">10 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td colspan="5">⟶</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">£738,046</td></tr>
</table>

Project Progress March 2013	Stage One to develop a PURL2 prototype has now finished. The first stage covered – • The investigation into the use of different styles of ultrasonic transmitters to allow measurement of both time of flight and attenuation of ultrasonic signals between sensors. • The investigation into two methods of moisture measurement of which the capacitive measurement was selected. • A new surface hardness measurement technique was devised which allows portable testing with a hammer and indenter. • The development of algorithms to generate a cross section, from which the residual strength value can be calculated for the pole compared to a new pole. • The completion of laboratory and field tests. The results from the PURL2 prototype were compared with the PURL1, and the PURL2 prototype demonstrated improved results. A report covering stage one was delivered by EATL.
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

<table>
<tr><td>Project Title</td><td colspan="11"><i>IFI 0701 - ENA IFI Projects</i></td></tr>
<tr><td>Description of project</td><td colspan="11">The Energy Networks Association (ENA) represents all the UK network operators. Several projects have been initiated by the ENA R&D Working Group and have been funded through the IFI.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £3,383
External £3,360
Total £6,743</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £23,935
External £70,266
Total £94,202</td></tr>
<tr><td>Project Cost</td><td colspan="3">c£50,000</td><td colspan="3">Projected 2013/14 costs for SP-EN</td><td colspan="5">Internal £3,000
External £15,000
Total £18,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">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 .</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">Yes</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">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).</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 - 10 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 – 20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">25 - 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 colspan="9"></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£100,000</td></tr>
</table>

Project Progress March 13	**Harmonic Impedance Modelling** The project addresses the detailed modeling of cable and overhead line components, to develop cable models appropriate for distribution networks. These will be incorporated in to a new revision of G5/4 to a new simplified Stage 3A methodology for simple and low harmonic connections. Work is ongoing to establish this simplified stage. Tests have been progressing and will be published in the new G5/4 in due course. Final document has been received from the ENA R&D Working Group (WG). The document was authorised for circulation within the ENA R&D WG in the first instance, with a view to wider circulation once approved. **Earthing Project – HV/LV Earthing Transfer** This project has developed 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 up to 33kV. It is proposed this is now extended to the 132kV networks with a new calculation method being developed to accurately estimate transfer potential between EHV, HV and LV earthing system. The new calculation method will be designed with different arrangements and soil resistivity in mind. Under the previous stage of this IFI project, an MS Excel based calculation tool has been developed for analysing the earth fault current distribution for the full range of representative 11kV cables required by the member companies. This was now complete up to 11kV. A CD was provided by Earthing Solutions (ES) which included modelling calculations. The extension to the project to include voltages from 33kV up to 400kV. This new proposal is to add a representative sample of DNO 33kV, 66kV and 132kV cables into the routines. The 33kV and 66kV circuits and cables have many similarities to those previously modelled and can be added using the methods already developed. The 132kV circuits are more complex in terms of cable construction, circuit configuration, end resistance value (low) and circuit length (quite long). The work proposal includes 6 key deliverables and the price quoted by ES to complete this work is in total £25.5K. As of March 2013 further information is still being acquired for the projects potential transfer to the transmission system. **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 agreed. Invoices have been calculated for respective DNO's. 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; Scottish Power Energy Networks; 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 Scottish Power, 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 operational 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 £ 7,228 External £ 21,693 Total **£ 28,920**	Expenditure in previous (IFI) financial years	Internal £ 39,236 External £ 89,076 Total **£ 128,312**	
Project Cost	Stage 1 - £100,000 Stage 2 - £150,000	Projected 2013/14 costs for SPEN	Internal £ 10,000 External £ 60,000 Total **£ 70,000**	
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
Expected Benefits of Project	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 current 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 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.			
Expected Timescale to adoption	1 Year	Duration of benefit once achieved	4 Years	

<table>
<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">£ 15,562</td></tr>
<tr><td>Project Progress March 2013</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
Follow on work commenced in June 2012 and a preliminary report was produced using Strathaven as site case study. Llandinam Windfarm Substation has been identified as a second case study site. The substation has a very high ROEP of over 10kV. Relevant site data is being compiled for onward transmission to Cardiff University.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Potential – The project is progressing to a next stage where the following items will incorporated into the software:
• Set up of fault clearance time database
• Calculate variation in fault current magnitude and its effect on prediction of individual risk
• Apply extended computer procedure to several case</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">National Grid</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Cardiff University High Voltage Energy Systems Research Group.</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0714 – Collapse Prediction Relay (CPR – D)</i></td></tr>
<tr><td>Description of project</td><td colspan="4">The project will investigate if the Collapse Prediction Relay (CPR-D) manufactured by A-Eberle can reliably predict if the GB/Irish network is operating close to its stability limit and if minor changes in the generation profile or the network topology could result in instability and a possible black-out. The CPR-D uses a combination of various “instability” monitoring techniques to provide early recognition that a critical network situation is starting to develop and if allowed to persist might lead to a black-out. The techniques are: - detection of gradual network breakdowns, using the tap/time method; evaluation of power frequency and its rate of change; measurement of low frequency oscillations and their comparison with a healthy network fingerprint; monitoring of voltage drift; evaluation of the behaviour of the Lyapanov exponents and monitoring of the damping profile of the network.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £3,383
External £38,713
Total £42,096</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£370,970</td><td>Projected 13/14 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">SPT is obliged under its licence and the Electricity Act to develop an efficient, co-ordinated and economic system of electricity supply.

Being able to operate the network nearer to stability limits could help to accommodate further increases in wind generation and other less ‘stable’ generation technologies that are likely to impact on the Scottish Network in response to Government renewable energy targets, and therefore reduce the degree of network reinforcement required.</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">• Improved understanding of capability and stability of GB network with emerging constraints due to asset replacement, intermittent generation and changing generation and demand patterns. Better utilisation of assets could be achieved if margins are better understood.
• Through a better understanding of risk and system margins, facilitate and optimise the connection of Renewable and Intermittent Generation in line with UK Energy policy
• Improved understanding of the available network capacity, security and constraints from a planning and system perspective.
• Ensuring the system and plant operates safely within its design capability, thermal limits and system stability margins
• This project has the potential to create a cost effective method of predicting and identifying a very high impact, low probability event and contributes to better informed asset management.
• Typically the Financial Benefits will be achieved through avoided investment in infrastructure reinforcement and replacement as part of the current Capital programme.</td></tr>
<tr><td>Expected Timescale to Adoption</td><td colspan="2">3 years</td><td>Duration of benefit once achieved</td><td>10 years</td></tr>
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<table>
<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="4">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="6">Not able to quantify at this stage</td></tr>
<tr><td>Project Progress March 13</td><td colspan="10">2009 Laboratory based testing of the CPR-D has been undertaken up until February 2009 at which point the relay was installed at a 400kV UK Transmission substation. Since February 2009, monitoring of the performance of the CPR-D in response to system incidents and normal operational practices has been carried out by the R&D provider (University of Manchester.)
A paper on the use of the CPR-D to predict power system collapse was published in 2008 by National Grid, University of Manchester, System & Dynamik and UCAutomation and presented to the IET developments in power system protection conference.
Project update meetings have been held with our collaborative partners on an interim basis and regular contact is maintained with the supplier of the relay to gain assistance on issues as they arise.
This project is now closed</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">CPR-D Relay is being installed on a number of Transmission Systems across Europe, following major incidents on their networks. There is great interest in this particular relay and its ability to predict and warn of incipient stability and collapse conditions.
The main drive of this project is to evaluate the CPR-D relay and any alternative relays/algorithms (as available) and verify performance in simulation and on line conditions. Benefits will be achieved if it can be clearly demonstrated that a relay of this type can give sufficient early warning for some mitigating actions to be taken in real time or if decision support can be provided to system planning to optimise their planning decisions.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">National Grid, Scottish & Southern Energy, Northern Ireland Electricity and ESBI (Ireland)</td></tr>
<tr><td>R&D Providers</td><td colspan="10">University of Manchester and A-Eberle who manufacture the Collapse Prediction Relay (CPR-D)</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0801 - IEC 61850 Application in SP - Transmission</i></td></tr>
<tr><td>Description of project</td><td colspan="4">The key objective of this project is to maximise economic and effective utilisation of the transmission asset and network. The deployment of the technology advocated for this IFI project will allow ongoing substation secondary equipment retrofitting (refurbishment) projects to proceed whilst limiting the duration and frequency of circuit outages, required to facilitate the work.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,383
External £14,242
Total £17,625</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £33,687
External £102,134
Total £135,821</td></tr>
<tr><td>Project Cost</td><td>£455,000</td><td>Projected 2013/14 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">Project 1 (IFI 0801-1) – Microsol
This proposal is twofold, to develop, test and commission the IEC Protocol on the Microsol RTU to allow us to trial interfacing to two specific devices at two specific locations, namely:

a) Busby 275kV Hathaway Fault Recorder.
b) Strathaven 400kV Operational Intertripping Relay.

At Busby 275kV we propose to recover all the Analogue information from the fault recorder, this will allow us not only to present more information to the Control Engineers in real time, it will eliminate any issues with faulty transducers, faulty resistor scaling and faulty wiring.

Project 2 (IFI 0801-2) - University of Manchester and NGC
This IFI application aims to investigate, quantify and optimise the level of security, dependability and speed in secondary schemes using IEC 61850. This project is strategically aligned with Iberdrola Networks and will provide procurement benefits.

Project3 (IFI 081-3) – “Hardfibre” Process Bus Field Trial & RTDS Testing
GE Multilin is first to market with IEC61850-9-2 products and the proposal is to undertake a field trial at the new Inverarnan 275kV substation and to perform RTDS testing of the scheme. This will achieve the following objectives:
Proof that the protection performance of a process bus system is at least equal to conventional schemes
To gain experience of the installation, configuration and operation of a process bus system.
To measure the time and cost benefits of process bus.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td>No</td></tr>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="10">In summary, if this protocol is developed, implemented and tested and commissioned successfully on our Microsol RTU then it gives us some real flexibility for the future and will fundamentally influence decisions regarding substation design and choice of relay manufacturer, and will have the added advantage of allowing us to cease the highly expensive option of flood wiring with multi-core copper cables within the substation environment and adopting a LAN approach to comms and data capture.
However, IEC61850 also offers benefits in the protection realm. The use of GOOSE services has been demonstrated (in the West Coast operational Intertrip scheme) to provide significant performance benefits over hard-wiring and significantly reduced installation and testing times as much of the scheme functionality can be factory tested. Additionally, part 9-2 permits the use of a process bus which can, in addition to reduced wiring, provide additional reliability and the future promise of outage-free protection replacement.</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">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="4">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">No NPV calculated for this limited trial</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">This project is now closed.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The University project Evaluation of IEC61850-9-2 Process Bus and Its impact on Substation Protection and Control Reliability is now coming to a close with the final report due mid 2012.
It is hoped than the learning from the project will give guidance on SPs direction in the use of IEC61850.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Project 1 and 3 none, Project 2 Manchester University, SSE, NGC</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Manchester University</td></tr>
</table>

<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>Internal £6,943
External £11,693
Total £18,636</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £23,631
External £21,886
Total £45,517</td></tr>
<tr><td>Project Cost</td><td>**£121,500**</td><td colspan="2">Projected 13/14 costs for SPEN</td><td>Internal £6,000
External £10,000
Total £16,000</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>
<tr><td>Expected Benefits of Project</td><td colspan="4">Durham University are already working with Scottish Power 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>
</table>

<table>
<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 13</td><td colspan="10">The current work is focussing on the development of the off-line planning tool and builds on the state-of-the-art computational fluid dynamic (CFD) modelling and high resolution terrain topology mapping developed previously. This tool aims to take 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 combine 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">Having an offline planning tool for analysing the dynamic ratings of circuits will enhance our ability in understanding the impact of utilising these technique in real time and power flow analysis. The tool will assist in the analyses and management of constraints in the network and also support design engineers to make informed decisions with regards to enhanced dynamic rating for circuits and their impact on the network, power flow and constrains on embedded generation.</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>

<table>
<tr><td>Project Title</td><td colspan="12"><i>IFI 1002 - Supergen HiDEF</i></td></tr>
<tr><td>Description of project</td><td colspan="12">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</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal
External
Total</td><td colspan="2">£4,807
£81,693
£86,500</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal
External
Total</td><td colspan="2">£20,167
£20,565
£40,732</td></tr>
<tr><td>Project Cost</td><td colspan="4">£4,492,000</td><td colspan="4">Projected 13/14 costs for SPEN</td><td colspan="2">Internal
External
Total</td><td colspan="2">£0
£0
£0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">This Highly Distributed Energy Future (HiDEF) programme researches the essential elements of a decentralised system that could be implemented over the period 2025 & 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.</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">The project has a strong academic and industrial representation and will strengthen SPEN’s engagement into the future of network systems and the influences of developments across the supply chain. In general the benefits will entail:
• The engagement with academia and industry into the understanding of the impact of a future decentralised system.
• The impact of a decentralised system on networks infrastructure, operation and control.
• The impact of a decentralised system on regulatory and commercial frameworks.</td></tr>
<tr><td>Expected Timescale to Adoption</td><td colspan="4">Year 2012 onwards</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 colspan="3" 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 colspan="4">→</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="6">£78,648</td></tr>
</table>

Project Progress March 2013	The Decentralised Energy Workstream has completed the realisation of open source models of energy storage, energy conversion and energy demand components. The library of domestic building models has now been complemented with commercial building models featuring hybrid and low carbon systems. These have been used by IEA (International Energy Agency) and Distribution Network Operator (DNO) partners. Further progress has been made in the realisation and testing of new cell control solutions within the team's hardware rigs and simulation environments. The Decentralised Network Infrastructure Workstream has developed a number of new power and energy system analytical techniques and tools, and has applied these to the analysis of industrial case studies. Projects at Ebbw Vale, Ashton Hayes and Shetland have thus been supported, and the data sets and tools in relation to DSM, EV, HP, thermal and electrical storage refined with this experience. The Decentralised Participation team have realised stochastic optimisation techniques and novel pricing techniques that help maximise the expected portfolio of DG and DR services. Furthermore, their hardware platform showcasing frequency response functions for smart meters has now been demonstrated at a smart meter exhibition. The Decentralised Policy and Macro Impact Assessment team have continued their assessment of the effectiveness of alternative policy measures including in Glasgow, Brighton & Hove, and Milton Keynes. The ability to conduct macro-economic modelling incorporating the impact of renewables and advanced generation deployment has been enhanced through augmentation of the established CGE model to incorporate household energy demands. This will now feature in ongoing economic modelling activity. The team continue to support a number of engagement and impact case studies, including a number of LCNF projects. The values of HiDEF datasets, simulation and analysis tools, and models have thus been assessed with academic partners, industrial colleagues, community groups, and agency staff. This has been complemented with significant dissemination and engagement, including 37 new publications, a HiDEF workshop in London concerning "The Future of Community Energy", and participation in a variety of conferences and meetings.
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="10"><i>IFI 1004 - Remote Access to Pole Mounted Auto Reclosers</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The Noja pole mounted auto recloser 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 £24,688
External £1,693
Total £26,380</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £14,878
External £37,106
Total £51,984</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">£76,800</td><td colspan="4">Projected 13/14 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="10">The project aims to address the issue of safe and automated remote access to active and historical data from SPEN’s population of Noja PMAR.

The project will enable circuits to be ranked accordingly to agreed performance indicators e.g. circuits with most trips which could inform operational and maintenance activities.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Health and Safety benefit realised by negating the need to climb PMAR poles to access information
• Automatic collection of all Noja PMAR event logs, removing the need to drive to site and consequent delays in getting data
• Summary analysis of PMAR activity with dashboard showing league table of operations
• Central storage of event logs</td></tr>
<tr><td>Expected Timescale to Adoption</td><td>3 years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">10 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>⇒</td><td>⇒</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£343,820</td></tr>
</table>

Project Progress March 13	Deployment of 50 prototype devices is underway, with 11 units in commission. Nortech are now finalising an agreed design for a browser dashboard to give clear and concise summary information about all the NOJAs on a single page as well as suggestions for where to “drill down” looking at possible areas of further interest. This would be ideal place for up to date comments like “3 NOJAs have reported multiple EF trips in the last 24 hours”. Testing of this final phase will commence in May 2013.
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

<table>
<tr><td>Project Title</td><td colspan="12"><i>IFI 1005 - GIS Impedence Mapping - zMap</i></td></tr>
<tr><td>Description of project</td><td colspan="12">Carrying on from the work that was completed in IFI project – IFI 0709 Network Monitor using Web Systems, it is proposed to utilise the voltage and current values obtained from sub.net and PQR during faults and feed them into GeoField, SPEN's GIS mapping software.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £3,383
External £4,621
Total £8,004</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="6">Internal £25,377
External £41,743
Total £67,120</td></tr>
<tr><td>Project Cost</td><td colspan="3">£130,520</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="6">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The laborious process of tracing a circuit length will be obsolete with the GIS platform that we currently use able to trace via impedance based on a table of impedance values per cable type.

Currently SP have roughly 200 PQR that are able to record faults, but these units are only polled once a day or on an ad hoc basis. This project will enable fault information to be emailed to a user or iHost which can then deduce and impedance value.

As the new ENMAC is currently some time away its imperative that a frontend for new IFI projects and current IFI projects is developed to ease the transition into SPENs SCADA network.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">• The existing GeoField Network Map Viewer tracing engine will be configured to allow tracing from a start point to a specified accumulated impedance value. This will behave in an identical fashion to the existing length-based trace.
• Integration to implement a scheme for SP Power Systems to allow PQRs to trigger autocomms for retrieval of fault records using email. This is required because SP current IT policies do not allow modems to answer incoming calls and the only way to retrieve data from recorders is to use autopoll, automatic or manual.</td></tr>
<tr><td>Expected Timescale to Adoption</td><td colspan="3">2 years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="6">10 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="3" 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 colspan="3">→</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="6">£151,554</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="12">This project is now closed.</td></tr>
</table>

Potential for achieving expected benefits	Scottish Power own and operate 30 substation disturbance recorders from Embedded Monitoring Systems (EMS) known as a sub.net device. Currently information can be retrieved from the sub.net device either by using an inbuilt web interface, or by receiving e-mails sent by the device in response to events occurring on its monitored inputs. By using the data from the 30 disturbance monitors we will be able to get a good idea of the potential.
Collaborative Partners	None
R&D Providers	Sigma7

<table>
<tr><td>Project Title</td><td colspan="4">***IFI 1007 – Outram Fault Level Monitor***</td></tr>
<tr><td>Description of project</td><td colspan="4">The aim of this project is to 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 in at various locations where there is uncertainty in fault level in Low Voltage, 11kV, 33kV and 132kV groups on the network.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £16,911
External £27,309
Total £44,221</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £30,569
External £103,898
Total £134,468</td></tr>
<tr><td>Project Cost</td><td>£121,196</td><td>Projected 2013/14 costs for SPEN</td><td colspan="2">Internal £7,500
External £30,000
Total **£37,500**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">It is proposed that the instrument could provide a viable alternative for fault level assessment 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.</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">• 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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="3">TRL Development (Start – Current)
<table>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="3">→</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">£188,953</td></tr>
</table>

Project Progress March 2013	• Over the last 12 months SPEN has trialled x6 FLM units on the network to refine the FLM algorithm and firmware and assess the instruments capabilities. • The results from each site have been very encouraging and have lead to further refinement of the FLM algorithm. • Typically the FLM has generated results that are within 5% of the values generated by IPSA and DIGSILENT models. • Additionally there has been major development in the devices graphical interface and user software to enable the FLM to deliver results in a user friendly format. • As of March the project is almost at an end, with only some final tests programmed in 2013 prior to the projects close down.
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"><i>IFI 1101 – EPRI</i></td></tr>
<tr><td>Description of project</td><td colspan="9">SPEN has taken out membership of the Electrical Power Research Institute (EPRI) in order to gain technical guidance and expertise to support the 2020 Project. This project will employ technologies that have not yet been used in GB and membership of EPRI provides access to a wide range of technical documentation and expertise covering HVDC, Series Compensation and Wide Area Monitoring & Control which feature in the 2020 proposals. EPRI provides a wide range of information in other aspects of power engineering such as smart grids and asset management.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £4,726
External £140,671
Total £145,397</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £11,465
External £97,931
Total £109,396</td></tr>
<tr><td>Project Cost</td><td colspan="3">£360k for 3 year participation</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="3">Internal £12,000
External £120,000
Total £132,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">SPEN is one of the principle organisations involved in the Department of Energy and Climate Change (DECC) Electricity Networks Strategy Group (ENSG) work on the 2020 vision for the transmission network. This work has set the footprint for the transmission system in the UK to facilitate the delivery of renewable energy in Scotland in excess of 10GW by 2020. An essential deliverable of this work is the HVDC link between ScottishPower and National Grid. It is proposed for this link to be operational by 2016 to facilitate the flow of the expected renewable energy from Scotland to England. This is the first off many proposed DC links in the UK to deliver the 2020 vision.
Involvement with EPRI will provide information in the technology areas applicable to the HVDC link development.</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">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">• EPRI membership will give SPEN immediate benefits in terms of surveying the technologies and application of these technologies in the areas of designing, monitoring, controlling and operating HVDC links.
• SPEN individually or jointly with National Grid, can utilise EPRI expertise in the assessment of possible designs and solutions provided internally or by external companies.
• As well as the HVDC module, there are many other modules that can be of considerable benefit to SPEN, such as in areas of wide area monitoring, losses minimisation and smart grids.</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">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td colspan="4">→</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">£537,245</td></tr>
</table>

Project Progress March 2013	• HVDC Technology Surveillance and Reference Guidelines ○ HVDC Reference Book was published with 24 chapters at the end of 2012. ○ HVDC Tech Watch Newsletter was also issued in January 2013. ○ Contracts are being placed to work on additional chapters such as Life Extension of HVDC and AC to DC Conversion, Grounding. Also some chapters such as VSC (Voltage Source Converter) technology will be updated with the latest information. ○ EPRI HVDC & FACTS conference will be held at EPRI Palo Alto, USA, on Aug 28-29, 2013, which will provide an opportunity to exchange information on latest technology developments and applications. • Applications of HVDC Technology and New Developments ○ DC cable technology assessment report was published in Dec 2012. ○ AC vs. DC Wizard V1.0 software to evaluate AC versus DC application options was released in Dec 2012. ○ Contracts are being placed to work on AC vs. DC Wizard V2.0 ○ Technical and Economic Guidelines for DC Applications will be developed by Dec 2013. • Integrating HVDC in an AC Grid ○ An EPRI Report on - Advanced Control Methods for Power Flow Control Optimization, Power Oscillation Damping Methods, and Wide Area Control System Methods – was published in Dec 2012. ○ Research has started on the topics - Coordination of DC Control with AC Network Controllers, Transmission Requirements for Wind Integration & Special Protection and Control Schemes. ○ This project is coordinated with a supplemental project on the same topic in which application studies are conducted for the GB network for National Grid and Scottish Power. • HVDC System Performance and Component Testing ○ Live line work tests were conducted at the Lenox laboratory and a technical update was published in Dec 2012. ○ HVDC insulator performance – a technical update issued in Dec 2012. ○ HVDC Overhead Trans Design Guide: outline - issued in 2012. ○ Insulator testing, live line work testing, and HVDC Overhead Trans Design Guide development will be continued in 2013. • Electrical Effects of HVDC ○ HVDC Electrical Effects software (beta version) & a technical update on Electrical Effects of HVDC Transmission Lines – were issued in Dec 2012. ○ Experiments are being performed at the high voltage laboratory in Lenox and a revised technical update with test results will be published in 2013. ○ HVDC Electrical Effects V1.0 software will be issued in by the end of 2013
Potential for achieving expected benefits	Work has started on the collaborative supplemental project 'Integrating HVDC in an AC Grid' in 2012 and will be continued through 2013 working on different aspects.
Collaborative Partners	NGC (Integrating HVDC in an AC Grid)
R&D Providers	EPRI

<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 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 £6,231
External £20,493
Total £26,724</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £14,272
External £186
Total £14,457</td></tr>
<tr><td>Project Cost</td><td colspan="3">£326,000</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="3">Internal £10,000
External £15,000
Total £25,000</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">⟶</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>

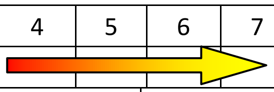
Project Progress March 2013	Good work has been carried out in the comparison of different electrical energy storage operating schemes and the resultant decrease in losses, voltage events, and OLTC operations.
Potential for achieving expected benefits	It is hoped that the eventual output of the project will help Scottish Power plan strategically how and the operation of energy storage can be optimised in terms of decreasing losses, voltage events, and OLTC operations.
Collaborative Partners	Electricity North West
R&D Providers	Durham University

<table>
<tr><td>Project Title</td><td colspan="11"><i>IFI 1103 – PD Monitoring in Supergrid Transformers</i></td></tr>
<tr><td>Description of project</td><td colspan="11">The aim of this project is to remotely monitor partial discharge (PD) activity on a 275KV / 33KV transformer using a PD monitoring system supplied and installed by DMS Ltd. After a period of testing the transformer will be inspected to determine the accuracy of the monitoring system in determining PD location.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £7,670
External £98,498
Total £106,167</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £8,750
External £76,421
Total £85,170</td></tr>
<tr><td>Project Cost</td><td colspan="3">£184,000</td><td colspan="4">Projected 2013/14 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">The issue addressed by this project is the determination of the long term health of a supergrid transformer by the identification and location of PD activity.</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">• Detection and measurement of PD and logging, reporting and alarming for continuous health checks on transformer condition.
• Research and Development in conjunction with Strathclyde University to model the transformer tank and the internal construction and then using triangulation techniques using the data from the PD couplers to determine the location of any PD.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2"><2 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3" 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="7">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£28,905</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="11">All partial discharge monitoring equipment has now been installed. Work is now beginning to pull the data into a 3D model using a combination of the commercial system and the R&D Strathclyde University triangulation techniques. In the event that further work is required on this project then it will be registered under the NIA funding arrangement.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="11">This project is on target to deliver the benefits once a substantial collection of data has been achieved.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="11">None</td></tr>
<tr><td>R&D Providers</td><td colspan="11">University of Strathclyde</td></tr>
</table>

<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 £9,079
External £13,693
Total £22,772</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>£348,895</td><td>Projected 2013/14 costs for SPEN</td><td colspan="2">Internal £7,500
External £15,000
Total **£22,500**</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 & 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>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td>Duration of benefit once achieved</td><td colspan="2">15 Years</td></tr>
</table>

<table>
<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">TBC</td></tr>
<tr><td>Project Progress March 2013</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. In addition to the papers listed below, a further two papers are scheduled to be published in the Summer and Autumn of 2013.
• Paper 1 – GB Electricity Demand – Context and 2010 Baseline Data
• Paper 2 – GB Electricity Demand – 2010 and 2025
• Paper 3 – What Demand Side Service Could GB Customers Offer?
• Paper 4 – What Demand Side Services can provide value to the electricity sector?
• Paper 5 – The Electricity Demand Side and Wider Policy Developments
• Paper 6 – What Demand Side Services Does Distributed Generation Bring to the Electricity System?
• Paper 7 – Evolution of Commercial Arrangements for More Active Customer and Consumer Involvement in the Demand Side</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The project is on track to realise expected benefits.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">BEAMA
Cable & Wireless
Consumer Focus
British Gas
EDF Energy
Elexon
E-Meter (a Siemens Business)
E.ON UK
National Grid
Northern Powergrid
Ofgem
UK Power Network</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Sustainability First</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1107 –Cable Identification Devices</i></td></tr>
<tr><td>Description of project</td><td colspan="10">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.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £6,729
External £23,592
Total £30,321</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £9,703
External £186
Total £9,889</td></tr>
<tr><td>Project Cost</td><td colspan="3">£42,000</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• 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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2"><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">90%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></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">£1,123,305</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">• The order was placed for five SEBA KMT cable identification devices for subsequent trial. Trialling to date has not provided the success rate expected. In the meantime these units will be recommended only for indication and not identification.
• Development work with SEBA required to progress trial through 2013.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Assuming that the trials of the cable identification devices and any required upgrade work is successful then the potential for achieving the expected benefits is high.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">None</td></tr>
<tr><td>R&D Providers</td><td colspan="10">SEBA KMT</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="12"><i>IFI 1108 –ESRI Powerfactory</i></td></tr>
<tr><td>Description of project</td><td colspan="12">ScottishPower uses an enterprise wide Geographic Information System delivered by Esri UK known as FGIS. This holds electrical plant and circuit data in an ‘ArcFM’ database. The system is used to create and maintain electrical system models on a geographic basis.
ScottishPower also use DIgSILENT PowerFactory for electrical network modelling and analysis. This tool enables ScottishPower to model and simulate electrical loading and size plant to meet given business requirements.
Currently in the ScottishPower area there are no robust 11kV system models and it will take considerable amount of time to generate such system models to assist in the design and analysis of the 11kV network. The project will attempt to develop an interface between ESRI and PowerFactory to enable the quick and efficient modelling of the 11kV network.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £7,582
External £82,554
Total £90,136</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £8,822
External £186
Total £9,007</td></tr>
<tr><td>Project Cost</td><td colspan="3">£98,000</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The aim is to develop a demonstrator project to proof the concept of interfacing the ESRI system with PowerFactory hence enabling the business to quickly develop network models of the 11kV system and possibly LV system. This will provide design engineers with up to date network models that can be utilised and enhance the design process and solutions evaluation. Generating 11kV models is laborious, time consuming and prone to errors. This project will prove the concept of using GIS information to develop up to date electrical models.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">• To provide mechanisms to quickly model the 11kV network in PowerFactory.
• Streamline existing business processes for the design and connection on the 11kV network.
• To quickly run 'what if' scenarios to assist in the design process.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3"><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 colspan="3" 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="4"></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">£1,608</td></tr>
</table>

Project Progress March 2013	The integration process between ESRI and PowerFactory has been completed with mixed results. There are issues around the quality of data and also the final output in PowerFactory is not entirely suited to the user's requirements. As well as this, the PowerFactory solution is a much more powerful application than is required. Work is being carried out with xml file from ESRI GIS platform to see if it can be incorporated into other modelling applications that are more suited to our connections engineers.
Potential for achieving expected benefits	This project has proven to be successful and will now close. Work will be carried out on the ESRI XML extraction tool to look at the integration into other design packages.
Collaborative Partners	None
R&D Providers	ESRI UK and DIgSILENT

<table>
<tr><td>Project Title</td><td colspan="10">***IFI 1202 – Nanodielectrics***</td></tr>
<tr><td>Description of project</td><td colspan="10">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.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £6,943
External £33,682
Total £40,625</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £8,750
External £186
Total £8,935</td></tr>
<tr><td>Project Cost</td><td colspan="3">£104,980</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £7,500
External £30,429
Total **£37,929**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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.</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="3">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">Yes</td><td colspan="2">Yes</td><td colspan="3">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• 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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3"><3 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">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="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">Not known at this stage</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">The project started on 1 June 2012. A review has been undertaken to identify the physical properties of interest for HVDC applications. Components have been suggested to demonstrate scalability and performance of the nano-dielectrics technology. A set of materials has been selected to potentially achieve the properties targets. These raw materials have been sourced and tested. Some formulation trials have been performed and the research providers are now looking at the process to obtain reproducible and scalable composite materials.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">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.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">NGC, SSE</td></tr>
<tr><td>R&D Providers</td><td colspan="10">GnoSys UK, University of Southampton and Areva Research & Technology Centre, National Physical Laboratory</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="12"><i>IFI 1203 – Psymetrix ACAM Phase 1</i></td></tr>
<tr><td>Description of project</td><td colspan="12">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
External
Total</td><td colspan="2">£34,585
£149,331
£183,915</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal
External
Total</td><td colspan="2">£17,327
£186
£17,513</td></tr>
<tr><td>Project Cost</td><td colspan="4">£320,655</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="2">Internal
External
Total</td><td colspan="2">£20,000
£160,000
£180,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The project will contribute to the UK environmental targets by enabling a greater penetration of renewable generation on to the electrical network.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="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">• To prove and quantify the additional capacity that an ACAM scheme could introduce
• To prove the correlation of modelled ACAM angles against network PMU measurements
• To identify the operational requirements of an ACAM scheme
• To gain the necessary evidence to justify an operational trial of the ACAM scheme</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">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 colspan="3" 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 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">£187,974</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="12">• Installations completed with only snagging and VT connections to be carried out in April 2013
• Cloud based PhasorPoint server built and demonstrated
• Psymetrix report on the process for the identification of acceptable phase angles has been produced and circulated to SPEN for consideration</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="12">The projects potential to deliver the expected benefits has been enhanced as the technical challenges of installing the kit in the substations and achieving a reliable 3G and GPS signals has been largely achieved. Additionally, the Psymetrix report on the identification of acceptable phase angles has demonstrated an approach that could be adopted by SPEN.
Over the course of 2013/14 the onsite measured angles will be compared to the expected IPSA study angles for the network and the ACAM feasibility will be proven.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="12">Psymetrix</td></tr>
<tr><td>R&D Providers</td><td colspan="12">Psymetrix</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 1204 – LV Jumpers with Integral CB</i></td></tr>
<tr><td>Description of project</td><td colspan="4">The development of a set of a prototype Low Voltage (LV) jumper set to be used in conjunction with a suitably graded portable LV circuit breaker. The full arrangement to be used to energise LV circuits from adjacent live circuits during LV busbar outages, hence reducing customer outages and mobile generator costs. Assuming the prototype proves successful the project will be extended to include evaluation of several units on the network.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £8,625
External £4,755
Total £13,379</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £11,008
External £186
Total £11,194</td></tr>
<tr><td>Project Cost</td><td>£25k</td><td>Projected 2013/14 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 prototype arrangement would provide a technical solution to reduce customer outages and mobile generator costs / emissions.</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">• Improved customer service via the reduction in the CI and CML associated with the LV busbar outages.
• Reduction in the mobile generation emissions and costs associated with LV busbar outages.
• Additional operational applications and benefits derived from field trials and business exposure to the device.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="3"><table><tr><td colspan="9">TRL Development (Start – Current)</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td colspan="2">→</td><td></td><td></td></tr></table></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">TBC</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="4">• The LV JumpBox was tested during a busbar outage during 2012/13, the test was a success.
• Subsequently there have been no further outages suitable to trial the LV JumpBox on.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The prototype JumpBox has proven itself to be suitable for use in an Operational capacity, however the need case for the device has not yet been as strong as first believed. Over the course of 2013/14 the JumpBox’s performance will be further assessed and disseminated to the wider business.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">Non e</td></tr>
<tr><td>R&D Providers</td><td colspan="4">Ten47</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="9"><i>IFI 1205 –Transient Earth Detector</i></td></tr>
<tr><td>Description of project</td><td colspan="9">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 colspan="3">Internal £4,451
External £15,039
Total £19,490</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td colspan="3">£207,000</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="3">Internal £3,000
External £6,480
Total £9,480</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">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 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">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="4">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td colspan="4">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£11,745</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="9">As part of the development and issues raised by SPEN re the original concept a 4th Specification has been agreed by all involved.
EATL to look at how to build some design cost targets into the early project stages to give confidence that the eventual target of £20/pole “at volume” is achievable. A suggested methodology has been proposed to EATL</td></tr>
</table>

Potential for achieving expected benefits	The project has progressed well with regards to developing a technology solution that will have potential in the field.
Collaborative Partners	None
R&D Providers	EA Technology Ltd

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1206 –Sudafix Conductive Concrete</i></td></tr>
<tr><td>Description of project</td><td colspan="10">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 £3,383
External £36,090
Total £39,473</td><td colspan="3">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">£59,192</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The project will 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="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• 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="5">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="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£24,734</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">• The thermal shock tests have been completed and report delivered.
• The mechanical impact tests have been completed and report delivered.
• The resistivity test measurements are close to completing with only the analysis and reporting remaining.</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="10"><i>IFI 1207 –Smart 3 Phase Voltage Regulator</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The distribution network controlled using transformers and tap-changing has proven reliable, however controllability of voltage is limited at best and faces the greatest challenge in remote and rural areas.
An active series voltage regulator to be developed by Gendrive Ltd (supported by EA Technology) aims to provide a more stable and smarter local supply. The unit proposed will in effect prevent or at worst delay the cost of reinforcing problematic distribution circuits.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £4,095
External £21,342
Total £25,437</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td>£142,814</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="5">Internal £5,000
External £24,000
Total £29,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Although voltage issues in rural/urban areas are not currently a major issue, ongoing work in a number of Low Carbon Network projects suggests that the increasing load scenario (particularly heat pumps) that will develop in the next 20 years will generate increases in customer supply problems. The smart voltage regulator unit offers the potential to solve issues in problem feeder circuits as well as providing an opportunity to moderate harmonic and to a certain extent power factor issues that are also anticipated to grow.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• The unit would be able to service feeders carrying up to 500 Amps, and provide voltage stabilisation capacity up to +/-30 volts
• Fluctuation in voltage amplitude on the distribution-side will be de-coupled from the load-side, so it can be regulated whenever the distribution voltage varies outside of normal operating limits
• Distributed Generation on the customer side will suffer fewer loss-of-mains trips whenever voltage rises above the permitted voltage range, as the effective network voltage (load-side) can be reduced
• Heavy load will not cause excessive voltage drop as the voltage regulator will act to increase the load /consumer voltage</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">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 colspan="3">→</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£76,055</td></tr>
</table>

Project Progress March 2013	• A functional specification was created including performance metrics • A model based simulation was undertaken for the initial topology and found to be insufficiently flexible for the project targets • The creation of an alternative topology was completed and any further work on this project will be based on the improved topology
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="4"><i>IFI 1208 –ESRI ECMP</i></td></tr>
<tr><td>Description of project</td><td colspan="4">The Dynamic Energy & Carbon Master Planning (ECMP) project aims to develop a specialised GIS based spatial energy/load forecasting modelling toolkit within the ESRI GIS asset database. This specialized planning tool will build on current ESRI development work on existing building spatial energy density modelling and Low and Zero Carbon (LZC) technology opportunity which was completed in conjunction with local authorities in England (Nottingham). This project will develop a model of 'new-development' energy density (heat and electric) using standard industry (including BRE for housing) datasets. The unique outcome that this proof of concept aims to delivery is a GIS based spatial 'Energy' planning tool that will provide an adaptive Energy Density, Peak load, CO_2 and LZC picture for existing and major new development areas overlaid upon an existing GIS infrastructure database. This will then be used to support stakeholder engagement on 'Energy' infrastructure requirements.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £18,500
External £86,957
Total £105,456</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>£109,834</td><td>Projected 2013/14 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">With the use of dashboard inputs, the model could then be easily adapted for a wide variety of future development scenario planning, and the functionality could be used by either an external stakeholder or DNO to understand the LZC and energy infrastructure requirements and energy delivery concepts (electrification of heat and transport, centralised district heating systems etc). Though the initial project will deal mainly with heat and electrical energy density modelling it is hoped that future development will lead to better modelling of energy profile & peak loading.</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 benefits that this adaptive spatial/load forecasting modelling toolkit can provide are:
• Help develop ECMP techniques with major high level City based stakeholders (Councils and major redevelopment organisations) and others.
• Help develop 'Energy Data Analysis' expertise to support future Smart Grid development and increased Distribution Management System (DMS) implementation
• Inform future asset strategy and planning through adaptive Infrastructure scenario Planning.
• Help to ensure that, in the final delivery of the wide variety of smart grid concepts, energy and asset management, external stakeholder aims to reduce energy and CO_2 and the DNO requirement to minimise new reinforcement infrastructure to facilitate this are met.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 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 colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">Not applicable for this proof of concept project</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">ESRI UK delivered required project input ‘Data’ and the agreed series of GIS ‘Toolkit’ models in the ‘Model Builder’ programmable format consisting of,
• Commercial Energy Demand Model – City level modelling of Commercial Building Energy Density on a building by building basis
• Domestic Energy Demand Model – City level modelling of Domestic Building Energy Density on a building by building basis
• Future Energy Demand Model – Modelled potential future Developments Building Energy Density
• Solar PV & Thermal Model – Modelled potential of Photovoltaic or Solar thermal on a building by building basis
• Combined Heat & Power Opportunity Model – Aggregates individual buildings energy density into predefined CHP opportunity analysis
• Urban wind Opportunity Model – Looked at City wide opportunity for wind generation location mainly through analysis of constrains
Proof of concept analysis of these models was carried out over a three month period while adapting and integrating them into a real project environment.
The project is now closed following a number of successful outcomes. The techniques delivered by this project will enhance future low carbon stakeholder engagement.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The uses of these low carbon toolkits and GIS data analysis techniques in general will continue to develop through a constant process of evolution and some of the delivered toolkits within the original project were more useful than others. A big factor in the learning curve of geospatial analysis has been the availability and cost of Data sources and this has led to having to adapt the techniques on an ongoing basis. This was highlighted by the Domestic Energy demand model which was supplied by the commercial organisation BRE in partnership with ESRI. This model proved to be more detailed than required. The investigation and integration of ‘best fit’ available data sources will be an ongoing requirement when utilising GIS data analysis techniques and models.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">None</td></tr>
<tr><td>R&D Providers</td><td colspan="10">ESRI</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="9">***IFI 1209 - Substation Earth Integrity Monitoring System***</td></tr>
<tr><td>Description of project</td><td colspan="9">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 £7,969
External £141,284
Total **£149,253**</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £7,418
External £186
Total **£7,604**</td></tr>
<tr><td>Project Cost</td><td colspan="3">£189,347</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="3">Internal £8,000
External £20,000
Total **£28,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">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="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">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 grounding 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="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">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="3">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£71,378</td></tr>
</table>

Project Progress March 2013	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. Cresatech CuTS Prototype Unit • Strong and consistent results achieved at ScottishPower site in Wales and in the USA • Digitisation of much of the system, enabling filtering and other capabilities has been undertaken • Requirement to split larger substation earthing infrastructures into zones to ensure that compromising of the earthing integrity is detected by a CuTS monitoring unit identified • Development of earthing spur monitoring units has not progressed further under this project as considered to be both impractical and not cost effective. • Communication requirements for alarms are under consideration for further site trials planned in the second quarter of 2013.
Potential for achieving expected benefits	Given the success of the RFID testing and substation trials of the Cresatech CuTS protype unit the potential for achieving expected benefits is considered to be high.
Collaborative Partners	None (SSE has expressed interest in collaborating in the Cresatech project)
R&D Providers	Nortech Online Ltd and Cresatech

<table>
<tr><td>Project Title</td><td colspan="12">***IFI 1210 –Transmission SSR & Harmonics***</td></tr>
<tr><td>Description of project</td><td colspan="12">SPT is currently undertaking two projects to improve the visibility of the transmission network in readiness for the 2020 reinforcement programme. One project looks to provide essential data on the network harmonics that are required to be Grid Code compliant and is now required to the design of HVDC filters. The second project is the monitoring of several generation sites in England and Scotland that have been identified as being at risk to Sub-Synchronous Resonance (SSR) as a result of the proposed Series Compensation schemes on the Anglo-Scottish border.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £4,807
External £11,393
Total £16,200</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £9,226
External £186
Total £9,412</td></tr>
<tr><td>Project Cost</td><td colspan="3">£140,300</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="5">Internal £0
External £0
Total **£0**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The aims of this project are to enhance both projects using advanced hardware / software solutions to: (1) Automatically accumulate process and analyse the harmonic data to create useful system harmonic information. (2) To advance the design of a network fault recorder to accommodate SSR detection as a standard feature in readiness of the Series Compensation being added to the network.</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">• Production of automatic harmonic reports that would have otherwise required several man hours of effort each day to recreate.
• Both projects will decrease the risk to external parties connected to the transmission network. In particular SSR detection will prevent the mechanical failure of SSR susceptible turbines connected to the network.
• SPT will have increased awareness of the SSR phenomena and its detection in advance of series compensation. SPT will have greater visibility of the networks harmonic performance and have a greater ability to police it against the Grid Code, with increasing levels of low carbon technology connecting to the network.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3"><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 colspan="3" rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></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">To be determined</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="12">Work is being carried out to integrate a suitable algorithm into existing fault recorders and also to enable remote access to this data. As of April 2013 this project will be placed on hold pending potential transfer to NIA/NIC funding arrangement.</td></tr>
</table>

Potential for achieving expected benefits	The potential of this project will be realised once equipment is installed in the field and we start to obtain results.
Collaborative Partners	None
R&D Providers	QUALITROL & PI

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1211 –Smart CCU Development</i></td></tr>
<tr><td>Description of project</td><td colspan="10">To enable retrieval of complex data from Network Controllable Points (NCP) Intelligent Electronic Device (IED), for example the Noja Pole Mounted Auto Recloser (PMAR), it is necessary to develop a digital radio that will interrogate the DNP3 mapping and transmit the information to the relevant source primary substation. In tandem with this, the project will also develop a new style Central Control Unit (CCU) to accept the data and display it locally as well as sending it via an IEC 86870-5 -104 com-link for remote display.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £64,625
External £85,015
Total £149,641</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="2">£88,000</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The project will:
• Develop a new CCU for accepting complex digital data and analogue values.
• Develop a digital radio to interrogate IED devices operating with DNP3 protocols.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">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="10">• This project will ensure the retrieval of complex data from NCPs and interrogation of DNP3 mapping which will consequently improve knowledge transfer.
• Recovering detailed information on secondary network HV loading and phase imbalance will help to ensure the system is optimally configured. This data may provide additional insight into network behaviour and assist in preparing for this.
• This project will provide immediate access to data to understand fault modes and provide the ability to model the network in real time and load it dynamically, or improve efficiency.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><1 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">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="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">Not determined at this stage</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">Prototype CCU and radio has been produced and delivered. Internal software and I/O configuration are being developed prior to the completion of the SAT process. Prototype will be installed at St Andrews LCNF project during 2013, where SAT will be completed.</td></tr>
</table>

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="10"><i>IFI 1212 –Voltage Regulating Secondary Transformer</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The increase of embedded generation penetration will create considerable voltage rise along LV feeders resulting in statutory limits not being met. Magtech offer a cheaper solution to this problem than system re-enforcement in the form of a voltage regulating transformer that does not use mechanical methods to alter taps. This new transformer will be rated at 500 kVA and will include an existing mechanical tap changer as a fail-safe. In addition, although not directly pertinent in this project, this technology can be used to boost as well as buck voltage and would give valuable insight into how voltage regulating transformers can be used to deal with the potential issues of heat pumps and electric vehicles.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £13,412
External £1,693
Total £15,105</td><td colspan="3">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">£154,000</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The main focus of this project is to implement and trial a self regulating secondary transformer that does not rely on the problematic traditional methods to alter tap position. After installation it is planned to involve Strathclyde University in the analysis of the transformer's performance and evaluate how to use this transformer in an interconnected network.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="2">No</td><td colspan="2">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• To provide a method to constantly manage voltage levels to remain within the statutory limits.
• To allow additional embedded generation onto the system that would have previously been refused
• To analyse the transformer's capability to determine its potential for an interconnected system.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">2 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">15 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">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">£237,044</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">• The original planned supplier for self-regulating transformer has ceased interest in progressing the development of the device.
• Further LV voltage regulating devices are under development and may become available. SPEN is in discussions with potential suppliers.
• ENW is undertaking trials of a secondary transformer with a tap-changer. SPEN is closely following this trial to pick up shared learning and to see if this is a possible solution which may avoid a similar trial.</td></tr>
</table>

Potential for achieving expected benefits	Potential to offer better control of LV voltage, avoid voltage complaints and allow further micro generation without network reinforcement is yet to be determined.
Collaborative Partners	None
R&D Providers	Magtech, University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1213 –Phase 3 Transformer Research Consortium</i></td></tr>
<tr><td>Description of project</td><td colspan="10">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 £5,519
External £1,693
Total £7,212</td><td colspan="3">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">£172,500</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £7,000
External £50,000
Total £57,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• 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="5">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">→</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">£1,067,034</td></tr>
</table>

Project Progress March 2013	**Work Package 1** • Literature review on using Methanol and Low Molecular Weight Acids as new paper ageing indicator is ongoing, initial information indicates that LMA are more soluble in paper than in oil, LMA increase paper aging rate more than HMA. Issue – LMA amount is very small in oil, no proper standard to measure LMA in oil or paper, there has been much less work done on LMA as a paper ageing indicator. • Building up transformer oil condition database with input from SPEN, NG and UKPN, it has been identified that there is a lack of sample temperature information. **Work Package 2** • Particle effect on partial discharges in mineral oil and ester liquid - initial results indicate that adding particles or increasing the moisture content both result in an increase in the PD number of Gemini X but neither of them affect the apparent charge measurement. • The PD behaviour of MIDEL 7131 is not affected by cellulose particles; increasing the moisture content of MIDEL 7131 suppresses the number of PD. **Work Package 3** • Setting up DGA test system using SERVERON device has begun. **Work Package 4** • Thermal Analysis of Transformer Insulation System (not started)
Potential for achieving expected benefits	Early indications are 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

<table>
<tr><td>Project Title</td><td colspan="12"><i>IFI 1214 –DNO Trial of Power Line Carrier to support LV SCADA</i></td></tr>
<tr><td>Description of project</td><td colspan="12">While Power Line Carrier (PLC) is predominantly focussed on smart meter data collection, it also includes functionality suitable for DNO applications and operational communications, including event/alarm reporting at Low Voltage (LV) substations and support for Demand Side Management (DSM).
The operation of LV PLC signalling systems within GB LV-interconnected urban environments has yet to be tested. Therefore, there is some concern by DNOs about the practical issues around LV-PLC deployment, including safe working procedures in live LV cabinets, such that PLC data concentrator installation can be effected without interruption to customers' supplies. The project is to trial this technology in the above situations to evaluate the performance.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="4">Internal £16,199
External £11,983
Total £28,182</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="4">£42,890</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">Deploy a small population of PLC connected end devices and install four PLC data concentrators at two distribution LV networks in order to the following:
Confirm that any installed data concentrators can pass operational `SCADA' messages to remote control system.</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">• Demonstrate no interruption to supplies during installation of LV-PLC data concentrator at distribution substation(s).
• Development of safe working method statement for routine data concentrator installation.
• Demonstrate the collection of routine data (as a proxy for revenue meter data) from PLC devices.
• Demonstrate the ability to collect non-routine data (voltage, current, power quality, interruption messages) at each data concentrator and to dispatch operational message to/from a remote control system.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3"><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" colspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="7">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">N/A for this small trial</td></tr>
</table>

Project Progress March 2013	• 4 x PLC data concentrators installed in LV distribution substations without interruption to supplies. • Development of safe working method statement for routine data concentrator installation has been completed. • The collection of routine metering data has been demonstrated. • The collection of non routine data has been demonstrated.
Potential for achieving expected benefits	Enabler for future PLC communications to smart meters and smartgrid devices.
Collaborative Partners	Alcatel-Lucent, Parsons Brinckerhoff, Current Group (LV PLC Data Concentrator Supplier)
R&D Providers	None

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

An initial study will review, rank and laboratory-trial a number of new candidate materials technologies. This would be followed by laboratory trials on one or more candidate repair technologies. If successful, commercial development of an improved performance MV cable system could follow in collaboration with one or more cable companies to produce MV cables that would be suitable for installation in the UK power network.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £4,807
External £34,959
Total £39,766</td><td colspan="3">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">£112,175</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £5,000
External £25,000
Total **£30,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">New developments in self repairing polymers and reactive chemical technologies could potentially be capable of providing a repair function for a variety of cable sheath defects and damage that may occur.

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

Project Progress March 2013	• Stage 1 has exceeded expectations in terms of candidate chemistries that would be suitable for stage 2 and there has been a positive response from cable makers and materials suppliers. • Gnosys has visited both General Cable and Ericsson and seen their different manufacturing processes, their different approaches to cable design and manufacture and end of line testing methods. • NDAs have been set up with a number of materials suppliers to supply information and samples/materials • Three rig designs have been developed. These rigs will be able to represent under sea pressures, and take into consideration the need to test with both fresh and sea water. • In total, seven companies have been identified internationally for supply of suitable test technologies.
Potential for achieving expected benefits	Based on initial stage 1 objectives the project is on track to realise the potential for achieving expected benefits.
Collaborative Partners	SSE, Energy Innovation Centre
R&D Providers	Gnosys Ltd

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 1216 – The Role of the Demand Side in Delivering Effective Smart Grids</i></td></tr>
<tr><td>Description of project</td><td colspan="4"><p>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.</p><p>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.</p></td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £8,878
External £11,693
Total £20,571</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>£19,925</td><td colspan="2">Projected 2013/14 costs for SPEN</td><td>Internal £7,000
External £5,000
Total £12,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4"><p>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.</p><p>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.</p></td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>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>

<table>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>➡</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">N/A</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">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.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">There is real potential for achieving the expected benefits based upon the current level of activity being undertaken to determine the role and appetite of customers to engage effectively in the delivery of Demand Side activity to enable the transition to Smart Grids.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">EON, ENW and NG, National Grid</td></tr>
<tr><td>R&D Providers</td><td colspan="10">EA Technology</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="12"><i>IFI 1218 – Impact of Residential Heating and Building Standards on Demand Profiles</i></td></tr>
<tr><td>Description of project</td><td colspan="12">There are a number of changes to the built environment that will impact on the way that domestic properties are heated and constructed. Government policy is that all new homes will be constructed to net zero carbon standard by 2016 and housing providers are carrying out a process of refurbishment on existing multi-occupancy residences. There will be a greater reliance on electricity to provide heating in the future and low carbon heating will become more common in domestic properties. This project will examine the impact of heating technologies and building standards on low carbon homes at the BRE Innovation Park at Ravenscraig and representative multi-occupancy residences in the central belt.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="4">Internal £11,927
External £1,693
Total £13,620</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="4">£96,000</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £8,640
External £49,800
Total £58,440</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">This project will examine the impact of and provide a range of up to date ADMD and demand profiles to allow for more appropriate network design. This will be achieved through monitoring the power flows and demand profiles at the various properties and through using this data to model demand profiles and ADMD values for different combinations of heating type, building standard and low carbon technology.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">• Successful project completion will bring about improvements to the time required to carry out design for areas with high take-up of low carbon heating, zero carbon homes and multi-occupancy homes.
• Improved data on buildings and technologies being assessed will facilitate new tools, designs and academic outcomes
• Significant improvements in network design for low carbon buildings and multi-occupancy residences which will contribute towards the goal of developing the grid for the future
• Project will improve on accuracy of cable sizing through improved ADMD values, improving accuracy of cable sizes for domestic properties.
• Use of monitored data to model demand profiles and ADMD values for different combinations of heating, building standard and low carbon technology</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">3 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="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 colspan="2">→</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">£84,113</td></tr>
</table>

Project Progress March 2013	• Sites selected for monitoring kit installation • Gridkey LV monitors have been ordered to cover these sites • 2 Gridkeys installed to Toryglen, a set of high rise blocks with a high concentration of heat pumps in operation • Procurement of equipment for use at the BRE Ravenscraig Innovation Park plots • Work carried out with Strathclyde University on analysis of data collected
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="12">***IFI 1219 – Substation Efficiency***</td></tr>
<tr><td>Description of project</td><td colspan="12">Substations are critical to the successful operation of the distribution network. SPD 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="3">Internal £20,471
External £49,608
Total £70,079</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td colspan="3">£139,800</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="5">Internal £12,582
External £71,880
Total £84,462</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">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="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">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">• 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="3"><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 colspan="3" rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">→</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="6">£850,809</td></tr>
</table>

Project Progress March 2013	• Tinytag Temperature monitors procured and deployed to 32 substations throughout SPD so far, more to be installed to reach target of 50. • Online temperature dataloggers installed at 2 Primary sites • Work has been carried out alongside Strathclyde University that will allow data collected to be modelled and extrapolated to fit the whole SPD network • Analysis of current heating and lighting demands within SPD network • First dataloggers being collected during April • Potential technologies for controlling substation environments have been investigated
Potential for achieving expected benefits	High
Collaborative Partners	None
R&D Providers	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="9"><i>IFI 1220 – Smart Grid Forum WS3</i></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 £4,095
External £37,693
Total £41,788</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £0
External £20,693
Total £20,693</td></tr>
<tr><td>Project Cost</td><td colspan="3">£649,420</td><td colspan="3">Projected 2013/14 costs for SPEN</td><td colspan="3">Internal £5,000
External £41,000
Total £46,000</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 2013	ENA hosted the DECC/Ofgem Smart Grid Forum launch of their Work Stream 3 report that looks at the impact of low carbon technologies. This groundbreaking report has highlighted the potential for billions of pounds to be saved if funding is available to implement 'smart' solutions to the UK electricity network. It reinforces the fact that a smarter network is critical to delivering a low carbon future affordably, securely and sustainably. The 'Assessing the impact of Low Carbon Technologies on Great Britain's Power Distribution Networks' event took place on Monday 12 November 2012 at The Rubens Hotel, 39 Buckingham Palace Road, London SW1W 0PS. It heard from Sandy Sheard, Head of Future Electricity Networks at DECC; Gareth Evans, Head of Profession, Engineering at Ofgem; and Steve Johnson, Chief Executive of Electricity North West, Chairman of ENA and Chair of the Work Stream 3 working group for the Smart Grid Forum. http://www.energynetworks.org/electricity/smart-grid-portal/decc/ofgem-smart-grid-forum/work-stream-3.html
Potential for achieving expected benefits	The project is managed by the Energy Networks Association and coordinated at a working level by a cross DNO group. Supervisory steering will be via the Smart Grid Forum Work Stream 3 group. EATL will provide regular reports and opportunities for DNOs to ensure the project is on track. The insight gained from the project will be directly applicable and relevant to all network operators preparing long term business plans.
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="10"><i>IFI 1301 – Enhanced Weather Modelling for Dynamic Line Rating</i></td></tr>
<tr><td>Description of project</td><td colspan="10">This project makes use of an advanced spatial/temporal model developed within the Electronic and Electrical Engineering Department at Strathclyde University over the last 5 years. The model will use hourly meteorological data from 14 sites across the UK and will be extended and applied to the estimation of wind speed and directions in the vicinity of key overhead line spans for the purpose of calculating real-time - 'dynamic' - overhead line ratings to facilitate greater transfer of available wind power. Spatial interpolation techniques will be applied to provide forecasts at regular intervals along the overhead line. The model will also be applied to air temperature forecasting as it is the combination of wind speed and air temperature that determines overhead line cooling and subsequent maximum current carrying capacity.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £4,095
External £1,693
Total £5,788</td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td>£51,082</td><td colspan="5">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £5,000
External £25,000
Total £30,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The key extension in this work relative to earlier dynamic line rating projects is the provision of a forecast of ratings. In addition, it will provide an estimate of uncertainty associated with the forecast so that the system operator can make appropriate judgements with respect to management of risk and the necessity for preventive actions.
The overall aim is to better understand and manage the growing impact of wind generation on the network and dynamic rating is a powerful tool in this context since line ratings can be increased at precisely the same time when more power is available.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Develop a forecasting capability for dynamic overhead line rating using weather data at multiple sites
• Develop an estimation of the uncertainty associated with a forecast</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">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 colspan="2">→</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">N/A.</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">• The project outline has been generated and a suitable student has been recruited by the University of Strathclyde.
• This project will be registered under the NIA funding arrangement.</td></tr>
</table>

Potential for achieving expected benefits	The project is yet to officially start, but the project plan and student is in place and the project will be of benefit to DNOs / TSOs
Collaborative Partners	NGET
R&D Providers	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="10">***IFI 1304 – Smart Meter Enablement***</td></tr>
<tr><td>Description of project</td><td colspan="10">The overall goal of the project is to determine the basic infrastructure and processes required to innovatively store and use Smart Meter data within SPEN management systems and to ensure SPEN is capable of meeting its regulatory requirements for connecting to smart meter infrastructure.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £5,519
External £1,693
Total £7,212</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td>£350,000</td><td colspan="4">Projected 2013/14 costs for SPEN</td><td colspan="5">Internal £15,000
External £250,000
Total **£265,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The project aims to take an innovative view of how Smart Meter data can enhance the way network management and operations can work rather than just appending additional information to the existing processes</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Readiness for the implementation of smart meters and accession to new Smart Energy Code
• Ability to innovatively use smart meter data</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>⇨</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">N/A at this trial stage</td><td colspan="4"></td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">• The project was kicked off with a separate supplementary scoping study in February 13 which is due to deliver in April 13
• The project was approved in mid-March 13 and initial meetings with possible vendors have been set up</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">This is a developmental project to assess the potential for realising benefits from smart meter information. The expectation is that there is a good prospect of realising these expected benefits.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Kyria, potentially GE, AMT-Sybex other DNO.</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Kyria, potentially GE and AMT-Sybex.</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 1305 – Low Power Radio Alarm System</i></td></tr>
<tr><td>Description of project</td><td colspan="10">This project is to develop a low cost simple radio that will interface into the existing NCP radio communications infrastructure using spare I/O channels to recover single digital data alarms. Although a ground mounted NCP RTU is able to control up to three objects, in many installations only two are used. By developing a way to utilise the digital channels of the un-used control channel, the existing NCP asset could be used as a route for remote alarms into SCADA.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £8,114
External £8,559
Total £16,673</td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Cost</td><td>£104,277</td><td colspan="5">Projected 2013/14 costs for SPEN</td><td colspan="4">Internal £10,000
External £105,000
Total £115,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">HV secondary substations equipped with basic monitoring, or sensing devices, are largely blind to SCADA as the infrastructure required to recover a few digital alarms is not cost effective. Returning single digital data points for battery alarms, watchdog alarms, fault passage indications, etc. would give visibility of the secondary network and ensure such conditions were reported into central systems.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">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="10">• 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="5">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>➡</td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">-£15,760</td></tr>
<tr><td>Project Progress March 2013</td><td colspan="10">A prototype device has been produced and will be delivered to SPEN for testing by July 2013. I/O configuration and SAT works will commence upon receipt of the prototype.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The potential for achieving expected benefits is considered to be high.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Smart Grid Networks</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Smart Grid Networks</td></tr>
</table>