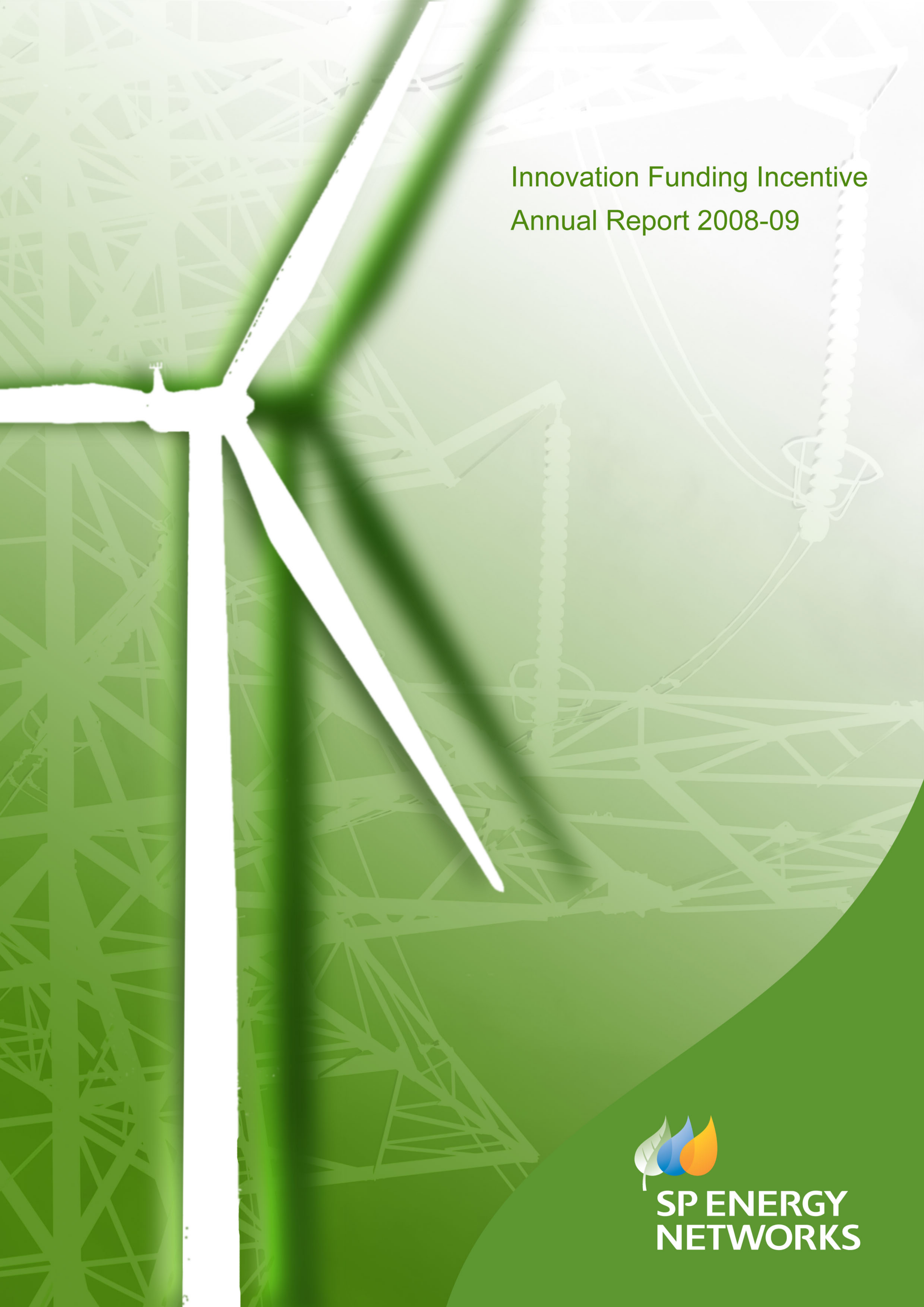


Innovation Funding Incentive
Annual Report 2008-09

SP ENERGY
NETWORKS

Foreword

Welcome to the SP Energy Networks' Innovation Funding Incentive (IFI) Annual Report for 2008/09.

It has been another significant year for the energy sector with increased focus on the challenges of carbon emission reduction and the vital role of innovation in delivering 2020 and 2050 targets. Research, Development and Demonstration (RD&D) will not only contribute to setting the strategic directions for the industry but also help to shape the way we produce, transport and consume energy. The government's 2020 vision for the transmission system and desire to deliver smart meters in every home are but two initiatives aimed at transferring Britain into a low carbon economy that is sustainable, affordable and places the UK at the forefront of technological developments. Utility companies will have a central role to play in developing and delivering this economy and the IFI programme contributes considerably towards this.

Over the past five years many notable technical solutions have been developed under the IFI programme contributing to all aspects of managing the electricity network. Some of our IFI projects such as the overhead line fault passage indicators have now been put into practice and visible benefits are being realised in terms of quicker fault location and customer restoration, whilst others have been converted into design recommendation such as the distance of wind turbines from overhead transmission lines. This year the 4energy low carbon comms cooling project has shown a potential for reducing energy consumption in communication cabinets by at least 80%. As part of our ongoing IFI strategy we will continue to consolidate on our portfolio of projects and utilise our allowances sensibly and effectively to ensure technological advances are realised to meet future industry challenges.

We continue to work and collaborate with our parent company Iberdrola on RD&D projects ensuring benefits are shared within the group and the industry. Experiences on projects in areas of electric vehicles and smart meters among others are shared to enhance the understanding and impact of these technologies. The nature of many new technologies is such that not only closer collaboration between DNOs is required but also with other stakeholders in the energy value chain including suppliers, generators and consumers. We think RD&D will play an increasingly important role in the coming years and will contribute significantly to the delivery of the UK vision and targets.

Alan A. Bryce

Alan Bryce
Director
SP Energy Networks

Contents

1 Introduction & Background

1.1 Context

As part of the most recent Distribution and Transmission Price Control Reviews (DPCR/TPCR), Ofgem introduced the Innovation Funding Incentive (IFI) as a mechanism to promote and encourage network related Research & Development (R&D). In addition to the development focus of the IFI, a second incentive the Registered Power Zone (RPZ) was introduced for Distribution Licensees to promote the use of novel techniques in the connection of Distributed Generation to the network.

The primary aim of the two incentives 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 incentives provided by the IFI and RPZ mechanisms are designed to create a risk/reward balance that is consistent with research, development and innovation. The two main business drivers for providing these incentives 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.

1.3 Registered Power Zone (RPZ)

In contrast to the IFI, RPZs are focused specifically on the connection of generation to distribution systems. The estimates made by DNOs as part of the DPCR process indicated that some 10GW of generation could be connected from 2005-10. This generation could connect at every distribution voltage level bringing new system design and operating challenges. RPZs are therefore intended to encourage DNOs to develop and demonstrate new, more cost effective ways of connecting and operating generation that will deliver specific benefits to new distributed generators and broader benefits to consumers generally. The detail of the RPZ mechanism is set out in the Special Licence Condition D2 and the DG Regulatory Instructions and Guidance (RIGs).

2 SP Energy Networks Structure

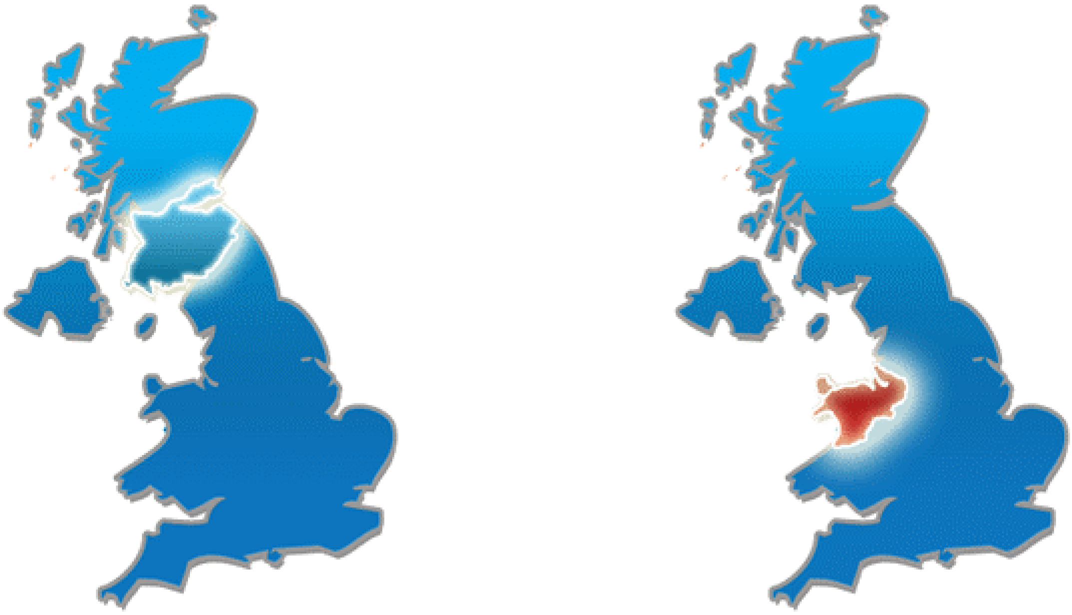
SP Energy Networks (SPEN) is the part of ScottishPower UK Ltd, which owns and operates the electricity transmission and distribution network of southern Scotland and the electricity distribution network of Merseyside and North Wales. Day-to-day operation of our network, approaching 112,000 km, is conducted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

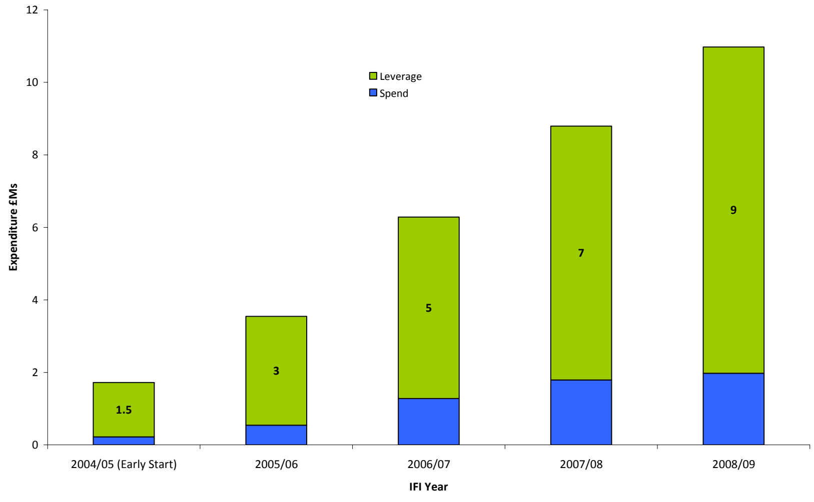
A total of 38 IFI projects are being reported by SP Energy Networks on behalf of the three ScottishPower Network licence areas for the period 1st April 08 – 31st March 09.

At time of writing SPEN has a total of £6.5m authorised IFI projects, representing a levered portfolio of over £33m. The projects cover a breadth of R&D providers from academia, to consultants, to manufacturers with projects ranging in investment from £15k to £1m 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 2008/09 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

Figure 2 R&D expenditure growth SPEN (SP-D, SP-M and SP-T) since the introduction of the IFI

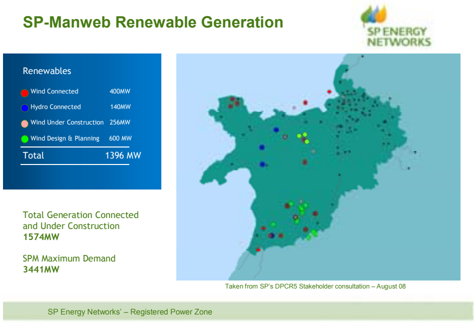


3.2 RPZ

Pipeline RPZ application

As an outcome of the AuRA-NMS and Dynamic Thermal Ratings projects, it is proposed to apply for an RPZ application in 2009/2010 to manage generation constrains in North Wales.

The application will refer to the connection of a number of wind generators to the SP Manweb network in the St Asaph area of North Wales. This area is predominantly rural, and is a rich wind resource. There is presently a number on-shore and offshore wind farms in the area, and further wind farms are either under construction, or at the planning stage.



SP-Manweb Renewable Generation

Renewables

●	Wind Connected	400MW
●	Hydro Connected	140MW
●	Wind Under Construction	256MW
●	Wind Design & Planning	600 MW
	Total	1396 MW

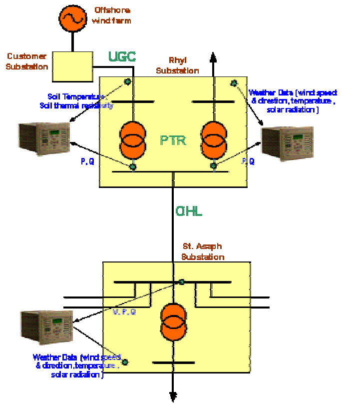
Total Generation Connected and Under Construction
1574MW

SPM Maximum Demand
3441MW

Taken from SP's DPCR5 Stakeholder consultation – August 08

SP Energy Networks' – Registered Power Zone

Plans are being developed which could include an offshore windfarm as well as generation to the south of St Asaph, known as Area 'A', which has been designated for additional wind generation as part of a Welsh Assembly Government' TAN 8 (Technical Adviser Note) initiative.



SP Manweb expects to receive generation connection applications totalling up to 200MW in Area 'A'. A system of constraints will be used to connect the off shore generation, while preventing the ratings of the existing 132kV circuits from St Asaph substation being exceeded. To facilitate the connection of the Area 'A' generation without significant reinforcement of the 132kV network, the constraints scheme will be extended to manage both sites.

4 Summary Tables

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

IFI Summary - SP Distribution Ltd Licence Area 08/09	
SP Distribution Ltd Network Revenue	£ 315,210,000
IFI Allowance	£ 1,576,050
Unused IFI Carry Forward to 2008/09	£ 728,150
Number of Active IFI Projects	31
Summary of benefits anticipated from IFI projects 2008/09	£ 160,800[1]
External expenditure [2008/09] on IFI projects	£ 824,023
Internal expenditure [2008/09] on IFI projects	£ 198,367
Total expenditure [2008/09] on IFI projects	**£ 1,022,390**
Benefits actually achieved from IFI projects to date	£2,137,000

IFI Summary - SP Manweb plc Licence Area 08/09	
SP Manweb plc Distribution Network Revenue	£ 186,420,000
IFI Allowance	£ 932,100
Unused IFI Carry Forward to 2008/09	£ 213,950
Number of Active IFI Projects	36
Summary of benefits anticipated from IFI projects 2008/09	£ 107,200[1]
External expenditure [2008/09] on IFI projects	£ 634,421
Internal expenditure [2008/09] on IFI projects	£ 152,364
Total expenditure [2008/09] on IFI projects	**£ 786,835**
Benefits actually achieved from IFI projects to date	£2,137,000

IFI Summary - SP Transmission Ltd Licence Area 08/09	
SP Transmission Ltd Distribution Network Revenue	£ 179,940,000
IFI Allowance	£ 899,700
Unused IFI Carry Forward to 2008/09	£ 412,000
Number of Active IFI Projects	9
Summary of benefits anticipated from IFI projects 2008/09	£69,000[2]
External expenditure [2008/09] on IFI projects	£ 118,118
Internal expenditure [2008/09] on IFI projects	£ 50,870
Total expenditure [2008/09] on IFI projects	**£ 168,870**
Benefits actually achieved from IFI projects to date	£69,000

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

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[1] Added benefits detailed section 7.2

[2] Added benefits detailed section 7.1

5 Achievements for 2008/09

At the end of 2008/09 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:
    - 38 live projects
    - 47 projects fully authorised with 2 receiving preliminary approval
    - 5 new projects were authorised during the 2008/09
    - Of the 47 projects, 6 are now complete and either awaiting adoption or formal closure
- Over £9m of leverage obtained
- 20 projects achieving Technology Readiness Level (TRL) 7 (network integration) or above with further trials scheduled
- 3 projects formally adopted into the business with several more near the final stages of trials
- As part of the Iberdrola group, SPEN are actively participating in regular R&D meetings with other network businesses within the group, to recognise synergies and other areas of learning. More information can be obtained at the following link to Iberdrola's Innovation Report 2007-08:

http://www.iberdrola.es/webibd/gc/prod/en/doc/innovacion_informe.pdf

5.1 Development of Partnerships

The current programme consists of the following collaborative projects:

- Engineering & Physical Science Research Council (EPSRC) strategic partnership: AuRA-NMS
- EPSRC – 3x industry roles in Supergen programmes: Supergen 1 - Flexnet; Supergen 3 - Highly Distributed Power Systems; Supergen 5 - AMPerES
- Technology Strategy Board (TSB) technology programme projects: Fault calculations - K/EL/00352; Thermal State Estimation - TP/4/EET/6/I/22088; Redox Flow Cell Battery - TP/3/ERG/6/1/16587(D05/726039); MANtIS - K/EL/00365/00/00
- DNO specific – 20 collaborative projects with some / all UK DNOs via EA Technology, ENA or through direct collaboration (see Appendix D for details).
- Direct university partnership – 1x ScottishPower Advanced Research Centre (SPARC) with the University of Strathclyde.
- Capenhurst Energy Innovation Centre – A non-profit trust that over sees the management of the centre in collaboration with ScottishPower, Electricity North West, CE Electric, Scottish & Southern Energy and the North West Development Agency.
- Working with a Glasgow based consortium on the Ultra Low Carbon Vehicle Demonstration Program (ULCVD). This programme was set up by the Technology Strategy Board and will run trials in various locations in the UK. The Glasgow trial will roll out around 40 Electric Vehicles including a charging infrastructure to assess consumer behaviour and practicality of running EV. Although this is not an IFI programme it is expected this trial will initiate further R&D projects to look at the impact of EV.

5.2 Deployment of Trials

Trials are a significant and necessary part of our R&D programme. A trial can consist of:

- Physical network trial – a piece of equipment physically installed on the network, following successful development and type testing. The purpose of this trial is to ensure the device integrates with the existing network.
- Software trial – the processing of SP network data through an appropriate software model. The purpose of this trial is to prove the quality of a piece of software, and the suitability of SP data formats.

As a trial signifies the latter stages of an R&D lifecycle (Technology Readiness Level 7: *Technology system prototype demonstration in an operational environment*) many of the technologies undertaken since the start of the IFI reflect our work with manufacturers / consultants, which are further down the R&D lifecycle. Further details are provided on specific projects in Appendix D.

5.3 Identifying the Issues and Developing the Enablers

This project initially proposed and led by SPEN, was to develop the first of its kind, in the UK, a full scale 11kV and LV prototyping network as a test-bed 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. The centre can be used to investigate the impact of intermittent generation and penetration of EV technologies on the LV network as well as testing of new tools and training.

Since late 2008, SPEN have been working with collaborative partners (University of Strathclyde, Scottish & Southern Energy and Scottish Enterprise) to develop the design.

It is aimed to start building the centre in Q2 of 2010 and to be ready by Q2 2011.

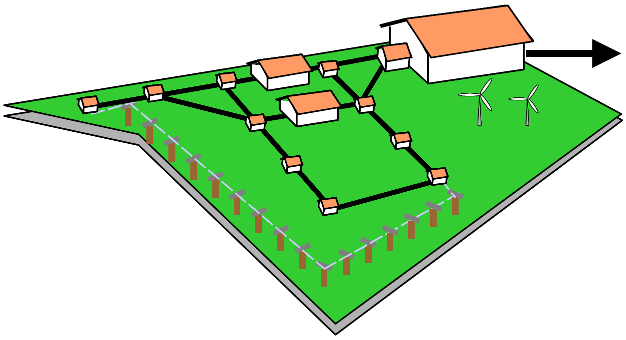


Figure 3 Pictorial representation of the Demonstration Facility

6 Realised Benefits from IFI Projects

Whilst not all benefits have a direct monitory value, we have indicated the benefits brought to SPEN in improvements to customer service, reductions to capital cost of equipment and the reduction in energy usage/carbon emissions.

6.1 Benefits from Adopted IFI Projects

IFI 0704 - 4E Comms Cooling

Following the successful installation and testing, the design and development brief under the IFI project has been fully met. 4Energy have been able to develop a flexible package of parts that can be tailored to fit any telecoms site and will ensure that Cisco equipment is maintained in a safe working temperature with an ultra reliable, maintenance free cooling system without the use of energy and maintenance hungry systems. The temperature data gathered during the trial period has proven that traditional air conditioning is not needed in these locations and that 4energy's system offers a genuine alternative.

Without the RFI Cool system the use of air conditioning in summer is unavoidable in telecoms rooms in order to keep Cisco cabinets below 40°C. However, the 8-10°C reduction from 'RFI cool' means that the room temperature can be safely elevated up to 35°C without any harmful effects on the equipment. This opens up the opportunity to use the Directed Air solution developed under this IFI project which guarantees temperatures will remain under 40°C in the Cisco cabinets under Glasgow climatic conditions.

Following the installation of the Directed Air systems with 'no maintenance' filtration the telecom rooms have been held at ambient around 7-10°C hotter than outside environmental temperature which ensures that the Cisco cabinets will be maintained at less than 40°C.

The proposal is to install energy efficiency cooling in telecommunication rooms in major grid sites in which Cisco servers are being located. This initiative will deliver a saving of approximately 40% on the capital cost of installing traditional vapour compression air conditioning.

Once installed a greater than 90% saving versus estimated air conditioning power will be made in those telecommunication rooms.

Comparison Table of Air Conditioning vs. 4energy Solution			
	Aircon cost	4energy Cost	Saving
Per Site		~40% less than AC	
Power Usage (pa)	~15,000kWh	~1,000kWh	~93%
Carbon Emissions (pa)	~6,450kgCO_2	~430kg CO_2	~6,020 CO_2
All Installations (17)		~40% less than AC	
Power Usage (pa)	~255,000kWh	~17,000kWh	~93%
Carbon Emissions (pa)	~109,650kg CO_2	~7,310kg CO_2	~102,340kg CO_2

6.2 Benefits from IFI Trials

The following examples are given to demonstrate some of the benefits being delivered from SP's IFI trials:

IFI 0409 – LV Fault Location Device

Since SP EnergyNetworks started using the TP22, it has made a big difference to the customer and to the number of complaints received within the Customer Contacts Team.

If a customer contacts SP EnergyNetworks about multiple interruptions the contact is dealt with within the Contacts Team, who then talk with the TP22 controller who organises the TP to be installed. With this equipment the Contacts Team can give the customer the assurance that the fault is being worked on. Prior to the team having this equipment, they could only advise the customer that the fault would be found in due course but it could take weeks which would result in further interruptions. This meant CML (Customer Minutes Lost) & CI (Customer Interruptions) increased therefore increasing the cost to the business in CML/CI penalties.

As well as the benefit to customers, there have been benefits in both reducing the amount of trial excavations that occur during the use of older techniques of fault location.

Savings For LV Fault Locations		
5% usage on non repair faults	North(117) + South(62)	169 locations
60% success rate	(169 locations) * 0.6	107 successes
Savings	107 * £2500	£268k savings

IFI 0709 - Network Monitoring using Web Systems

Sub.net is a substation based multifunction disturbance recorder, which monitors various aspects of the power network. It is connected to protection VTs and CTs and auxiliary contacts from protection relays and switchgear. Sub.net process the information at site and sends formatted reports of events detected on the network directly to individual users by email.

It is possible to capture an event and distribute the processed data in around three minutes to the parties that can take the appropriate action. Monitors should be able to aid early indication of 11kV fault location, confirm that overhead line protection or automation schemes are functioning properly and determine if circuit breaker operating times are within acceptable limits, in addition to covering the full range of Power Quality phenomenon.

Through the event capture process it is estimated that 3 potentially 'sticky' breakers have been found prior to them having to operate for an actual fault. SPEN estimate that this could have saved as much as £500k. Along with slow/stuck breakers it has been possible to identify the location of transient faults using impedance maps, this part of the project will be developed in 2009/10.

7 Looking Ahead - Focus for 09/10

Our focus for 2009/10 will continue to build on the foundations laid in the five years of IFI and on engagement; trials; adoption and extension.

- Continue to maximise value of programme through collaboration and project leverage.
- Real focus on driving projects through trial and making a decision on implementation.

Improving engagement and activity: With over 38 live projects, SP is strengthening outreach into the business, in addition, during 2008/09 we aim to raise the profile further through internal workshops and linkage to R&D activity in Iberdrola SA.

Increasing the number of network trials: SP recognise the complications and extensive timescales involved in getting multi-party R&D projects off the ground (both technically and contractually), but with a healthy portfolio of approved projects and signed contracts, we can now focus firmly on delivery. SP aim to accelerate projects towards trial with a focus on delivery and adoption. Trials scheduled for 2009/10 include:

- Moving on from data gathering to implementation of algorithm for the Dynamic Ratings / Thermal State Estimation (IFI 0513) project to open loop operation of new protection equipment
- Continuing work with Smarter Grid Solutions in the RPZ application. As the TAN 8/Area A RPZ is time sensitive, its is thought that having two options available to increase the connection of wind generation
- IFI 0509 Superconducting Fault Current Limiter – The project is starting its first network trial with ENW at Bamberbridge s/s. SPEN will begin installation in December 2009 with final commissioning and the SCFCL going ‘Live’ in February 2010.

Convert successful projects into adoption: Whilst trials on a live network are an essential step in technological development, true value will only occur when technologies are fully embraced and adopted in the business. With several projects successfully completing trials, we aim to focus on formally closing down projects and transferring into the business as an approved product or service.

In order to accelerate the route to adoption, we will continue to work with partners on our proposal for a UK networks demonstrator.

Appendix A – IFI Highlights for 08/09 submitted to ENA R&D Brochure

Fault Current Limiter based on Superconducting Materials

A Consortium comprising CE Electric UK, Electricity North West, Scottish Power Energy Networks, and Applied Superconductor have been working on a superconducting fault current limiter based on bulk BSSCO superconductor for installation in each of the DNOs' respective 11kV networks.

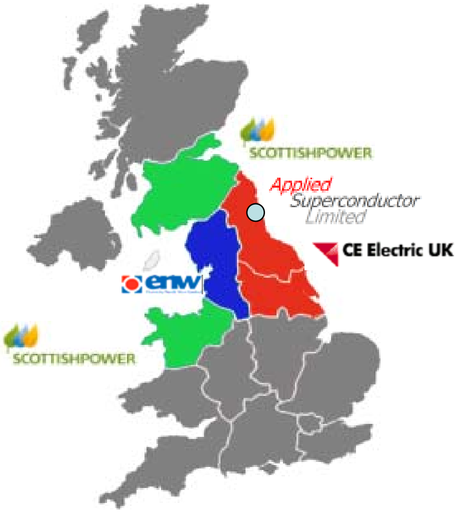


Figure 1 Consortium Network Areas

Fault levels have always been a constraint in the development of electricity networks and have been controlled by increasing source impedance, (either by installing higher impedance components or by splitting networks) or by purchasing components designed for higher fault levels. With the continued increase in electrical load, the redevelopment of city centre areas and the increase in embedded generation, particularly CHP in city centres, but also renewable energy generators such as wind, the pressure to cope with rising fault levels continues and is likely to increase.

Superconductors, when in their superconducting state are perfect conductors and have zero resistance to the flow of electrical current. They lose their superconducting properties when they are subjected to current, magnetic fields or temperature above critical values, and 'quench' back to their normal (poor) conducting state. This is a physical property of the material so a fault current limiter using superconducting material does not require external triggering and is exempt from fault detection failures. It fails to a safe (resistive) state.

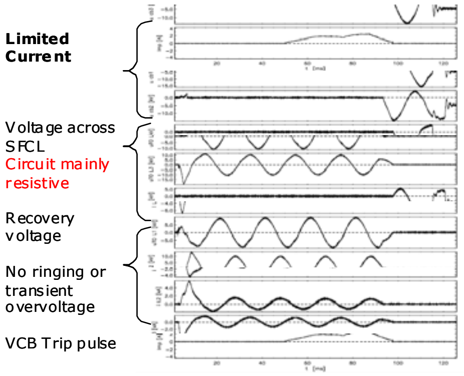


Figure 2 Trace of FCL 'Quenching'

By harnessing this physical property an effective fault current limiter can be designed which is low loss during normal operation, yet quenches to limit fault current. The quench transition happens quickly (~1ms) and early during the onset of a fault, prior to the first peak, allowing lower rated switchgear and components to be deployed.

Figure 3 Trial 1 SCFCL (ENW)

4energy Comms Cooling

An IFI funded investigation and system development project was carried out to innovatively regulate the temperature of CISCO radio equipment inside RFI cabinets within substation telecoms rooms.

This equipment is a key part of Scottish Power's transmission communication network. The subject of the innovation was to develop a cooling solution that doesn't rely on energy and maintenance hungry traditional air conditioning.

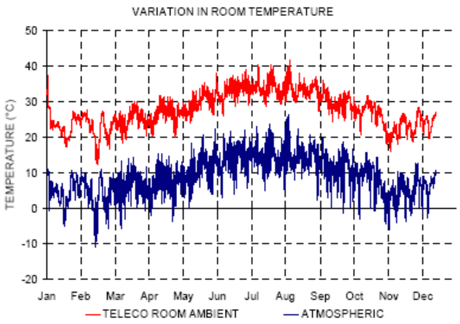


Figure 1 Atmospheric and Ambient Temperatures

The objective of 4energy's work was twofold:

- Assess potential cooling solutions for the RFI cabinets
- Develop and install on-line 3 low energy alternative cooling solution to vapour compression air conditioning on heat affected sites

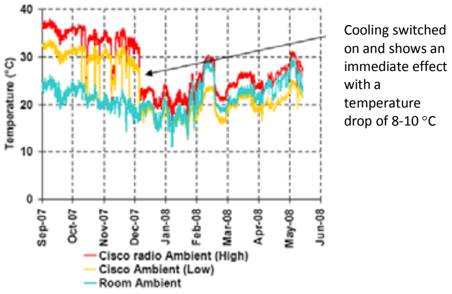
Cooling solutions for RFI cabinets

Following the first site visit SPEN supplied an RFI cabinet in which 4energy installed a simulated heat source and then investigated various heat dissipation techniques to cool the cabinet. Successful off-line testing was completed with encouraging results.

An on-line test was successfully started in December 2007 at Strathaven, with 4 other sites selected to demonstrate installation procedures.

The result of this innovation is that Cisco cabinets have been reduced in temperature by 8-10°C. In total 19 'RFI cool' systems have been delivered for installation.

Without the RFI Cool system the use of air conditioning in summer is unavoidable in telecoms rooms in order to keep Cisco cabinets below 40°C. However, the 8-10°C reduction from 'RFI cool' means that the room temperature can be safely elevated up to 35°C without any harmful effects on the equipment.



Cooling switched on and shows an immediate effect with a temperature drop of 8-10 °C

Figure 2 Temperature Drop on Installation

This opens up the opportunity to use the Directed Air solution developed under this IFI project which guarantees temperatures will remain under 40°C in the Cisco cabinets under Glasgow climatic conditions.

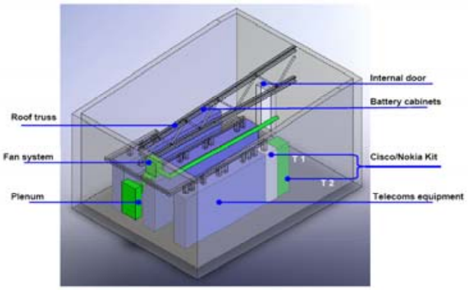


Figure 3 Complete System at Strathaven

Following the installation of the Directed Air systems with 'no maintenance' filtration the telecom rooms have been held at ambient around 7-10°C hotter than outside environmental temperature which ensures that the Cisco cabinets will be maintained at less than 40°C.

Appendix B – 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 – further information is detailed in Appendix C.

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 (08/09)	Percentage Split Distribution	Percentage Split Transmission
SP-Distribution	£315.21 million	~60%	NA
SP-Manweb	£186.42 million	~40%	~25%
SP-Transmission	£179.94 million	NA	~75%

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 B3). This is defined when the project inception document is developed.

Programme Management Costs

Internal costs for projects detailed in Appendix D 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. Programme management is provided by 1x FTE and external contract resource, applied equally across all projects.

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 09 the status of the 38 projects reported as well as those that have stopped is detailed below.

IFI Project Status			
No.	*Phase*	*Definition*	*External Cost*
2	*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)*
5	*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 B1 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.

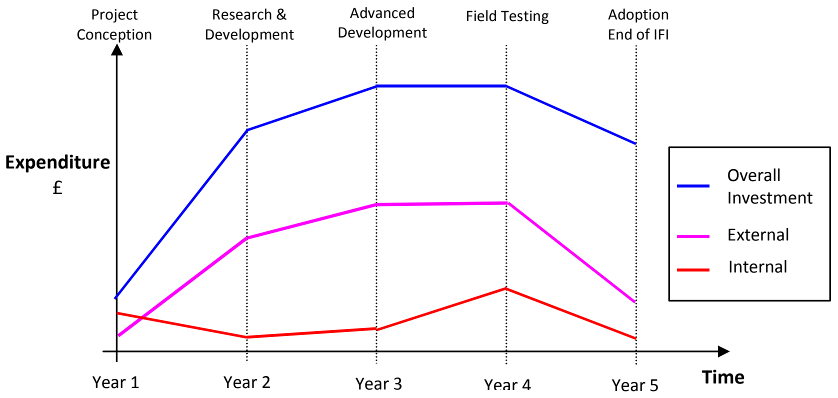


Figure B1: Example Expenditure Profile for an IFI Project

Table B1 and B2 are ordered chronologically.

Table B1: Overview of 08/09 projects showing application between licences

Project Description	Percentage split			£ split SPD		SPM		SPT	
	SPD	SPM	SPT	External	Internal	External	Internal	External	Internal
IFI 0401 - Strategic Tech Prog	60%	40%	0%	£ 114,812	£ 16,687	£ 76,541	£ 11,125	£ -	£ -
IFI 0402 - LV Voltage Regulator	60%	40%	0%	£ 9,562	£ 5,258	£ 6,374	£ 3,505	£ -	£ -
IFI 0404 - Alternative Insulating Oil Proje	60%	40%	0%	£ 14,824	£ 3,033	£ 9,883	£ 2,022	£ -	£ -
IFI 0406 - Fault Passage Indication / GSM c	60%	40%	0%	£ 39,950	£ 10,888	£ 26,633	£ 7,259	£ -	£ -
IFI 0409 - LV Fault Location devices	60%	40%	0%	£ 6,428	£ 5,928	£ 4,285	£ 3,952	£ -	£ -
IFI 0502 - Fault Level Monitor Project	60%	40%	0%	£ 824	£ 2,484	£ 549	£ 1,656	£ -	£ -
IFI 0505 - Supergen V	60%	40%	0%	£ 15,824	£ 2,292	£ 10,549	£ 1,528	£ -	£ -
IFI 0507 - Smart Dust	60%	40%	0%	£ 50,324	£ 15,008	£ 33,549	£ 10,005	£ -	£ -
IFI 0508 - Redox Energy Storage	60%	40%	0%	£ 4,029	£ 1,872	£ 2,686	£ 1,248	£ -	£ -
IFI 0509 - Superconducting Fault Current Li	60%	40%	0%	£ 21,599	£ 3,195	£ 14,399	£ 2,130	£ -	£ -
IFI 0510 - Alt 11kV Prot	0%	100%	0%	£ -	£ -	£ 61,180	£ 9,768	£ -	£ -
IFI 0511 - ACTIV Voltage Control	60%	40%	0%	£ 25,818	£ 7,910	£ 17,212	£ 5,273	£ -	£ -
IFI 0513 - Thermal State Estimation	60%	40%	0%	£ 12,778	£ 10,200	£ 8,518	£ 6,800	£ -	£ -
IFI 0515 - Power Networks Demonstration Centre	60%	40%	0%	£ 20,007	£ 2,101	£ 13,338	£ 1,401	£ -	£ -
IFI 0526 - PD Monitoring of Cables	60%	40%	0%	£ 12,734	£ 3,717	£ 8,489	£ 2,478	£ -	£ -
IFI 0532 - AURA - NMS	60%	40%	0%	£ 108,895	£ 23,574	£ 72,597	£ 15,716	£ -	£ -
IFI 0535 - Radiometric Arc Fault Loctn	60%	40%	0%	£ 12,792	£ 7,322	£ 8,528	£ 4,882	£ -	£ -
IFI 0540 - MANtIS	60%	40%	0%	£ 1,139	£ 2,673	£ 759	£ 1,782	£ -	£ -
IFI 0607 - LV Automation	60%	40%	0%	£ 40,424	£ 20,372	£ 26,949	£ 13,581	£ -	£ -
IFI 0615 - SP Advanced Research Centre	60%	40%	0%	£ 87,605	£ 3,440	£ 58,403	£ 2,294	£ -	£ -
IFI 0618 - Supergen 1 - Flex Net	60%	40%	0%	£ 24,824	£ 1,718	£ 16,549	£ 1,146	£ -	£ -
IFI 0619 - Advcd Cabling Technologies Prog	60%	40%	0%	£ 7,331	£ 6,118	£ 4,887	£ 4,078	£ -	£ -
IFI 0620 - Tower Foundation Assmnt DevTrail	0%	60%	40%	£ -	£ -	£ 4,907	£ 2,335	£ 3,271	£ 1,556
IFI 0621 - Energy Innovation Centre	60%	40%	0%	£ 824	£ 1,718	£ 549	£ 1,146	£ -	£ -
IFI 0624 - Met Office Climate Change Ph2	40%	40%	20%	£ 698	£ 2,017	£ 698	£ 2,017	£ 349	£ 1,008
IFI 0625 - Vegetation Management Project	60%	40%	0%	£ 60,224	£ 2,550	£ 40,149	£ 1,700	£ -	£ -
IFI 0628 - Asset Decisn Support Dashboard	60%	40%	0%	£ 28,591	£ 4,302	£ 19,061	£ 2,868	£ -	£ -
IFI 0701 - ENA De-minimis Rapper	60%	40%	0%	£ 2,305	£ 1,718	£ 1,537	£ 1,146	£ -	£ -
IFI 0702 - Lattice Tower Protective Coat	0%	30%	70%	£ -	£ -	£ 2,157	£ 446	£ 19,415	£ 4,013
IFI 0704 - 4E Comms Cooling	0%	10%	90%	£ -	£ -	£ 1,744	£ 451	£ 15,692	£ 4,056
IFI 0706 - Ashton Hayes Microgrid Devel.	60%	40%	0%	£ 26,924	£ 3,087	£ 17,949	£ 2,058	£ -	£ -
IFI 0707 - Wind Turbine Effects-Trans L	0%	0%	100%	£ -	£ -	£ -	£ -	£ 22,615	£ 17,533
IFI 0708 - Health Indices for Ast Mgmt DM	60%	40%	0%	£ 27,224	£ 7,841	£ 18,149	£ 5,227	£ -	£ -
IFI 0709 - Network Monit using Web Sys	35%	35%	30%	£ 8,767	£ 2,516	£ 8,767	£ 2,516	£ 7,515	£ 2,157
IFI 0710 - GBSQSS Review Studies	0%	0%	100%	£ -	£ -	£ -	£ -	£ 10,707	£ 3,502
IFI 0711 - 3rd Party ROEP Risk Assessment	35%	35%	30%	£ 1,426	£ 1,560	£ 1,426	£ 1,560	£ 1,222	£ 1,338
IFI 0712 - BT21 CN Solutions	50%	50%	0%	£ 34,516	£ 15,265	£ 34,516	£ 15,265	£ -	£ -
IFI 0801 - IEC 61850 Applications in SPT	0%	0%	100%	£ -	£ -	£ -	£ -	£ 37,333	£ 15,589

Totals	SPD		SPM		SPT	
	External	Internal	External	Internal	External	Internal
	£ 824,023	£ 198,367	£ 634,471	£ 152,364	£ 118,118	£ 50,752
Ratios	81%	19%	81%	19%	70%	30%

Table B2: Project NPVs, split between licences

Project Description	Percentage split			Project NPV				
	SPD	SPM	SPT	Total NPV	SPD	SPM	SPT	
IFI 0401 2 - STP Module 2 - Overhead Networks	60%	40%	0%	£64,624	£38,774	£25,850	£0	* See Note
IFI 0401 3 - STP Module 3 - Cable Networks	60%	40%	0%	£87,318	£52,391	£34,927	£0	* See Note
IFI 0401 4 - STP Module 4 - Substations	60%	40%	0%	£67,777	£40,666	£27,111	£0	* See Note
IFI 0401 5 - STP Module 5 - Distributed Generation	60%	40%	0%	£89,367	£53,620	£35,747	£0	* See Note
IFI 0402 - LV Voltage Regulator	60%	40%	0%	£45,198	£27,119	£18,079	£0	
IFI 0404 - Alternative Insulating Oil Project	60%	40%	0%	£98,922	£59,353	£39,569	£0	
IFI 0406 - Fault Passage Indication / GSM	60%	40%	0%	£297,916	£178,750	£119,166	£0	
IFI 0409 - LV Fault Location devices	60%	40%	0%	£349,240	£209,544	£139,696	£0	
IFI 0502 - Fault Level Monitor Project	60%	40%	0%	£92,045	£55,227	£36,818	£0	
IFI 0505 - Supergen V	60%	40%	0%	£46,609	£27,965	£18,644	£0	
IFI 0507 - Smart Dust	60%	40%	0%	£554,500	£332,700	£221,800	£0	
IFI 0508 - Redox Energy Storage	60%	40%	0%	£243,753	£146,252	£97,501	£0	
IFI 0509 - Superconducting Fault Current Limiter	60%	40%	0%	-£267,191	-£160,315	-£106,876	£0	
IFI 0510 - Alt 11kV Prot	0%	100%	0%	£50,000	£0	£50,000	£0	
IFI 0511 - ACTIV Voltage Control	60%	40%	0%	£67,445	£40,467	£26,978	£0	
IFI 0513 - Thermal State Estimation	60%	40%	0%	£301,867	£181,120	£120,747	£0	
IFI 0515 - Power System Demonstration Network (PSDN)	60%	40%	0%	£709,171	£425,503	£283,668	£0	
IFI 0526 - PD Monitoring of Cables	60%	40%	0%	£108,661	£65,197	£43,464	£0	
IFI 0532 - AURA - NMS	60%	40%	0%	-£364,068	-£218,441	-£145,627	£0	
IFI 0535 - Radiometric Arc Fault Loctn	60%	40%	0%	£45,787	£27,472	£18,315	£0	
IFI 0540 - MANtIS	60%	40%	0%	£0	£0	£0	£0	
IFI 0607 - LV Automation	60%	40%	0%	-£31,000	-£18,600	-£12,400	£0	
IFI 0615 - SP Advanced Research Centre	60%	40%	0%	£0	£0	£0	£0	
IFI 0618 - Supergen 1 - Flex Net	60%	40%	0%	£0	£0	£0	£0	
IFI 0619 - Advcd Cabling Technologies Prog	60%	40%	0%	£90,726	£54,436	£36,290	£0	
IFI 0620 - Tower Foundation Assmnt DevTrail	0%	60%	40%	£14,220	£0	£8,532	£5,688	
IFI 0621 - Energy Innovation Centre	60%	40%	0%	£0	£0	£0	£0	
IFI 0624 - Met Office Climate Change Ph2	40%	40%	20%	£0	£0	£0	£0	
IFI 0625 - Vegetation Management Project	60%	40%	0%	£681,000	£408,600	£272,400	£0	
IFI 0628 - Asset Decisn Support Dashboard	60%	40%	0%	£163,235	£97,941	£65,294	£0	
IFI 0701 - ENA De-minimis Rapper	60%	40%	0%	£255,876	£153,526	£102,350	£0	
IFI 0702 - Lattice Tower Protective Coat	0%	30%	70%	£1,600,000	£0	£480,000	£1,120,000	
IFI 0704 - 4E Comms Cooling	0%	10%	90%	£905,595	£0	£90,560	£815,036	
IFI 0706 - Ashton Hayes Microgrid Devel.	60%	40%	0%	£7,549	£4,529	£3,020	£0	
IFI 0707 - Wind Turbine Effects-Transmission Lines	0%	0%	100%	£835,466	£0	£0	£835,466	
IFI 0708 - Health Indices for Ast Mgmt DM	60%	40%	0%	£0	£0	£0	£0	
IFI 0709 - Sub.net monitoring	35%	35%	30%	£0	£0	£0	£0	
IFI 0710 - GB SQSS Review Studies	0%	0%	100%	£0	£0	£0	£0	
IFI 0711 - 3rd Party ROEP Risk Assessment	35%	35%	30%	£15,562	£5,447	£5,447	£4,669	
IFI 0712 - BT21CN Protection Solutions	50%	50%	0%	£951,763	£475,882	£475,882	£0	
IFI 0801 - IEC 61850 Applications in SPT	0%	0%	100%	£1,044,386	£0	£0	£1,044,386	

	Total NPV	SPD NPV	SPM NPV	SPT NPV
Overall NPV	£9,223,319	£2,765,124	£2,632,951	£3,825,244

* Note - NPV calculated by external company

Appendix C – Methodology for NPV calculations in IFI projects

Introduction

SP Energy Networks utilises a slightly different approach in the calculation of Net Present Value (NPV) to that described in Engineering Recommendation G85 Issue 2. For transparency, this methodology is outlined below.

In all IFI projects the expected benefits are defined at the outset of the project. In the case of financial benefits the standard business approach is the Net Present Value (NPV) calculation, giving a quantitative representation of the financial benefits that the new technologies will bring verses the cost of the development. As R&D is naturally higher risk than more traditional projects there are many factors, which need to be carefully considered at a projects outset. As a result, the standard NPV assessment approach must be altered to reflect this.

General Methodology

Risk can be factored into an NPV calculation in two ways, with both achieving similar results:

- Applying a variable discount rate
- Using a separate multiplying factor to reduce the benefits.

In line with guidance from Ofgem, our NPV calculations utilise a fixed 6.9% discount rate in line with the agreed cost of capital for the SP-Distribution and SP-Manweb licences in DPCR4 (this rate is also used for SP-Transmission). We therefore introduce risk as a separate factor, the Probability of Success to scale the benefits of each project, as described in the equation below.

$$NPV = \sum_{t=0}^{N} \frac{Ct}{(1+i)^t}$$

$$C_t = (Benefit - \text{Adoption Expenditure}) \times PoS - \text{Development Expenditure}$$

t	time (in years) that cash has been invested in the project
N	the total length of the project (in years)
i	the cost of capital and
C$_t$	the cash flow at that point in time
PoS	the probability of successful development

Aside:

Benefit	–	Cash benefits for at a point in time
Adoption expenditure	–	Adoption expenditure at a point in time
Development expenditure	–	Development expenditure at a point in time

The NPV, and in particular, the C_t factor is calculated is as follows:

- The cost of development will always be a direct cost, as the money will be spent if the project goes ahead – there is a PV associated with this figure.
- Benefits in the development phase are scaled by the probability of success, as benefits are possible in the development phase, but these will only be realised if the development work is successful.

Both benefits and expenditure in the adoption phase are scaled by the probability of success of development; as expenditure will only occur in the adoption phase if the development work is successful. Similarity the benefits in the adoption phase show the same dependence on successful development.

Phasing

It is noted that if the NPV were taken on solely the development phase of a project, many projects would not commence. This is indicated in Figure C1, where, even by showing the development phase split into two: feasibility and pilot, the magnitude of rollout in the pilot is generally too low to re-coup the original development costs (which can be high). Assumptions on this uptake therefore need to be identified into the adoption phase to ensure a credible result.

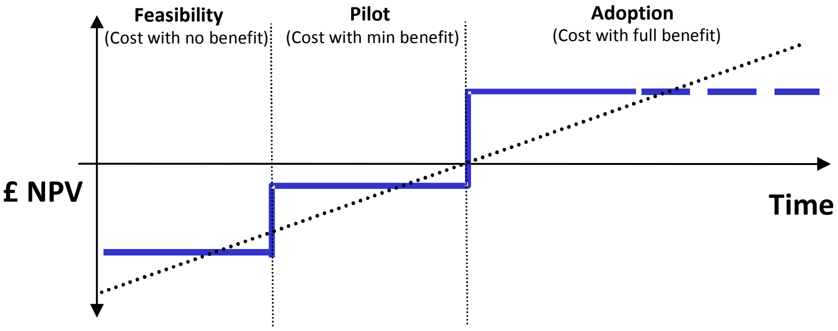


Figure C1: How project NPV changes over the course of its development

Cost Assumptions

The costs of an IFI project for the purposes of the NPV calculation can be complicated to quantify, often relying on a number of assumptions. As a minimum, the following are considered:

Development Costs

- Cost to develop a product / service / etc
- Purchase of equipment (e.g. necessary equipment to commence the trial, e.g. units for trial)
- Internal cost to project manage and steer
- Cost of installation (equipment, manpower, etc)

Adoption Costs

- Anticipated product unit cost
- Anticipated installation cost
- Anticipated rollout across network

Benefit Assumptions

Benefits too can come in a variety of manners. In some cases a direct financial saving between an existing solution and technology solution may be possible, but in others we must consider more complex mechanisms such as:

- the balance between CAPEX reductions and increasing OPEX (for communications)
- the companies exposure to risk, be that Regulatory or Statutory (CI/CML, environmental or the impact on safety, etc)
- improved understanding and targeting of investment.

Duration of Benefit

The NPV for IFI projects considers projects beyond the traditional development phase and into adoption. In order to measure similar projects this has been simplified as:

- Current carrying Plant (e.g. cables, overhead lines, switchgear) – 20-year asset life
- Auxiliary Plant (e.g. protection equipment, comms, etc) – 10-year asset life
- Tools & Equipment (e.g. portable fault location equipment, etc) – 5-year asset life

Probability of Success (PoS)

The Probability of Success is applied as a scaling factor to all expected benefits during the development phase of a project, and can consequently, have a significant impact on the financial assessment. In order to give a level of consistency to the application of PoS figures, we link our project Probabilities of Success to the concept of Technology Readiness Levels (TRLs). See Table C1.

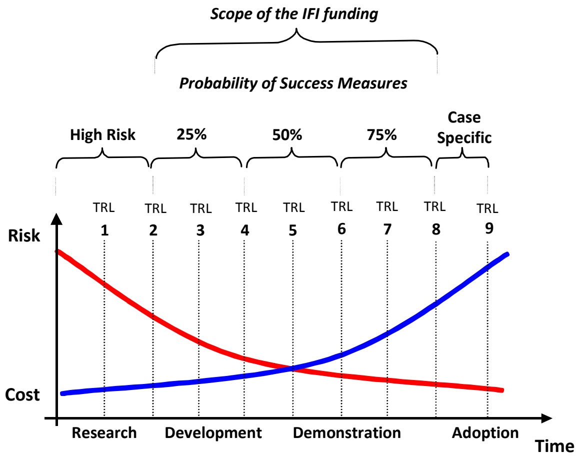
Technology Readiness Levels (TRLs): Provide a clear indication of how far a product may be from commercialisation. TRLs were first conceived by NASA and are much used in military R&D as a way of gauging a projects status and therefore risk by indicating how far a technology development may be from adoption.

TRL	Definition	Networks Interpretation	Company Resource (time / €)	Likelihood of Success (adoption)
1	Basic principles observed and reported.	Blue skies research	🟨	2%
2	Technology concept and/or application formulated.	Applied research (research to address a network related problem or issue)	🟨🟨	5%
3	Analytical and experimental critical function and/or characteristic proof of concept.	Bench-top testing phase of a research project	🟨🟨🟨	10%
4	Technology component and/or basic technology sub-system validation in lab environment.	Component lab testing phase of a research project	🟨🟨🟨🟨	25%
5	Technology component and/or basic sub-system validation in relevant environment.	Connectivity and successful operation of products in a 'network' lab environment	🟨🟨🟨🟨🟨	35%
6	Technology system/subsystem model or prototype demonstration in a relevant environment.	Successful equipment type testing (e.g. independent HV test lab)	🟨🟨🟨🟨🟨🟨	50%
7	Technology system prototype demonstration in an operational environment.	One-off system integration testing with installation on live electricity network	🟨🟨🟨🟨🟨🟨🟨	75%
8	Actual technology system completed and qualified through test and demonstration.	Widespread network trial	🟨🟨🟨🟨🟨🟨🟨🟨	90%
9	Technology System "qualified" through successful mission operations.	Trial completion: Development of. business case, application documents, etc	🟨🟨🟨🟨🟨🟨🟨🟨🟨	100%

Table C1: Technology Readiness Level / Probability of Success Definition

Figure C2 show diagrammatically, the likelihood of obtaining benefits from a project to its stage of development and probability of success. It is noted that this assessment is a simplification, as it does not fully consider some of the non-linear steps, e.g. from TRL 6 – TRL 7, a commonly expensive transition, which can make/break a project.

It is important to note that the TRL and PoS used in the NPV will be based solely upon assumptions at the outset of a project. As IFI is a mechanism to encourage technological developments, projects will naturally be driven up the TRL scale (with a rising PoS) as they progress to trial and demonstration (specific information in project TRLs is given in Appendix D). However, in the interests of efficiency, the NPV calculation will not be revisited during the development phase.



TRL Development (Start – Current)								
1	2	3	4	5	6	7	8	9
	✦						✦	

Figure C2: Relationship between Technology Readiness Level and Probability of Success

The PoS has a significant bearing on the NPV assessment, as projects with a low TRL will give rise much lower, and in some cases negative, NPVs if the development costs are high, and the roll out is conservative. We believe this to be in line with the true spirit of IFI, demonstrating that risk is being taken in areas where without such a recovery mechanism, these developments would have been seen as too risky for a Regulated business to undertake. By way of example, the AuRA-NMS project starts from a low TRL, and hence low probability of success (for the case study we have identified this and translates as a negative NPV).

Successful development of this project would also open up the options to deploy such a system to more applications, further improving the scope for benefits.

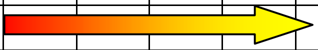
Probability of Adoption (PoA)

In all cases for the NPV calculations, there is an assumption that once developed, the technology will be adopted. However, R&D is inherently speculative in nature and only a small fraction of projects developed will actually be adopted within an organisation, this being dependent on a range of factors such as:

- Scale / cost of Rollout
- Complexity
- Regulatory opportunities / barriers (Revenue / Penalties)
- Legislative barriers

All NPV assessments will be revisited and improved prior to adoption. Any lessons learnt will feedback into our NPV methodology outlined above. Although a figure has not been applied to the NPV calculations, it is recognised that only 10%-20% of successfully developed projects are likely to be implemented.

Appendix D – Project Reports IFI Projects
April 08 – March 09

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 0402 - Single Phase LV Voltage Regulators</i></td></tr>
<tr><td>Description of project</td><td colspan="10">Development of a single-phase power electronic LV voltage regulator, for connection into a LV line to provide fast response voltage compensation for both over and under-voltages effectively managing / mitigating LV voltage complaints</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£8,763
£15,936
£24,699</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal
External
Total</td><td colspan="2">£32,124
£172,958
£205,082</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">c£250,000</td><td colspan="4">Projected 09/10 costs for SPEN</td><td colspan="2">Internal
External
Total</td><td colspan="2">£0
£0
£0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">It is envisaged that this device will primarily used as a means of rapidly resolving voltage complaints in rural areas.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">The device may be capable of resolving both temporary and permanent voltage complaints dependent on the type of complaint and the economics of the situation.
Where there is a clear case for network reinforcement, which would require time to engineer the most cost effective solution, the voltage regulator could be used to resolve the complaint whilst a reinforcement scheme is designed, way-leaves negotiated and construction undertaken.
Where the voltage complaint is due to disturbing loads or unidentified causes it could provide a permanent solution due to the fast response of the device to voltage dips and sags.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><1 Year</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">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 colspan="5"></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£45,198</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">The regulators have been installed at various locations; some permanently and some are installed temporarily if network reinforcement is deemed a viable solution.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">This project will be closed in the 2009/10 period, with the use of the regulator being brought into line with SPEN’s reinforcement policy</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Phase 1(development): N/A;
Phase 2 (trial): Electricity North West, Scottish & Southern Energy</td></tr>
<tr><td>R&D Provider</td><td colspan="10">MicroPlanet USA (LV Regulator), GMC Instruments (monitoring)</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="11"><i>IFI 0404 - Alternative Insulating Oils – Phase 1</i></td></tr>
<tr><td>Description of project</td><td colspan="11">Applied research programme consisting of a series of investigations designed to make a thorough evaluation of the electrical/ageing properties of alternative oils for use in both aged power transformers and new plant.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£5,054
£24,707
£29,761</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal
External
Total</td><td colspan="3">£8,487
£29,512
£37,999</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£142,290</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="2">Internal
External
Total</td><td colspan="3">£3,000
£16,400
£19,400</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">Evaluation of the Characteristics of Alternative Oils is being undertaken to access the relative merits for Retro-Filling Power Transformers and filling New Transformers with alternative oils have over using standard mineral oils.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="5">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">No</td><td colspan="2">Yes</td><td colspan="5">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">• Reduced environmental risk associated with oil spills.
• Potential to up-rate transformers at strategic sites.
• Opportunity to improve SPEN credibility with SEPA and other governing bodies and reputation with regards environmental awareness.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">4 years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" 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="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£98,922</td></tr>
<tr><td>Project Progress March 09</td><td colspan="11">• PDIV of bulk oil and surface discharge in FR3 or Midel are almost the same.
• Introduction of pressboard speeds up the increase of PD magnitude with voltage rising.
• PDIV of surface discharge in FR3 is lower than that in Midel.
• However, in higher voltages, PD magnitudes in Midel are always higher than in FR3.
• Relationship in breakdown voltages of three oils for both bulk oil and surface tests are: Mineral oil > FR3 > Midel
• When gap is small, difference in breakdown voltages between with and without pressboard can hardly be observed. However when gap is larger, difference becomes more obvious.
• Existence of pressboard affects propagation of creeping discharge more than initiation.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="11">• It is SP company policy to use Midel filled distribution transformers within embedded/basement substations to mitigate environmental or fire issues. It is likely that only one ester oil product will be adopted by SPEN however further work is required to determine which is most suitable for larger power transformers.
• It would be the intent to adopt one of the ester-based oils for use within transmission transformers. Benefits would include environmentally sensitive sites and sites of significant fire risk and consequence due to the higher flash point of these oils. However, given the significant finance and operation risk of using these oils in transmission transformer, further testing is considered necessary by the</td></tr>
</table>

<table>
<tr><td></td><td>collaborative partners in order to gain confidence in their application.
• Results of testing are so far proving positive with regards to using Midel oil in large power transformers.</td></tr>
<tr><td>Collaborative Partners</td><td>National Grid, Electricity North West, EDF Energy, Areva T&D, TJH2B, M&I Materials</td></tr>
<tr><td>R&D Provider</td><td>University of Manchester</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="10"><i>IFI 0406 - Overhead Line Fault Passage Indicators</i></td></tr>
<tr><td>Description of project</td><td colspan="10">The development of a range of programmable fault passage indicators with wireless communications to measure and record transient and permanent system faults on both the 33kV and 11kV overhead networks.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £18,146
External £66,583
Total £84,729</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £28,046
External £131,812
Total £159,858</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£329,794</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £5,000
External £35,000
Total £40,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Implementing a reliable Fault Passage Indicator (FPI) with wireless GPRS communications for use on 33kV and 11kV overhead network will aid the location and isolation of faults.</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">• Fault indicators will identify a more targeted search area for faultfinding thereby improving response time and subsequent restoration of supplies to customers.
• This project focuses on reducing restoration time to rural customers.
• Reduced damage to land through unnecessary access. This also has customer service benefits, with a potential improved perception from landowners.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><1year</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% - Apr 07
75% - Apr 08</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">£297,916</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">Commenced in January 2008 with an analysis of the project to date, and a re-evaluation of the project direction. Throughout Stage 3, the following technology was purchased and trialled:

- 48 Bowden Brothers Pathfinder 360 Alpha FPIs, permanent pole-mounted
- 48 Nortech Management Polestar NX FPIs, permanent pole-mounted
- 24 FMC Tech Crystal Systems, conductor-mounted
- iHost Server space being rented
- 6 Nortech Management NX11 Power Outage Detectors
- 60 Bowden Brothers Rightway Mark 10 FPIs, portable pole-mounted

To date the following results have been obtained</td></tr>
</table>

	- Pathfinder 360 Alpha FPI was the most accurate option for permanent attachment. Their average accuracy was shown to be 92% after 17 faults. - The Polestar NX FPI was shown to be accurate 51% of the time after 18 faults. - The conductor-mounted Crystal Systems never operated or connected to iHost consistently to prove worthwhile. - The Rightway Mark 10 portable FPIs were shown to be a flexible and effective tool for the zones as long as they were used proactively. - The NX11 Power Outage Detectors were 100% accurate after 1 fault. The data collector, iHost, was shown to be effective at collecting information from many different types of unit and displaying it in an easily interpretable consistent manner.
Potential for achieving expected benefits	The objectives of the project were to ascertain what communicable FPI technology was available on the market for the overhead network, which was the most effective and how best to use the information reported. These objectives were met fully and the conclusions were that the Bowden Pathfinder 360 Alpha was the most effective permanent pole-mounted FPI. The best way to use the information was to collect it with the iHost server and, depending on the end user, to either display it on a web page or to route it directly into the control program. This project is due to be closed in August 2009
Collaborative Partners	N/A
R&D Provider	**Pole Mounted Devices**: Nortech, Bowden Bros. **Conductor Mounted Devices**: FMC Tech

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0409 - LV Fault Location Devices</i></td></tr>
<tr><td>Description of project</td><td colspan="4">A device for use on the Low Voltage networks to capture transient fault information and correlate to an associated fault location.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 9,880
External £ 10,714
Total £ 20,593</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £24,790
External £69,589
Total £94,379</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£184,800</td><td colspan="2">Projected 08/09 costs for SPEN</td><td>Internal £7,100
External £20,000
Total £27,100</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The device is being developed preliminary for transient/intermittent LV cable fault location.</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">Preliminary use of the device for fault location on persistent LV faults is expected to:
• Reduce the number of repeated fuse replacements
• Minimise the number of joint holes
• Remove the fault from the system in a shorter timescale than traditional ‘cut-and-test’ methods</td></tr>
</table>

Expected Timescale to adoption	1 Year	Duration of benefit once achieved	Typically 8-10 years depending on technology development

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	£349,240

Project Progress March 09	• Embedded into iHost the ability to configure the TP22 from the webpage rather than from base station. • iHost has been brought into line with base station software to record fault/incident records which enables information retrieval much easier
Potential for achieving expected benefits	• Collaboration with ENW to embed software into iHost • Develop TP22 further to communicate whilst monitoring (sending fault record back while recording fault incident) • Automate fault location process as far as possible
Collaborative Partners	Phase 1: N/A; Phase 2: EDF-Energy; Electricity North West
R&D Providers	Kehui (UK) Ltd, Nortech

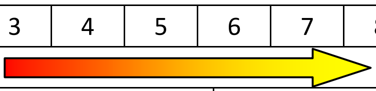
Project Title	***IFI 0502 - Fault Level Monitor Project***
Description of project	An ENA co-ordinated project the objective of which is the development of an on-line instrument that can successfully measure / estimate fault level on a distribution network with repeatability and reliability.

Expenditure for financial year	Internal £4,140 External £1,374 **Total £5,513**	Expenditure in previous (IFI) financial years	Internal £7,468 External £13,237 **Total £20,705**
Project Cost (Collaborative + external + [DNO])	**£190,000**	Projected 09/10 costs for SPEN	Internal £4,000 External £30,550 **Total £34,550**

Technological area and / or issue addressed by project	The device will connect to the network, and establish the network source impedance from small-scale disturbances / perturbations resulting from transformer tap changer operation, etc. This impedance can accurately be correlated to a true network fault level for that location, providing near real-time information to network control and planning engineers alike.

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

Expected Benefits of Project	The developed unit will allow the DNOs to accurately assess fault infeed levels and design distribution networks appropriately. The particular benefits of this project are seen to be: • Provide a real-time and consistent estimation of fault level • Accurately take into account all connected network elements (e.g. Motors); • Facilitate the connection of distributed generation by providing a standardised methodology for the assessment of network fault levels • Enable an ongoing assessment of the effects of connected distributed generation to be made;

<table>
<tr><td></td><td colspan="10">• Provide reassurance to generator developers that decisions to upgrade networks are not subjective but based on objective measurement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">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 colspan="9"></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£92,045</td></tr>
<tr><td>Project Progress to March 09</td><td colspan="10">The results of the tests carried out at NaREC show that the EA Technology Fault Level Monitor is capable of delivering an assessment of both the source and motor infeed elements of fault level. The accuracy of the assessment can be delivered with the tolerance levels (+/- 5%) which were set down by ENA OSG sub-group. However, it should be noted that the instrument is based on a hardware platform which is obsolete and no longer supportable. Stage 2 of the previous work carried out in conjunction with the University of Strathclyde, was intended to develop a new Fault Level Monitor. Consideration should be given to the need to carry out further development of a new platform to collect and analyse the disturbance data.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The confidence limits in the case of the induction motor infeed assessment were affected by the relatively low number of recorded disturbances and also appear to have been affected by the ‘two-stage’ nature of many of the disturbances. Further work should be undertaken to examine the effect of the load response of non-linear static loads on the estimate of fault level contribution from induction motors. A PhD studentship at the University of Strathclyde the PNRA to explore this issue is being advertised</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">National Grid, Scottish & Southern Energy, CE Electric UK, Electricity North West, Central Networks, Western Power Distribution, EDF-Energy Networks</td></tr>
<tr><td>R&D Providers</td><td colspan="10">University of Strathclyde, EA Technology</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5"><i>IFI 0505 - Supergen V - AMPerES</i></td></tr>
<tr><td>Description of project</td><td colspan="5">Supergen is an EPSRC strategic partnership programme incorporating a collection of projects across a number of UK academic establishments. This fifth call, Supergen V is entitled Asset Management & Performance of Energy Systems (AMPerES).</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£3,821</td><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td>£7,974</td></tr>
<tr><td>External</td><td>£26,374</td><td>External</td><td>£77,902</td></tr>
<tr><td>Total</td><td>£30,194</td><td>Total</td><td>£85,876</td></tr>
<tr><td rowspan="3">Project Cost (Collaborative + external + SPEN)</td><td colspan="2" rowspan="3">£ 2,800,000</td><td rowspan="3">Projected 08/09 costs for SPEN</td><td>Internal</td><td>£5,000</td></tr>
<tr><td>External</td><td>£25,000</td></tr>
<tr><td>Total</td><td>£30,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">WP 1: Programme delivery, outreach and implementation
WP 2: Enhanced network performance and planning
WP 3: Adaptable protection and control techniques
WP 4: Infrastructure for reducing environmental impact
WP 5: Ageing mechanisms
WP 6: Condition monitoring techniques</td></tr>
</table>

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td colspan="3">Project Benefits Rating</td><td colspan="3">Project Residual Risk</td><td colspan="3">Overall Project Score</td></tr>
<tr><td colspan="3">11</td><td colspan="3">-4</td><td colspan="3">15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">The expected aims of the project are:
- To deliver a suite of intelligent diagnostic tools for plant
- To provide platform technologies for integrated network planning and asset management
- To progress plans to develop and implement improved and reduced environmental impact networks
- To develop models and recommendations for network operation and management</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2013</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 colspan="5"></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">£150k</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Asset management is core to the business. The appropriate use of the emerging opportunities for condition monitoring is key to optimising performance, both financially and in quality of supply. Some of the technologies being developed in this programme are likely to be utilised, however much more important is the broader window this work gives to the global research community. Through demonstration sites the true value of condition monitoring will be identified, enabling appropriate business decisions on adoption of technologies.</td></tr>
<tr><td>Project Progress
June 2009</td><td colspan="10">Technology & trials:
- The detection, control and protection synchronous islands have been demonstrated on a 50kVA diesel generator. The demonstration employs a real-time phasor measurement system. An AC optimal power flow method for assessing the maximum distributed generation (DG) penetration in distribution networks has been developed. A novel method of detection of loss of grid techniques is being developed. A low-cost system with internet broadcast capability has also been developed: four are currently in operation. An investigation into how regions of a distribution network can operate during emergency islanded mode conditions is also underway.
- Optimized design of existing overhead lines of wood pole line, and a lattice tower line. The methodology has been employed to analyse the behaviour of low-sag composite conductors on a 33kV wood-pole structure. The model is now being utilised on a wood-pole line on Scottish Power and a lattice tower line on the National Grid, and may substantially improve the performance of sections of the network without major infrastructure changes.
- A unique installation for transformer monitoring at National Grid comprising of two 275/132kV, 180MVA transformers, is implementing results of research on condition monitoring architectures, diagnostics and machine learning.
- Development of condition monitoring architecture for power networks has progressed well and is being implemented on a National Grid transmission transformer. Diagnostic and support modules are included, and exploit a range of ageing models including those developed within this project. Work on ageing has shown that the rate of damage may not be affected by harmonic content, but resulting partial discharge signals change significantly.</td></tr>
</table>

	• PP-based alternatives to XLPE cable insulation have been characterised. Additional funding has been secured for the more applied work to develop routes to commercial exploitation. Vegetable oils have been shown to be a basis for replacement of mineral oils in HV equipment. • Strathclyde and Liverpool have been applying knowledge-based partial discharge analysis and chromatic analysis to data from EdF Energy cable monitoring systems. All publications and reports are available to all the partners from a secure web site: http://www.supergen-amperes.org/
Collaborative Partners	National Grid, Scottish Power, Scottish and Southern, United Utilities, Western Power Distribution, Central Networks, CE Electric, NIE, Advantica & EDF Energy Networks.
R&D Provider	Universities of Manchester, Southampton, Edinburgh, Liverpool, Strathclyde, Queens (Belfast).

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0507 - Sensor Networks (Smart Dust) – Phase 2</i></td></tr>
<tr><td>Description of project</td><td colspan="4">“Smartdust” is a concept developed by the University of California that is based on a self-configuring wireless sensor network, capable of transmitting low bandwidth information in a series of short hops. Data acquired and transmitted from sensors is relayed through a gateway for data interpretation. ScottishPower led a feasibility study into the use of this technology for detecting the passage of fault currents on 11kV overhead line networks.
Following on from this work, a collaborative project has been scoped between EDF-Energy, Central Networks and SPEN to develop a product based on this principle for the remote signalling of fault passage indication on OH networks.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £25,014
External £83,874
Total £108,887</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £10,257
External £16,708
Total £26,965</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>Phase 1 = £16k
Phase 2 = £191k</td><td>Projected 09/10 costs for SPEN</td><td colspan="2">Internal £7,500
External £50,000
Total £57,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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).</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td>Yes</td></tr>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="11">Sensor Networks implemented as a method of fault passage indication (FPI) could have an enormous effect on how faults on the overhead network are located. They could have a huge impact on CI/CML figures as the technology would be effectively pin pointing faults on the network. This results in a significant financial saving</td></tr>
<tr><td>Expected Timescale to adoption</td><td>5 Years</td><td>Duration of benefit once achieved</td><td colspan="9">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="10">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="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£554.5k</td></tr>
<tr><td>Project Progress March 09</td><td colspan="11">The development of a software algorithm to enable multiple point communication, whilst maintaining radio battery life at an optimum, created a significant challenge for the designer Willow Technologies.

Although a radio based communication system generally reports by exception, and is therefore power efficient, if it is to become aware of those in the vicinity that may have data relevant to the purpose, they must also be able to receive transmissions and this becomes a power drain. Willow have developed a system that causes a staged radio awakened period to conserve power, and also to cater for single point redundancy that can enables diverse alternate routes.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="11">SPEN have selected two trial sites, one in each of the distribution licences, with each circuit having 30 sensors each.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="11">Central Networks</td></tr>
<tr><td>R&D Providers</td><td colspan="11">Willow, E.ON Power Technology</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0508 - Development of Redox flow battery for energy storage</i></td></tr>
<tr><td>Description of project</td><td colspan="4">A part funded project through the TSB Technology Programme TP/3/ERG/6/1/16587(D05/726039) that aims to develop (design, build, test and install) an 11kV 250kW Redox flow battery unit for energy storage.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,121
External £6,715
Total £9,836</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £10,493
External £1,144
Total £11,637</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£965,567</td><td>Projected 07/08 costs for SPEN</td><td colspan="2">Internal £3,500
External £30,000
Total £33,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Uses include, voltage support of long lines, overcoming reverse power effects through transformers and potential improvements to network performance. Development of a device which can be connected to the 11kV network and provide power by charging from the AC supply</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>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="10">• This could provide financial benefits through offering solutions through module stacks which may prevent the need to upgrade certain parts of the network where voltage problems exist.
• By placing these devices in the network, voltage problems could be reduced. Furthermore, a device could be employed where providing a supply is difficult or costly.
• As a replacement for current lead-acid batteries, this technology has a low environmental impact.
• One of the most significant outcomes expected of this project is the understanding for how storage systems could be connected to the network, and their likely applications.</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">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>→</td><td>→</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="7">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£243,753</td></tr>
<tr><td>Project Progress
March 09</td><td colspan="10">This project has been put on hold indefinitely due to financing issues</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">This project has been put on hold indefinitely</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">DTI (via Technology Programme), ESD Ltd, Univ. of Southampton, Econnect, Swanbarton Ltd</td></tr>
<tr><td>R&D Providers</td><td colspan="10">ESD Ltd (project managers)</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="6"><i>IFI 0509 - Superconducting Fault Current Limiter</i></td></tr>
<tr><td>Description of project</td><td colspan="6">This project aims to design, develop and trial three 12kV Superconducting Fault Current Limiting (SFCL) devices on three different UK networks.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£5,325
£35,999
£41,324</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal
External
Total</td><td>£20,543
£105,245
£125,788</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£2,345,967</td><td colspan="2">Projected 08/09 costs for SPEN</td><td>Internal
External
Total</td><td>£10,000
£49,187
£59,187</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">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</td></tr>
</table>

<table>
<tr><td></td><td colspan="10">applications: transformer tails, bus section, interconnected network connection. The successful completion of this project is likely to pave the way for higher voltage devices.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="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">To develop, understand and address the issues associated with the connection of an 11kV fault current limiting device to the network.
Successful trials will result in the development of commercially available devices that are capable of clamping fault levels to within network design limits. Once proven, this will open up another option for tackling network fault level, potentially providing an alternative to network reinforcement.</td></tr>
<tr><td>Expected Timescale to Adoption</td><td>3 years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>→</td><td>→</td><td>→</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">£-267,191
Project NPV is negative due to the low TRL / high costs upon commencement</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">• The first pilot SFCL was delivered to ENW in early March and is awaiting final commissioning once ENW have incorporated it into their network
• The cryogenic system was made operational in March. Some initial acoustic noise issues have been mitigated.
• Work on pilot 2 (SPEN) design has been completed and purchasing/assembly due in 2009.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">• Pilot 1 is expected to go live in summer 2009 and work progresses on pilots 2 and 3 with installations in 2009/2010.
• The project is managed against milestones and future milestones include the assembly and type testing at an independent test house prior to installation and commissioning of all units.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Electricity North West, CE Electric UK, Applied Superconductor Ltd</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Applied Superconductor Ltd</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5"><i>IFI 0510 - Innovative Protection Solutions</i></td></tr>
<tr><td>Description of project</td><td colspan="5">The aim of this project is to investigate and develop a radio-based directional blocking scheme for use on interconnected ring-type 11kV and 6.6kV networks in the SP-M licence area.</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£9,768</td><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td>£6,833</td></tr>
<tr><td>External</td><td>£61,180</td><td>External</td><td>£2,902</td></tr>
<tr><td>Total</td><td>£70,948</td><td>Total</td><td>£9,735</td></tr>
<tr><td rowspan="3">Project Cost (Collaborative + external + SPEN)</td><td colspan="2" rowspan="3">£150,000</td><td rowspan="3">Projected 08/09 costs for SPEN</td><td>Internal</td><td>£10k</td></tr>
<tr><td>External</td><td>£35k</td></tr>
<tr><td>Total</td><td>£45k</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">At present the interconnected 11kV and 6.6kV networks are protected through the use traditional unit based schemes. However a subset of these networks utilise bi-directional overcurrent and earth fault relays at remote primary substations.

Protection theory shows that it is impossible to achieve true time-based discrimination in a solidly interconnected ring network. In practice, experience shows that suitable</td></tr>
</table>

<table>
<tr><td></td><td colspan="10">grading can be achieved, with limitations (such as the use of relatively high time multipliers, and limited deployment around the ring resulting in large protection zones)</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">Yes</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Reducing the size protection zones CI and CML figures
• Reducing time multiplier, protection clearance times should be improved
• Resolving sympathetic tripping of adjacent breakers</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 year (assuming successful trial)</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">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">£50,000</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">There are two communication solutions being trialled
• Oswestry – Lord Street – Mimomax radio link has proved successful
• Lord Street – Coney Green – BT solution to be trialled

The five limb VT's are now in stock. VT receptacle and circuit chamber for both ends, in order to accept the new VT's are due to be refurbished</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Protection panel has been design and will be constructed by SPEN fitters.
Relays are on order from SEL and should be delivered June/July</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Schweitzer Engineering Laboratories / FreeWave Radio</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5">***IFI 0511 - Voltage Control ACTIV (EATL)***</td></tr>
<tr><td>Description of project</td><td colspan="5">This project is to investigate active voltage control to increase the efficiency of the network and facilitate the connection of distributed generation. More specifically it is to undertake field trials of the Fundamentals SuperTAPP n+ automatic voltage control (AVC) relay and develop associated modelling criteria for network planners.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£13,183
£43,030
£56,213</td><td>Expenditure in previous (IFI) financial years</td><td>Internal
External
Total</td><td>£6,188
£39,177
£45,365</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£254,206</td><td>Projected 08/09 costs for SPEN</td><td>Internal
External
Total</td><td>£6,000
£69,369
£75,369</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">It is proposed that this relay could provide a viable alternative for voltage control across SP-M / SP-D in areas where the ratios of generation to load is high.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td colspan="2">Yes</td><td>No</td><td>No</td><td>No</td></tr>
</table>

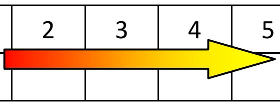
<table>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Enabling the connection of distributed generation using a simple solution which requires minimal network modification;
• Improving the voltage profile of supply;
• Reducing the requirement for network extensions or reinforcement and increasing the capacity for the connection of distributed generation; and
• Reducing the risk of voltage being outside statutory limits and thus damaging equipment and injuring personnel.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td 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">£67,445</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">Three of the four trial sites are now installed and producing data for validation. These include:
• A simple landfill generator on an 11kV radial network;
• A 33kV lightly interconnected network with wind generation;
• An 11kV radial network with Load Drop Compensation and large amount of generation and varying load types.
• Over 10,000 operational hours have now been recorded.
• A number of issues have been discovered and addressed.
• Desktop studies have been completed on two of the sites and indicate that more voltage headroom for generation can be created with little requirement for additional operator intervention.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The voltage control scheme is operating as expected over a range of operating conditions. It is likely that the expected benefits will be achieved.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Central Networks, Scottish & Southern Energy, Electricity North West</td></tr>
<tr><td>R&D Providers</td><td colspan="10">EATL, Fundamentals</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5"><i>IFI 0513 - Thermal modelling and Active Network Management</i></td></tr>
<tr><td>Description of project</td><td colspan="5">A part funded project through the Technology Strategy Board (TSB) Technology Programme (TP/4/EET/6/I/22088) that aims to optimise network design, operation and control by exploitation of dynamic circuit ratings.</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£17,001</td><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td>£13,800</td></tr>
<tr><td>External</td><td>£21,296</td><td>External</td><td>£42,976</td></tr>
<tr><td>Total</td><td>£38,297</td><td>Total</td><td>£56,776</td></tr>
<tr><td rowspan="3">Project Cost (Collaborative + external + SPEN)</td><td colspan="2" rowspan="3">£903,000</td><td rowspan="3">Projected 08/09 costs for SPEN</td><td>Internal</td><td>£15,000</td></tr>
<tr><td>External</td><td>£71,000</td></tr>
<tr><td>Total</td><td>£86,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">• The ratings given to circuits are a function of the temperature by which they operate. The thermal status of a power system component is determined by factors such as: current flow, meteorological conditions and component heat transfer characteristics.
• This project seeks to explore the potential benefits arising from:
    o Improved utilisation of power system assets through the use of real time</td></tr>
</table>

<table>
<tr><td></td><td colspan="11">knowledge of the thermal status of the power system.
○ Development of an active controller to facilitate this exploitation and to balance those issues requiring action by operational staff and those that can be dealt with by machine intelligence.
• The result of this work will be a prototype active controller, using novel thermal state estimation and control techniques, installed on the network.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">• Active network management and exploitation of equipment latent thermal ratings may be a way of accommodating increased levels of renewable generation in distribution networks cost effectively.
• Improved utilisation of distribution assets resulting in deferral and/or avoidance of reinforcement investments in distribution systems.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3" colspan="2">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="5">→</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">£301,867</td></tr>
<tr><td>Project Progress March 09</td><td colspan="11">• IEC standard-based thermal models for overhead lines, electric cables and power transformers have been developed and validated with offline data
• A thermal state estimation algorithm has been developed for overhead lines, electric cables and power transformers. The process facilitates the calculation of component thermal ratings from minimal meteorological measurements. The algorithm has been validated for overhead lines with offline data
• An algorithm has been developed to forecast component thermal ratings through forecasted meteorological data
• Computational fluid dynamic (CFD) models have been developed and validated for overhead lines and electric cables. CFD models are currently being developed power transformers
• Power flow sensitivity factors have been used for the offline control of distributed generation for network power flow management
• Strategies for the power output control of single and multiple generators have been developed and validated with offline data
• Joint electro-thermal simulations have been developed for a variety of case study networks
• Thermal controller deployment benefits have been quantified in terms of DG energy yields, impact on losses, impact on component power transfers, busbar voltages and a financial evaluation
• Work has been disseminated through journal publications with the IET and IMechE (in press late 2009), a book chapter with the publisher 'IN-TECH' and 7 international conference publications (including CIGRE and CIRED)
• Hardware for open-loop field trials ready for installation
• Site visits at trial site undertaken to determine CT connections and detailed design considerations.
• Field trial open-loop realistic relay settings determined
• Thermal instrumentation of the trial site has been specified and commissioned.
• Hardware for the field trials has been developed, using similar Areva hardware to a similar project in Skegness, but adapted to include transformer and cable ratings.
• The hardware architecture has been developed, and will be based on project programme has been extended by six months due to delays in installing the</td></tr>
</table>

	multiple MiCOM relays and a high-level host controller.
Potential for achieving expected benefits	The equipment needed for the open loop field trials. Network data is presently being gathering from the instrumented network and Open loop trials of the TSEA and control algorithm are expected to begin in June 09.
Collaborative Partners	TSB (via Technology Programme), Durham University, Imass, Areva T&D, PB
R&D Providers	PB (project manager), as above

Project Title	*IFI 0515 - Power System Demonstration Centre (PNDC)*			
Description of project	Development of a full scale 11kV and LV prototyping network as a test-bed / proving ground for active network management techniques and other 'high risk' technologies. Whilst not a technological development in itself, this project is a fundamental enabler of technology, with significant potential to accelerate adoption of significant / radical developments across a range of IFI projects.			
Expenditure for financial year	Internal £3,502 External £33,345 **Total £36,847**	Expenditure in previous (IFI) financial years	Internal £26,711 External £23,450 **Total £50,161**	
Project Cost (Collaborative + external + SPEN)	**£7,200,000**	Projected 08/09 costs for SPEN	Internal £10,000 External £42,500 **Total £52,500**	
Technological area and / or issue addressed by project	In partnership with collaborators, this project aims to: • Provide a demonstration network to allow the testing of new technologies on a 'real' network • Offer a real network that will incorporate 11kV and low voltage equipment, containing real loads, real generation and test real technologies • Create a facility which will be open to Academia, R&D Establishments, Manufacturers, and Network Operators The vision is to create a physical scale model that can represent different urban, suburban and rural electrical networks. The proposed system will incorporate real network components: cables, overhead lines, switchgear, transformers, protection and control equipment, in order to ensure it is both representative and credible to the real thing. Real Time Digital Simulators (RTDSs) will be used in parallel to model an underlying, more comprehensive network, effectively expanding the scale of the system. Technologies coming more prominently into play over the next 15 years, e.g. micro-generation, storage, fault current limiters, etc., will be included on the test network so as to test their effect, and vice-versa, on both marine and distribution systems.			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	Yes	Yes	Yes
Expected Benefits of Project	Benefits to DNOs from such a facility include: **Safety** – A test network with dedicated staff will offer a facility to train staff in the operation of a more complicated network. Specific what-if scenario courses can be run through repeatable simulation, in the same manner as flight simulators are used to train pilots. **Risk mitigation** – A real time simulator, with likely penetrations of high volume DG and microGen will indicate the technologies that will need to be developed in order to manage the increased risk this might pose to the network and/or our customers. **Acceleration of trials / increased adoption rate** – The ability to operate the whole network through a vast range of loading conditions in a short period of time, will lead to the end of long duration (12-24mth) network trials of new technologies.			

<table>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td colspan="5"></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£709,171</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">**Activity since Jan 2009**
• Draft project plan produced
• Design Specification Complete. SPEN and SSE have commented on specification
• EDF have been approached with a view to becoming a Tier 1 founding member
• Draft building functional requirements produced
Timescales for completion
• Construction work to begin March/April 2010 with final completion May 2011</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">**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.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Scottish & Southern Energy, Scottish Enterprise and University of Strathclyde</td></tr>
<tr><td>R&D Providers</td><td colspan="10">See Collaborative Partners</td></tr>
</table>

Project Title	***IFI 0526 - PD Monitoring of Cables (11 & 33kV)***
Description of project	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.

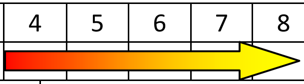
<table>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£6,195</td><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td>£6,647</td></tr>
<tr><td>External</td><td>£21,224</td><td>External</td><td>£47,058</td></tr>
<tr><td>Total</td><td>£27,419</td><td>Total</td><td>£53,705</td></tr>
<tr><td rowspan="3">Project Cost (Collaborative + external + SPEN)</td><td colspan="2" rowspan="3">£160,000</td><td rowspan="3">Projected 08/09 costs for SPEN</td><td>Internal</td><td>£5,000</td></tr>
<tr><td>External</td><td>£42,650</td></tr>
<tr><td>Total</td><td>£47,650</td></tr>
</table>

<table>
<tr><td>Technological area and / or issue addressed by project</td><td>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>
</table>

<table>
<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>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td>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>
</table>

<table>
<tr><td>Expected Timescale to adoption</td><td>1-2 Years</td><td>Duration of benefit once achieved</td><td>5 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 colspan="5"></td><td></td></tr>
</table>

<table>
<tr><td>Project NPV</td><td>(Present Benefits x Probability of Success) – Present Costs</td><td>£108,661</td></tr>
</table>

<table>
<tr><td>Project Progress March 09</td><td>Due to the nature of on-line cable PD monitoring, the availability of a suitable earthing connection is necessary.
18 Primary substations were surveyed for suitable connections with only half being appropriate.

As part of follow up visits from substation inspections where handheld PD monitors had picked up background PD, more in depth surveys were carried out at Haggs Road, Strathaven and Linlithgow Primaries to ascertain severity of PD.

Several courses of action were carried out.
At Haggs Road – the 33kV bushings were dismantled and cleaned
Strathaven – further examination of board to be carried out.
Linlithgow – the board should be monitored on a more frequent basis with and increase of PD necessitating intrusive maintenance on cable end box.</td></tr>
</table>

	At both Haggs Road and Strathaven there was some PD found in 2 cable circuits and again these will be monitored for an increase.
Potential for achieving expected benefits	Having correctly verified sources of PD in cable and identified cables with PD in the area of concern, the next stage is to monitor the top 20 most problematic circuits in both SPM and SPD. If these cable sections are found to have high levels of PD it is planned to identify location of PD section, expose cable section and replace with healthy cable.
Collaborative Partners	N/A
R&D Providers	HVPD (Formally IPEC HV)

<table>
<tr><td>Project Title</td><td colspan="4">***IFI 0532 - AURA-NMS***</td></tr>
<tr><td>Description of project</td><td colspan="4">This project aims to produce a control structure and set of control algorithms that realise the notion of an active distribution network and enhance the service a network operator provides to load and generation customers, improving network performance (asset use, etc.).</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £39,290
External £181,492
Total £220,782</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £26,456
External £371,857
Total £398,313</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>**£5,962,636**</td><td>Projected 08/09 costs for SPEN</td><td colspan="2">Internal £15,000
External £176,823
Total £320,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">In general the scoping and development will consider the following major areas.
• Distributed Generation and demand side management to facilitate the connection of DG to the network;
• Develop a controller that will monitor electricity networks, isolate faults quickly and allow distributed generation to remain connected and operating.
The SP portion of this work is to focus on constraint management techniques for use on new / existing generation connections, focussing on the 33kV and 132kV networks. Although relevant to both SP-D and SP-M networks, the principle focus in case studies will be to overcome existing limitations in SP-M, with a focus on:
• Overcoming complexity of existing hard-wired intertripping schemes
• Determining a solution for managing multiple generation connections in a given locality
• Developing and implementing a system that can work in harmony with existing SCADA infrastructure
• Overcoming communications / equipment limitations of existing systems</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td>Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Benefits are expected to include:
• Development of a constraint management solution with relevant experts
• Implement solution and prove concept
• Potential to create Registered Power Zone for additional revenue on the DG incentive
• Maximisation of the contribution of DG to the electricity network;
• Reduction in carbon emissions and help towards the UK governments climate change targets;
• Reduction in network losses by having the source of generation close to the load;
• Improvement in quality and security of supply;
• Improvement in network resilience; and
• Reducing the current market failures to increase network capacity for DG.</td></tr>
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<table>
<tr><td>Expected Timescale to adoption</td><td>7 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>→</td><td>→</td><td>→</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td>(Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£-364,068
The figure is negative as this is a costly project starting from a low TRL</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">• AuRA-NMS WP1 (System Design) have currently developed voltage control, thermal ratings and restoration algorithms based on DNO requirements. At this stage of the project individual algorithms are in the process of laboratory testing. Additionally work is underway on the development of suitable arbitration functionality to enable AuRA controllers to implement multiple functions where control instruction might otherwise conflict.
• AuRA-NMS WP2 (Communications design) has been driven from the outputs of WP1. and is well underway.
• AuRA-NMS WP3 (Business Case work) is looking the benefits of deployment of the AuRA solution and examining potential impacts on network losses. Further work will be required lifetime costs of solution and specific business cases for the DNO implementation</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">• AuRA-NMS R&D work is on target to deliver the key requirements of the industrial parties. There is the potential to develop the work further by adding to the scope, at this stage of the project it is accepted that further work of algorithm development and testing will be required prior to deployment of the technology to connect additional DG..
• The integration works requirements have been discussed with ABB and AuRA WP. SP is keen to develop project outputs so that a closed – loop trial may be made possible as functions become refined through testing.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">EDF-Energy, EPSRC Strategic Partnership, ABB</td></tr>
<tr><td>R&D Providers</td><td colspan="10">ABB, Universities: Imperial College London (lead), Strathclyde, Durham, Edinburgh, Loughborough, Bath, Manchester</td></tr>
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<tr><td>Project Title</td><td colspan="5">***IFI 0535 - Radiometric Arc Fault Location***</td></tr>
<tr><td>Description of project</td><td colspan="5">Applied research, and follow up installation of a system to triangulate fault locations on overhead lines from the high frequency radio wave signatures produced from an arcing fault.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£12,204
£21,320
£33,523</td><td>Expenditure in previous (IFI) financial years</td><td>Internal
External
Total</td><td>£4,767
£53,902
£58,669</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">**£292,000**</td><td>Projected 08/09 costs for SPEN</td><td>Internal
External
Total</td><td>£7,000
£37,000
£44,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The principle of the technology is:
• There is a correlation between RF discharges and network faults on overhead lines with the RF signal being picked up by a radio antenna up to around 70km away
• If antennae are spread across the network, a mesh is formed – in a similar manner to the GSM network
• If a fault can be accurately clocked, triangulation can be used from a number of base stations to give an approximate geographic location (accuracy ~300m) and linked to GIS / SCADA data to give a more accurate fault location.</td></tr>
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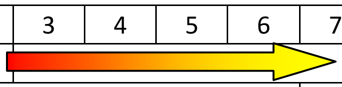
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td>Significant</td><td colspan="2">Technological substitution</td><td>Radical</td></tr>
<tr><td colspan="2">No</td><td>Yes</td><td colspan="2">No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">If successful, the use of radiometric 'cells' could be used to accurately locate fault locations on all overhead line networks within that zone.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="5">TRL Development (Start – Current)</td></tr>
<tr><td colspan="5">1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Project NPV</td><td colspan="4">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">£45,787</td></tr>
<tr><td>Project Progress June 09</td><td colspan="6">3 of the 4 monitoring sites have been brought into service:
Shotts – Dec 2008; Kirkintilloch and Bellshill Feb 2009, with Dealain House to be brought online in May 2009 (some equipment problems are delaying this last site being commissioned)
• All 3 are collecting large amounts of radiometric data,
• A number of correlations have been made between SP fault records and the data collected</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="6">The project has achieved a degree of success already and the analysis of the data collected so far is ongoing. As the project has progressed and more 'in the field' experience has been gathered it has become possible to make changes to the equipment setup which allow the sensitivity of the equipment to be increased and data to be gathered more quickly thus increasing the chances of success.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="6">Western Power Distribution, Scottish & Southern Energy, Central Networks, Electricity North West, CE Electric UK</td></tr>
<tr><td>R&D Providers</td><td colspan="6">University of Strathclyde</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0540 - MANtIS (Managing Active Networks through Intelligent Systems)</i></td></tr>
<tr><td>Description of project</td><td colspan="4">A part funded project through the TSB (K/EL/00365/00/00), MANtIS aims to demonstrate how the development and integration of key enabling technologies will allow innovative network control and protection schemes to be incorporated and will facilitate much greater adoption of distributed generation.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £4,456
External £1,899
Total £6,354</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £6,141
External £18,227
Total £24,368</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£2,453,030</td><td colspan="2">Projected 08/09 costs for SPEN</td><td>Internal £4,000
External £16,500
Total £20,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The project will address the scenarios where fault current is seen as a major obstacle to the adoption of 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>Yes</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Development of techniques to ensure operation in interconnected and islanded-modes, including load shedding
• Provision of fault ride-through capabilities by control of fault current limiting devices.
• Availability of proven enabling technologies should anticipated levels of DG be</td></tr>
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<table>
<tr><td></td><td colspan="11">realised.
• The ability to accommodate greater penetration of DG without the need for costly network reinforcement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="5">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="10">TRL Development (Start – Current)
A range of project TRL will apply</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 colspan="2">9</td></tr>
<tr><td></td><td colspan="3">→</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Project NPV</td><td>(Present Benefits x Probability of Success) – Present Costs</td><td colspan="10">To be determined once a suitable enabling technology has been aligned to a specific network application.</td></tr>
<tr><td>Project Progress March 09</td><td colspan="11">SPEN provided project partners with a summary of learning points from other similar projects.

Project suspended in Q1 of 2009.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="11">The project has been suspended indefinitely.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="11">Rolls-Royce, Manchester and Strathclyde University, TSB (via Technology Programme)</td></tr>
<tr><td>R&D Providers</td><td colspan="11">Rolls-Royce, Manchester and Strathclyde University</td></tr>
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<table>
<tr><td>Project Title</td><td colspan="3"><i>IFI 0607 - LV Network Automation</i></td></tr>
<tr><td>Description of project</td><td colspan="3">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>Internal £33,954
External £67,374
Total £101,327</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £12,830
External £33,964
Total £46,794</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£257,775</td><td>Projected 08/09 costs for SPEN</td><td>Internal £15,000
External £70,000
Total £115,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">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>
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<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">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>→</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">£526,7k</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">The overall plan is split in three major phases.
• “Mechanical step”
• “PLC trial step”
• “LVA prototype step”

The “Mechanical step” is the phase that includes the mechanical design, implementation manufacture and verification. It is finished when the mechanical part of the LVA prototype has been verified and demonstrated from mechanical point of view.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The “PLC trial step” will end up with the first PLC validation on SPEN site. The purpose of this phase is to validate if PLC communication protocol seems to work on the SPEN LV network. Minimal new electronic HW and SW will be developed to perform this validation. At this state there will not be a switch at all, just a validation of the PLC data quality.
To test the PLC communication and which chip is best suited a communication test will be made using development kits from the suppliers. Two test scenarios, one with PLC-communication between two PC’s and one manoeuvring a switch simulator connected to a FastNet from a PC via PLC.

This project is on target.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">None</td></tr>
<tr><td>R&D Providers</td><td colspan="10">RADIUS</td></tr>
</table>

Project Title	***IFI 0615 - ScottishPower Advanced Research Centre (SPARC)***
Description of project	Three workstreams have been proposed: • ***Asset Engineering***: Field based activities, concentrating on the technologies used to gather and interpret data then control and manage individual assets. • ***Asset Strategy***: Office, desktop, PC based analytical activities including the analysis of data, concentrating on underlying trends of asset populations (from asset ageing to network performance). • ***System Development***: Forward looking network design activities considering the connectivity between the assets. It should consider both the medium term (5 years) and longer-term trends (>10 years), which will affect the design of the

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<tr><td></td><td colspan="11">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 colspan="2">Internal £5,734
External £146,008
Total **£151,742**</td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £4,371
External £17,083
Total **£21,454**</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">**£460,083**</td><td colspan="5">Projected 08/09 costs for SPEN</td><td colspan="4">Internal £6,000
External £150,000
Total **£156,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">• Asset Engineering research stream focuses on methods and technologies that enable better use of individual assets.
• Asset Strategy research stream focuses on methods and tools that enable better management of populations of assets.
• System Development research stream focuses on analytical techniques that provide SP with better capability to plan and design the power system.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">Yes</td><td colspan="3">Yes</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">Research activities will seek to realise business benefits across a range of areas including system performance, OPEX and CAPEX. Key areas have been identified in the SPARC proposal, which are being used to form the basis of a more comprehensive programme of deliverable projects.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">Varies per project</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td colspan="3">⇨</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">TBC
In development for the core projects in each workstream</td></tr>
<tr><td>Project Progress March 09</td><td colspan="11">An outline of progress made on the three existing SPARC themes of Investment Strategy, System Development and Asset Technology, complete with deliverables, is provided below:

‘Investment Strategy’ Theme
•PEDA - Enhanced the existing diagnostic system for online implementation and operation of telemetry processor; improved user interface for ease of use; identified requirement for protection settings database to underpin automated analysis of fault records; fault record analysis system design and development ongoing (A meeting SPEN and Iberdrola, in July 09, discussed a possible change in scope of the PEDA PhD project). Following departure of Gary Napier a new PhD student will be appointed to resume this work in September ’09.

•Network Control Point Alarm Processor
The telemetry processor was adapted for the processing of Network Control Point alarms (conducted in association with John Kirkwood of SPEN). A prototype was demonstrated to SPEN in August ’08. Further SPEN input is required to define additional rules and any potential for additional functionality.

‘System Development’ Theme
•Distributed Generation Penetration Study – A report was produced on the estimated growth of different types of distributed generation (at EHV, HV and micro) from a</td></tr>
</table>

	baseline in 2010 to 2015 on an annual basis, based on Supergen Future Networks Scenarios. This approach was presented (i.e. presentation entitled “An Approach to Estimating DG Penetration”) at SPEN’s Stakeholder Price Control Workshop in August 2008. **•Optimal Distribution Network Architectures** Development of network design criteria and methodologies to maximise DG contribution and permit resolution of conflicts between maximisation of DG output, maximisation of reliability and minimisation of network losses while respecting fault level constraints A literature review was conducted and heuristic methods of loss minimisation and network optimisation were investigated. Initial testing of an algorithm on rudimentary network design was conducted. A one month placement has been arranged for August 2009 where the PhD student will develop a complex 11kV network model forming the basis for future algorithm development and testing, while also gaining an appreciation of the user requirements of the network optimisation algorithm developed for network design, planning and operation. **‘Asset Technology’ Theme** •PD Diagnostics in MV Cables – A literature review was conducted. A high frequency model of the CT was developed and the subsequent effect of PD signal on CT core material analysed using the developed model. A Remote Partial Discharge Mapping Unit (RPDMS) was developed (i.e. developed filter program, PD database and GUI for client and server) and laboratory tested. A preliminary substation visit was subsequently carried out in July to assess the feasibility of acquiring PD signals from the transformer earth strap. Frequency Response Analysis of the CT is currently in progress. Three conference publications have been produced and the PhD student is currently working on a journal publication describing this research. Installation of RPDMS in a designated substation is scheduled to take place in August 2009.
Potential for achieving expected benefits	• The Investment Strategy theme has undergone a change in personnel, which has resulted in the postponement of a progress review meeting, although project meetings with SPEN staff involved with this project (i.e. Tom Cumming and Iain Watts) have been ongoing. • The System Development theme has undergone one progress review meeting, held on 2nd June ’09 with Diyar Kadar, Colin Bayfield and Carl Woodman of SPEN present. • The Asset Technology theme has undergone two progress review meetings; the first held on 13th Nov ’08 with Paul Cunningham and Jamie McWilliam of SPEN present; and the second held on14th May ’09 with Diyar Kadar and Jamie McWilliam of SPEN present. • The research programmes are currently progressing in accordance with the original project plans. There has been a change n PhD personnel associated with the PEDA work in the Investment Strategy theme. In addition, following recent discussions with SPEN and Iberdrola, it is possible that the scope of this work may change from that originally defined. A meeting scheduled for early August will confirm and detail this change in scope. It is anticipated that any change in scope requested by SPEN will remain aligned with the deliverables and timescales originally defined. • Each of the research themes have already offered tangible deliverables, offering assurance to stakeholders that the potential for achieving expected benefits is being realised within the original timescales defined for each of the three PhD projects currently ongoing. • Discussions are in progress concerning the utilisation of SPARC to support the limited research resource that currently exists within SPEN, such that more short to medium term and timely research deliverables may be achieved (out with the existing PhD arrangements). This may require additional funding. • Active and regular engagement between SPARC programme managers from both the University of Strathclyde and SP Energy Networks will continue to ensure the successful transition of research outcomes into the business.
Collaborative Partners	N/A

R&D Providers	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0618 - Supergen 1 – FlexNet</i></td></tr>
<tr><td>Description of project</td><td colspan="4">FlexNet is a four-year EPSRC funded programme that takes forward the process of preparing electricity networks for a low carbon future and builds on an initial programme of works, FutureNet that is nearing completion.

The programme recognises the interdependence of many factors in achieving change through its integration of the work of internationally recognised researchers from disciplines such as social psychology, economics, power systems analysis, power systems technology and public policy and the long-term, radical nature of the changes needed and is not dependant on any particular form of generation</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,864
External £41,374
Total £44,238</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £3,324
External £2,753
Total £6,077</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£7.6m</td><td colspan="2">Projected 08/09 costs for SPEN</td><td>Internal £5,000
External £20,000
Total £25,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">FlexNet's intention is to put in place a substantial body of work that will build on the achievements of FutureNet and lay out the major steps, technical, economic, market design, public acceptance and others, that will lead to flexible networks, including starting to showcase these so that they can be taken up by the commercial sector, Government and Regulators for practical implementation.

Some of the key issues to be addressed by the programme include:
• How can we judge the degree of flexibility needed?
• How can flexibility be achieved?
• How much flexibility should come from primary plant giving margin and how much from secondary plant giving enhanced controllability?
• What constrains or encourages flexibility, what technologies are acceptable and what economic frameworks and public policies provide flexibility at the least overall long-term cost?</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td>Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Understanding of flexible network requirements able to cost-effectively deal with a wide range of possible futures
• Develop networks that can 'think' for themselves
• Engagement with stakeholders in progressing the research ideas toward deployment
• Research that forms the basis of policy advice
• Inputs to the UK government's Energy Review, the UKERC assessment of Intermittency, evidence to select committees of parliament and submissions to OFGEM consultations.</td></tr>
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<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>→</td><td>→</td><td>→</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">Not calculated at this point - dependent on flexible network solutions arising from the programme</td></tr>
<tr><td>Project Progress March 09</td><td colspan="11">The Management Executive meets quarterly and receives detailed progress reports. Thirty PhD projects and 20 research assistants have started although slow recruitment means detailed plans have been adjusted in some cases. Good progress has been made on various forms of modelling: energy resource models, transmission system models and distribution planning models. On top of these there are now outputs to support transmission access review and the security and quality of supply standards. Generic approaches to distribution planning for high DG penetration are being advanced and new technologies such as soft normally-open points are being evaluated. Work on demand-side control has reviewed European experience and proposed operational and settlement options for the UK. Researchers on the Future Energy Mix workstream supported the LENS report with techno-economic appraisals and that work is now disseminated.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="11">The new researchers are now integrated in the consortium and working well. Industrial partners have been providing case studies and data to allow researchers to make specific assessments of technologies. The "validation and showcase" workstream is now producing detailed plans for its crucial role in promoting the benefits. Research topics within FlexNet have been identified as directly supportive of the ENSG 2020 Vision and efforts are underway to create some focused studies on this vision. Similarly, we expect benefits for future distribution network design based analysis of the evolution of demand in the electricity sector and demand side management.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="11">EPSRC, National Grid, Scottish and Southern Energy, Central Networks, EDF Energy Networks, ScottishPower Energy Networks, CE Electric UK, and Electricity North West.</td></tr>
<tr><td>R&D Providers</td><td colspan="11">Universities of Bath, Birmingham, Cambridge, Cardiff, Edinburgh, Manchester, Strathclyde and Imperial College London.</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5"><i>IFI 0619 - Advanced Cable Technologies</i></td></tr>
<tr><td>Description of project</td><td colspan="5">Advanced Cabling Technologies Programme wrapper for a discrete programme of related IFI cabling projects with a de minimus expenditure level of £40k per annum. An example project being developed under this programme is a concept to reduce excavation and reinstatement costs and improve reliability of 11kV and 33kV jointing systems.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£10,196
£12,219
£22,415</td><td>Expenditure in previous (IFI) financial years</td><td>Internal
External
Total</td><td>£3,175
£2,902
£6,077</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">c£30,000</td><td>Projected 09/10 costs for SPEN</td><td>Internal
External
Total</td><td>£0
£0
£0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The programme addresses cabling technologies and associated issues. The example project considers the following.
• Given the extensive annual cable jointing activity this project seeks to realise savings on ever-increasing excavation and reinstatement costs as well as improving the reliability of cable joints.</td></tr>
</table>

<table>
<tr><td></td><td colspan="9">Enhanced reliability will be achieved by designing out failure mechanisms and reducing the prospect of installation error.</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">No</td><td colspan="3">No</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">A range of project benefits is expected under this programme. For the example project benefits expected would include the following.
Enhanced reliability of cable joints, with reduced likelihood of jointing installation error
Smaller cable joints enabling reduced excavation and reinstatement costs and quicker jointing times</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">3 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 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">£90,726</td></tr>
<tr><td>Project Progress March 09</td><td colspan="9">Improved 11kV cable joint project has gone through test stage and is now ready for trials, the 33kV cable joint should be ready at the end of September.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="9">This project is on target</td></tr>
<tr><td>Collaborative Partners</td><td colspan="9">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="9">Bound under confidentiality</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0620 - Tower Foundation Radar</i></td></tr>
<tr><td>Description of project</td><td colspan="4">When tower line circuits have been identified for refurbishment or replacement it is necessary to make an assessment of the foundation condition. Traditional methods involve invasive excavation to expose the foundation blocks for visual inspection.
This project will trial underground structure survey technologies already utilised in the civil and geotechnical engineering industries to assess the condition of tower foundations and compare with the findings of traditional techniques.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,891
External £8,178
Total £12,069</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £2,000
External £1,144
Total £3,144</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£51,400</td><td colspan="2">Projected 09/10 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">Due to the intensive labour and time effort involved it is normal practice when excavating foundations to perform an assessment on a 10% sample of towers. The objective with this non - invasive technology is to enable all tower foundations to be examined.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>No</td><td>Yes</td><td>No</td></tr>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="10">Ability to survey all tower foundations along a route
Survey times are dramatically reduced and cheaper
Proven portable equipment, allowing easier access to sites with reduced environmental damage
Ability to make a comparison between techniques</td></tr>
<tr><td>Expected Timescale to Adoption</td><td>1 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">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">£14,220</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">Trials took place 2008 to assess the condition of 132kV tower foundations on two circuit routes - the Southport tee Formby ‘D Route’ and the Crewe – Whitfield ‘YS Route,’ using radar technology which incorporated other techniques, including:
<u>Transient Dynamic Response Technique</u> – method of assessing the integrity and/ or length of buried frustrum block foundations
<u>Linear Polarisation</u> – determines the potential for corrosion and the rate of corrosion of steel components buried below ground
<u>Ground Penetrating Radar</u> – provides detail of foundation construction
<u>Ultrasound</u> – determines the quality of concrete under test
<u>Ultrasonic</u> – provides indication of steel integrity
In order to assess the merits of this technology, several sampled digs based on the findings of the radar survey were carried out in order to provide a comparison between the results of the two techniques.

Upon completion of the project, 35 out of the 37 towers on the ‘D Route’ were surveyed using the radar technique and two were selected to have digging assessments carried out.

Five towers on the ‘YS Route’ were surveyed using the radar technique with one assessed using the digging method.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Due to the large amounts of data obtained from the radar survey, the speed at which it can be gathered and the non-difficulty in gaining wayleave access, it is considered that this technology could be of use in sampling long tower routes if a general condition assessment is required. It is strongly advised however, that if decisions such as whether to build upon existing foundations are to be clarified, that several sampled digs are used to backup the information obtained from a radar survey, due to its limitations.

This project is now closed.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">None</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Sterling Geophysical Surveys Ltd</td></tr>
</table>

Project Title	***IFI 0621 – Energy Innovation Centre***
Description of project	The CEIC will be a unique new facility designed to enable start-up companies and individuals to turn innovative ideas into commercially successful products and services for our industry. It will be a market driven organisation strategically positioned to address the critical stages of the innovation cycle between proof of concept and early production stage. By focussing on these essential stages, the CEIC is the key link between the academic type R&D we fund and the specific needs we have for innovation in the form of tangible products and services at the network operational level.

Expenditure for financial year	Internal £2,864 External £1,374 **Total** **£4,238**	Expenditure in previous (IFI) financial years	Internal £0 External £0 **Total** **£0**
Total Project Costs (Collaborative + external + SPEN)	£500k	Projected 09/10 costs for SPEN	Internal £5,000 External £150,000 **Total** **£155,000**

Technological area and / or issue addressed by project	The Energy Innovation Centre is a new concept for DNOs. Traditionally, DNOs work with Universities for R&D and established suppliers for new innovative products and services. This project actively accesses a new mainly untapped market of small businesses and individuals to provide innovative solutions which will improve the performance of the network. The purpose of the centre is to support businesses via IFI money to accelerate new technologies to market. This approach is in collaboration with 3 other DNOs and has attracted an £2.1 million of public investment into the sector. In addition further Equity Investment is being attracted into the sector to support these same businesses to progress from TRL8 to full commercialisation. To date 12 businesses have been considered for IFI investment with 3 receiving investment from Scottish Power. As the centre develops over the next 6 months the number of opportunities for Scottish Power to invest through this mechanism will increase.

Type(s) of innovation involved	Incremental Tech Transfer Significant Radical	Project Benefits Rating	Project Residual Risk	Overall Project Score
		Per project	Per project	Per project

Expected Benefits of Project	• Increased exposure to new investment opportunities. • Reduction in risk and cost of managing projects • Increased collaborative working between DNOs. • Leveraging additional investment into the sector – both public and private money. • Improved performance in network operation.

Expected Timescale to adoption	1-2 years depending on project	Duration of benefit once achieved	10-20 years

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

Project NPV	NPV is calculated on an individual project basis
Potential for achieving expected benefits	The majority of KPI's are being achieved by the centre which supports that the benefits to the DNOs will be achieved.
Project Progress 09	This is the first year of the Energy Innovation Centre's operation. During this time a lot of effort has gone into developing a collaborative approach across the DNOs and the centre and the centre developing its networks and operational framework. To date the centre has 40 leads, DNOs have considered 12 businesses and achieved investment in 6. This is set to increase as the centre launches its marketing strategy to attract ideas and market potential technology gaps identified by the DNOs.
Collaborative Partners	Electricity North West, Scottish & Southern Energy, CE Electric, North West Development Agency, EATL
R&D Provider	Various

Project Title	***IFI 0624** - **Impact of Climate Change, Energy (Phase 2) - MET Office***			
Description of project	The Impact of Climate Change (IPCC) on the UK Energy Industry, is a year long research project sponsored by the majority of the UK energy Utilities and facilitated by the Met Office. Climate change and the impact on our environment is a major issue facing the world today. The latest findings from latest research confirm that global mean temperature continues to rise and 'almost certainly' attributable to man's activities in burning fossil fuels. Regional changes in temperature and precipitation patterns, wind and wave activity, and floods and storms have the potential to profoundly affect society. The project aims to provide practical guidance on the application of climate change scenarios to energy industry processes. It will look to make recommendations to the participating companies on how best to asses the impacts of climate change on the planning and operation of the supply industry. It will investigate the need for transmission and distribution systems to adopt new standards. How will climate change affect the risk of infrastructure damage; and, will the rating of lines, cables and transformers be affected? The networks' proportion of the project was funded through the Innovation Funding Incentive, as is covered in this summary report.			
Expenditure for financial year	Internal £5,042 External £1,745 **Total £6,787**	Expenditure in previous (IFI) financial years	Internal £4,855 External £45,819 **Total £50,674**	
Project Cost (Collaborative + external + SPEN)	**£450,000**	Projected 09/10 costs for SPEN	Internal £0 External £0 **Total £0**	
Technological area and / or issue addressed by project	The electricity infrastructure being installed today has as design life of c.40years, meaning that most of the network assets installed in 2005-2010 will still be in place in 2050. Changes in global climate are expected to occur over this timeframe, which are likely to have a direct impact on the operating conditions of the electricity network. • Understand the potential impact of climate change to network assets will ensure the network built today is fit for purpose into the future. • Create methodology for prediction of gas and electricity demand using climate models (dealing with limitations in spatial and temporal resolution). • Assess the importance of temporal resolution to the calculation of energy demand. • Investigate the differences of modelling demand using: climate model output, new climate model diagnostics, and weather generated output.			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	Yes	No	No
Expected Benefits of Project	The expected benefits of project are: • Probabilistic understanding of likely future electricity and gas demand • Model for projecting meteorologically driven demand suitable for inclusion in climate model or for application to climate model output • Demand from 'Energy' climate model simulation • Reporting of the affect of temporal and spatial resolution on the demand calculation, and recommendations for projecting demand from UKCIP08 when available • Recommendations for improvements in demand modelling approach if necessary. Investment decisions for energy networks – expected impacts of climate change, such as land surface modelling and urban heat island effects on network assets can be taken into account when making future investments.			

<table>
<tr><td rowspan="1">Expected Timescale to adoption</td><td>1 Year</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">50 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="5">Not Calculated</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">This project has:
• Developed innovative new techniques that apply climate models to energy applications so that the industry is better placed to adapt to climate change.
• Investigated future wind resource, enabling the industry to understand the continued uncertainty of future wind power. This will assist risk management and investment decisions.
• Modelled future soil conditions and their impact on cables so that Companies can understand the cost and benefits of installing cables for a more resilient future network.
• Built a tool to enable UK coastal and marine sites of interest to be screened to assess if sea level rise should be considered in more detail.
• Investigated how the urban heat island effect may change in the future so that Networks can develop plans for their infrastructure in cities.
• Produced guidance to help make best use of public domain information on climate change such as the United Kingdom Climate Impacts Programme new scenarios of climate change (UKCIP08).
• UKCIP08 will enhance regional detail and will be available in November 2008.
• Delivered new site-specific climatologies of temperature, wind speed and solar radiation that account for climate change so that decisions can be based on realistic climate expectations.
• Examined the relationship between historic weather patterns and network fault performance with a view to developing a tool to predict future network resilience.
The project has found that because of climate change:
• With a few exceptions, such as the thermal ratings of equipment and apparatus, there is currently no evidence to support adjusting network design standards. For example existing design standards for overhead line conductors do not require change.
• The risk profile for transformers will be affected. Design thresholds of temperature will be exceeded more often and there will be more hot nights in cities.
• Soil conditions will change; higher temperatures and seasonal differences in soil moisture are expected. Future conditions could be included in cable rating studies by increasing average summer soil temperatures in the models by approximately 0.5°C per decade.
• The output of thermal power stations (and in particular Combined Cycle Gas Turbines) could be suppressed with higher air temperature meaning lower air density and, in turn, lower mass flow. Conditions at each location should be considered, especially during re-design or new build and, if appropriate, adaptation planned.
• Historical climatologies are no longer valid because climate is not stationary. The new climatologies that take account of climate change are already being adopted and will improve demand forecasting and planning out to 10 years ahead.
• Wind resource is uncertain and understanding future resource represents a significant challenge. Although we don't yet have the answers, this project has highlighted possible strategies for improving our knowledge</td></tr>
</table>

Potential for achieving expected benefits	In order for the momentum of this project to be retained an energy and climate change industry group will be set up. This group will continue to share the latest science and its application to business. This would meet as necessary to discuss latest innovations and developments in climate science with leading experts. The group would share thoughts and ideas on areas of common interest as Companies work to adapt to climate change.
Collaborative Partners	**Networks Only:** C.E. Electric, National Grid, Electricity North West, Western Power Distribution **Networks, Generation & Supply:** E.ON, EDF Energy, Northern Ireland Electricity, Scottish & Southern Energy, ScottishPower **Generation & Supply Only:** Centrica, RWE, npower
R&D Providers	Met Office

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0625 - Vegetation Management - ADAS</i></td></tr>
<tr><td>Description of project</td><td colspan="4">Vegetation management in the vicinity of overhead lines represents a significant maintenance requirement and associated budget spend. While there is an on-going commitment to this issue, it is recognised that a better understanding of vegetation growth rates would greatly assist in vegetation management strategies and decision making; helping direct the focus of activity.

The project will seek to develop a software model that will analyse the relationships between key environmental variables (including the potential impact of climate change) and vegetation growth rate, for different vegetation types. The model will be used to consider the costs and benefits of undertaking vegetation management to different specifications.

Following tree cutting at selected sites the model will be validated against the first year of growth data, which will be determined by laser measurement. The model will subsequently be optimised based on annual growth rates determined over a further three-year period.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £4,250
External £100,374
Total £104,624</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £3,171
External £132,758
Total £135,929</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£1,744,000</td><td>Projected 09/10 costs for SPEN</td><td>Internal £8,000
External £41,000
Total £49,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">• This project is a UK wide study into the differing growth rates experienced in the 26 “bio-climatic” zones that are found across the country.
• It will involve cuts made to 2000 sample areas across the identified zones to a common specification, followed by monitoring to confirm growth.
• The output is expected to lead to modelling software that can portray different cut cycles.
• The common UK project should provide further evidence / justification in future Price Control Reviews.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• The model developed will identify areas that will require more frequent tree cutting to maintain safe clearance distances and meet legal requirements.
• Evidence-based decisions on the frequency and location of tree cutting will enhance network resilience and therefore improve security of supply and associated regulatory performance (CI and CML savings).
• Improved targeting of OPEX may be realised through proactive cutting and</td></tr>
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<tr><td></td><td colspan="10">extending the cutting cycle in high and low growth areas respectively.</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">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">£681.3k</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">All sites in SPM and SPD have been cut and measured with results being passed back to ADAS</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">ADAS are now processing the results from the first years monitoring in detail. This is providing some significant insights into growth rates across the bioclimatic zones and the potential impacts of climate change.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Electricity North West, Scottish and Southern Energy, Central Networks and National Grid.</td></tr>
<tr><td>R&D Providers</td><td colspan="10">ADAS</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="3"><i>IFI 0628 - Asset Decision Support Dashboard</i></td></tr>
<tr><td>Description of project</td><td colspan="3">Leading owners and operators of high value assets are moving rapidly towards centralised decisions around compliance, asset availability, performance and cost. They are bringing together information from disparate sources and platforms (concept of data fusion) into a single composite picture of the environment in order to make informed short, medium and long-term decisions on their asset base.

The desire to move from an ‘investigative’ use of data towards a ‘predictive’ use of data will identify opportunities for better use of asset data by considering tools, techniques and approaches applied in other markets with the development of a prototype Asset Decision Support Dashboard.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £7,170
External £47,652
Total £54,822</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £6,392
External £42,092
Total £48,484</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£98,391</td><td>Projected 08/09 costs for SPEN</td><td>Internal £15000
External £80000
Total £95000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The use of potentially untapped high value data that could be utilised for ‘predictive’ decision-making. A three-phase programme has been identified to fully address SPEN’s requirements.
• Phase 1 proves the concept with ScottishPower’s existing Asset Inspection System (AIS) database. Prior to considering subsequent phases a project closeout review will be undertaken to ensure that outcomes meet business needs and make recommendations as to the best way forward.
• Phase 2 applies to further AIS information and other databases to provide asset performance history and trending.
• Phase 3 includes the addition of SCADA outputs to produce a health-monitoring dashboard of alerts. Future diagnostics and prognostic systems as a learning system would also be considered.</td></tr>
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<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">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="11">The main business benefit will be to enable better asset decision-making based on key information extracted from AIS and displayed and trended, by traffic light status, in a prototype Asset Decision Support Dashboard web-enabled risk portal.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</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 colspan="2" 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="5">£163,235 (based on all 3 phases being developed)</td></tr>
<tr><td>Project Progress March 09</td><td colspan="11">• Project complete and closed
• Asset Decision Support Dashboard developed by DS&S and presented to SPEN Investment Strategy staff.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="11">Progress to phase 2 to be discussed in Q3 of 2009.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="11">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="11">Data Systems & Solutions (DS&S)</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5">***IFI 0701 - ENA IFI Projects***</td></tr>
<tr><td>Description of project</td><td colspan="5">Several small value projects are under development with a number of external parties, managed on behalf of the Network Operators through the Energy Networks Association (ENA)</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£2,864</td><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td>£7,560</td></tr>
<tr><td>External</td><td>£3,842</td><td>External</td><td>£6,554</td></tr>
<tr><td>**Total**</td><td>**£6,706**</td><td>**Total**</td><td>**£14,114**</td></tr>
<tr><td rowspan="3">Project Cost (Collaborative + external + SPEN)</td><td colspan="2" rowspan="3">c£30,000</td><td rowspan="3">Projected 08/09 costs for SPEN</td><td>Internal</td><td>£1,500</td></tr>
<tr><td>External</td><td>£2,000</td></tr>
<tr><td>**Total**</td><td>**£3,500**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The projects undertaken through budget year 2006/7 addressed real problems that had been identified by the ENA Working Groups as significant and which required technical investigation and development.
• **SG14 Earthing Project** – 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.
• **Cable Harmonic Impedance Modelling** - The report covers the detailed modelling of cable and overhead line components. Particular attention is paid to cable models appropriate for distribution networks, as this is was the initial objective of the project and literature on modelling of cables is not as widespread as that for other items of equipment
• **LoM** - To carry out testing on a range of LoM relays in order to develop a clear understanding of the stability of these relays when confronted by a range of network disturbances applied at a range of relay settings. This information will be used to develop a matrix of optimum settings and test procedures for relay specification.</td></tr>
</table>

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

Expected Benefits of Project	• **SG14 Earthing Project** – This project will investigate the effects of LV earth systems on HV systems. The results of this should determine the means to provide cost effective, safe earthing system without the need for expensive separations between HV and LV electrodes which in a PME system may be impractical and costly to achieve and maintain. • **Cable Harmonic Impedance Modelling** - The study objective is the development of an ETR type guidance note to supplement G5/4 (2001) and help reduce and simplify modelling requirements for relatively small capacity 33kV and 11kV connections • **LoM** - An improved understanding of LoM relays. Use of more effective settings resulting in a reduced number of unwanted generator trips due to system disturbances. More effective use of LoM relays (e.g. as interface protection) resulting in reduced installation costs

Expected Timescale to adoption	1 - 10 Years	Duration of benefit once achieved	10 – 40 Years

Probability of Success	25 - 75%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
			▬	▬	▬	▬	➤			

Project NPV	(Present Benefits x Probability of Success) – Present Costs	£255,876 **Note** – Project costs include implementation and have been calculated by the ENA assuming a typical distribution license area.

Project Progress March 09	**SG14 Earthing Project** - During the first four phases of the project (as per IFI 2007-2008) the project team were able to confirm by calculation and measurement (including analysis at two live substations) that the LV electrode system interacts with the external potentials created by a close, but electrically separated HV installation. The findings are completely new and help to explain why there is so little evidence of damage to LV equipment when there is an HV earth fault on equipment quite close by. It was possible to quite closely match the theoretical and measured results at the two live test substations but they were each considerably ore complicated that the vast majority of installations in terms of their earthing requirements. **Cable Harmonic Impedance Modelling** - An interim report has been issued following the first section of work on the cable modelling which addresses the technical cable modelling issues on the original project brief. The extension to the brief to stage 2.5 as it is called is the focus of the final report which is taking the time and will not be available until the meeting of the working group on the 9th of July 2009. **LoM** - The final report has been published and will be presented as an ENA Technical Report.
Potential for achieving expected benefits	**SG14 Earthing Project -** High. The results from tests and simulations can be used to propose a recommended procedure for measuring transfer potential between HV and LV systems, suitable for inclusion in a DNO policy document. **Cable Harmonic Impedance Modelling** - The frequency dependent behaviour of overhead lines and cables was assessed. A sensitivity analysis has shown that simplified models and power frequency models may be used to represent the harmonic behaviour of a single core conductor overhead line and cable with a reasonable degree of accuracy over the frequency range assessed. **LoM** - The final report provides the basis for new settings guidelines which should enable the majority of perceived benefits to be achieved.
Collaborative Partners	UK Distribution Network Operators (DNOs)
R&D Providers	**SG17 Lightning Protection** – External Consultant **SG14 Earthing Project** – Strategy & Solutions

Project Title	***IFI 0702 - Lattice Steel Tower Protective Coatings***
Description of project	The development of a prototype single coat epoxy protective coating for lattice steel towers to replace the two coat alkyd paint currently in use. In 2000 ScottishPower developed and introduced a single coat epoxy coating for lattice towers. However, without the use of appropriate protective clothing and barrier creams there was a small risk of becoming sensitised to the irritants in the paint. Once the applicator becomes sensitised it is unlikely that they will be able to tolerate using epoxy paints in the future. In conjunction with the Epoxy paint manufacturer this project will explore the removal of irritants in the paint system without reducing the protective properties of the coating. Once a prototype has been accepted trials would be undertaken in an acceleration chamber in parallel with field trail application.

Expenditure for financial year	Internal	£4,458	Expenditure in previous (IFI) financial years	Internal	£2,043
	External	£21,572		External	£26,220
	Total	**£26,030**		**Internal**	**£28,263**
Project Cost (Collaborative + external + SPEN)	£60,000		Projected 08/09 costs for SPEN	Internal	£4,000
				External	£33,500
				Total	**£39,500**

Technological area and / or issue addressed by project	Pending changes in EEC legislation (anticipated date 2010) will prohibit the two coat alkyd paint system used in current practise consequently there is a need to use a safe alternative system.

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

Expected Benefits of Project	The main business benefit of a safe one coat epoxy paint system will be as follows: Reduced exposure to falls during tower access/egress Reduced exposure to falls as painters and inspectors spend less time working at heights Application costs are anticipated to be 25% for the same degree of protection Outage duration times are expected to be reduced by 33%. More towers can be painted during outage window

Expected Timescale to adoption	April 2009	Duration of benefit once achieved	Unlimited

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	£1.6m

Project Progress March 09	• EATL testing is now complete with one of the 4 new paint systems being chosen. • Stage one is now complete with a trial tower on the ZV route being painted • Currently awaiting test report regarding effects on painters during trial tower painting
Potential for achieving expected benefits	On track for completion of 2nd trial which will be the complete painting of route to be to finish August 2009
Collaborative Partners	N/A
R&D Providers	Chemco International

Project Title	***IFI 0704 - 4energy Low Carbon Comms Cooling***
Description of project	Telecom rooms in major grid points on the transmission network contain sensitive electronic equipment e.g. Cisco routers. Recent installations have shown this equipment to be sensitive to temperatures above 40°C. This project will develop, test and install innovative low carbon solutions to cool

<table>
<tr><td></td><td colspan="9">telecom equipment and telecom rooms without the need for air conditioning. Directed airflows, filter-less centrifugal fans and the improvement of mass flow rates through the RFI cabinets will form the technical innovation required. This is understood to be the first such energy saving initiative using these technologies in equipment rooms and will avoid over 50% of the costs noted above.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £4,507
External £17,436
Total £21,942</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £3,567
External £52,406
Total £55,973</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">£62,500</td><td colspan="2">Projected 08/09 costs for SPEN</td><td colspan="4">Internal £4,000
External £21,000
Total £25,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">Currently 10 out of 19 sites utilise traditional air-conditioning.
It is proposed to trial 4energy's cabinet cooling solution in all our 19 existing sites.
The whole room cooling solution is to be trialled on 3 sites, if successful could be deployed into all 130-transmission 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">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">Operational Telecoms equipment needs to be available at all times, specifically avoiding any unplanned downtime because of thermal issues.

The implications of this thermal stress are two fold:
• Telecommunications with grid sites may be compromised if no solutions are installed.
• The installation of expensive building services air conditioning is being specified as the cooling solution with ~2MW of power each year - equivalent to a carbon footprint of almost 1000 tonnes of CO^2 per year.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</td><td colspan="2">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="4">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5"><u>£905,595</u>
based on comms room cooling only</td></tr>
<tr><td>Project Progress March 09</td><td colspan="9">Cooling alternatives to vapour compression air conditioning
Without the RFI Cool system the use of air conditioning in summer is unavoidable in telecoms rooms in order to keep Cisco cabinets below 40°C. However, the 8-10°C reduction from ‘RFI cool’ means that the room temperature can be safely elevated up to 35°C without any harmful effects on the equipment. This opens up the opportunity to use the Directed Air solution developed under this IFI project which guarantees temperatures will remain under 40°C in the Cisco cabinets under Glasgow climatic conditions.

Following the installation of the Directed Air systems with ‘no maintenance’ filtration the telecom rooms have been held at ambient around 7-10°C hotter than outside environmental temperature which ensures that the Cisco cabinets will be maintained at less than 40°C.</td></tr>
</table>

Potential for achieving expected benefits	The proposal is to install energy efficiency cooling in telecommunication rooms in major grid sites in which Cisco servers are being located. This initiative will deliver a saving of 20% on the capital cost of installing traditional vapour compression air conditioning. Once installed a greater than 90% saving versus estimated air conditioning power savings will be made in those telecommunication rooms. Strategic telecoms are looking to install units in a further 10 sites in SPT before the end of 2008.
Collaborative Partners	N/A
R&D Providers	4Energy

<table>
<tr><td>Project Title</td><td colspan="6"><i>IFI 0706 - Ashton Hayes Microgrid</i></td></tr>
<tr><td>Description of project</td><td colspan="6">Ashton Hayes, a village near Tarvin in mid Cheshire, is aiming to become carbon neutral (http://www.goingcarbonneutral.co.uk/). The village is pursuing a number of different carbon saving initiatives including small-scale generation. A number of community buildings are close together; namely the church, Women's Institute's (WI) hall, village hall and school have expressed a wish to use LV connected generation (microwind, PV and dCHP).</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£5,146
£44,874
£50,019</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal
External
Total</td><td>£2,819
£1,758
£4,577</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£56,500</td><td colspan="2">Projected 09/10 costs for SPEN</td><td>Internal
External
Total</td><td>£0
£0
£0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">The proposed project aims to develop a route map of the integration of small-scale generation into legacy networks.
It is envisaged that this will develop a simple strategy that can be used by the SP Energy Networks' Connections business to determine at which points different network technologies should be introduced to facilitate the connection of generation. Although developed using this network as a case study, the project will look to develop common, simple solutions.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td>Significant</td><td colspan="2">Technological substitution</td><td>Radical</td></tr>
<tr><td colspan="2">No</td><td>No</td><td colspan="2">Yes</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">The impact on adjacent parts of the network and the implications of legacy equipment will be taken into account.
In the case of Ashton Hayes the most appropriate technology will be identified, which allows more generation to be connected but that is flexible to future changes to the network but also is as simple as possible. The work will aim to be relatively high level and be as generic as possible to enable its conclusions to act as a guide for other possible applications rather than being specific to the Ashton Hayes network. As well as selecting an appropriate solution, the work should give a hierarchy of potential problems and solutions to be used across the network.
The effect of the use of various combinations of technology on the Quality of Supply, P28, P2/6 will be estimated and an evaluation of how the technologies fit with the DG incentive mechanism will be made.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">20 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="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£7,549</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">A report was produced by EATL that surveys literature and projects regarding small-scale generation. It then outlines the network issues and the relevant standards and policies for the LV network. Potential solutions and the additional benefits are identified. Models of a rural and urban network are used to establish the level of generation that will cause problems for the LV network and the frequency and severity of the problems. Conclusions and recommendations have been drawn from the work.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The recommendations should indicate the actions ScottishPower may need to take to accommodate increasing levels of connection of generation to the LV network and the potential to develop a more active LV network.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Ashton Hayes village</td></tr>
<tr><td>R&D Providers</td><td colspan="10">EA Technology</td></tr>
</table>

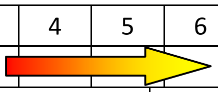
<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0707 - Wind Turbine Effects on Transmission Lines</i></td></tr>
<tr><td>Description of project</td><td colspan="4">The scope of the project is to determine the magnitude of the problem from constant speed and or variable speed wind generators through research / investigation on the effects of the wind pattern (down wind of wind turbines) on the structure and spans of adjacent overhead line.

Modern wind turbines can be as large as 80m diameter (for 1MW+). Behind the turbine, the mean wind speed/pressure can be reduced, and turbulence severely increased. The reduced pressure of the new wind pattern created by the rotating blades is considered likely to affect a structure / overhead line in the vicinity of wind turbines.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £17,533
External £22,615
Total £40,148</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £1,928
External £6,158
Total £8,086</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£70,000</td><td>Projected 08/09 costs for SPEN</td><td colspan="2">Internal £7,000
External £55,000
Total £62,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The Scottish Renewable Obligation (SRO) capped windfarm development at 15MW per site, which consequently required 33kV connection. Posts SRO a number of large scale developments are now being pursued that require transmission connections. With more transmission connected windfarms being developed and the standard turbine size increasing there is a need to understand the potential impact on adjacent tower structures and conductor spans.</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">Through a better understanding of turbine wake effects mitigating measures can be factored into windfarm connection design in order to maintain the integrity of the local transmission supply, therefore avoiding unforeseen outages and decreased network reliability.</td></tr>
</table>

<table>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2">→</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">£835,466</td></tr>
<tr><td>Project Progress March 09</td><td colspan="10">The report covers Stage 2 of an investigation into the wake effects of wind turbines on nearby overhead lines. A programme of work has been agreed with Scottish Power to investigate this phenomenon and specifically to look at one project associated with the existing ZS OHL Smeaton to Torness 400kV line at Crystal Rig which uses L12 towers and is planned to have several 3MW turbines positioned at 135m from this line. An initial report investigated the wake effect phenomenon through a literature survey and expert guidance world-wide. This led to the production of a programme for Stage 2 which uses a wind tunnel to investigate the wave eddy and wind speed reduction phenomena of a wind turbine over a range of wind speeds and modes of operation and orientation. The tests were carried out at Milan Polytechnic which has a world standard wind tunnels test facility. The scale of the wind turbine model used in the tests is 1:50, based on a Vesta V90-3.0MW turbine. Experiments were carried out using both smooth and turbulent flow to simulate the wind farm environment. Flow patterns at various distances from the turbine and different wind velocities were carried out. Visualisation techniques using fog and helium bubbles were also employed. Tests were performed on the aero-elastic response a 1:50 model of a simulated OHL conductor (Araucaria), reproducing the dynamic characteristics for a 400 m long span. The motion of the cable was measured in 5 points along the line using infrared cameras. The report will present the results of all the above mentioned activities in the following order:

1) Anemometric measurements in the wake of the wind turbine
2) Flow visualizations
3) OHL aero-elastic response</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The wind tunnel data suggests that conductor oscillations could occur on all phase conductors at 2.5D from the turbine. Contact with relevant experts world-wide via Cigré contacts indicated that there were concerns in other countries including Austria, Sweden, the USA and Canada. It is therefore recommended that:
Field tests be carried out at sub-span dampers using Sefag low frequency monitors
These tests be carried out on all phases
Tests also be carried out on the earth wire using a standard Sefag vibration monitor
These tests to be carried out if possible before and after installation of a wind turbine close to and upwind of the line
Future work should be carried out in cooperation with National Grid and the UK DNO’s through the EA Technology STP programme.
In the meantime no wind turbines should be built closer than 3.5D to an OH tower line.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Milan Polytechnic and Hydro Quebec</td></tr>
</table>

Project Title	***IFI 0708 - Health Indices for Asset Management Decision Making***

<table>
<tr><td>Description of project</td><td colspan="4">EA Technology has developed a Condition Based Risk Management (CBRM) process to link engineering knowledge and practical experience to investment planning.
CBRM defines the current condition of individual assets by a numeric ‘health index’. This health index is ‘calibrated’ against the probability of failure (POF). An ageing algorithm is applied that enables the future condition and POF to be estimated. The risk for an individual asset is the product of the POF, the average consequence of failure for the asset group and the criticality of the asset. Consequences of failure relate to the following four essential categories, which are related to the common unit of money:
• Network Performance (CMI & CI), Safety, Financial and Environmental
• Criticality is expressed as a multiplication factor and is the importance or significance of an individual asset relative to other assets in the group.
• The impact on asset health and subsequent risk can be determined for different investment intervention strategies.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 13,069
External £ 45,374
Total £ 58,442</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £ 1,609
External £ 1,758
Total £ 3,367</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SPEN)</td><td>£ 50,000</td><td>Projected 09/10 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">SPEN is looking to build on the quantitative techniques used for prioritising investment (asset criticality).
EA Technology’s work has been adopted by other DNOs consequently, there is a business requirement to at least understand the effectiveness of this technique either with a view of adopting in support of elements for DPCR5 submissions.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental
Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>12</td><td>-2</td><td>14</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Visual representation of asset condition in a consistent and coherent format for presentation at Executive level and to Ofgem.
• Ability to define and defend spending requirements
• Ability to advance age assets to help determine possible future condition, performance and risk
• Assess impact of different investment intervention strategies and ‘do nothing’ option
• A quantification, risk based approach to CAPEX investment with a clear audit trail</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td>Duration of benefit once achieved</td><td colspan="2">5 Years</td></tr>
<tr><td>Probability of Success</td><td>50%</td><td colspan="3">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
</td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">To be considered pending outcome of trial.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">As part of SPEN’s strategic improvement policy, experience gained from this project in health indices and asset health will be used in future asset management processes.</td></tr>
</table>

Project Progress **March 09**	The 'CBRM' process, developed by EA Technology in conjunction with electricity companies over the past 8 years, has been applied to two asset groups (11kV ground mounted CBs and 132kV OHLs). A CBRM report has been produced and CBRM spreadsheets defining a health index for individual assets have been produced for both asset groups.
Collaborative Partners	N/A
R&D Provider	EA Technology Limited

<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0709 - Sub.net Monitoring</i></td></tr>
<tr><td>Description of project</td><td colspan="4">Sub.net is a substation based multifunction disturbance recorder, which monitors various aspects of the power network. It is connected to protection VTs and CTs and auxiliary contacts from protection relays and switchgear. Sub.net process the information at site and sends formatted reports of events detected on the network directly to individual users by email.
It is possible to capture an event and distribute the processed data in around three minutes to the parties that can take the appropriate action. Monitors should be able to aid early indication of 11kV fault location, confirm that overhead line protection or automation schemes are functioning properly and determine if circuit breaker operating times are within acceptable limits, in addition to covering the full range of Power Quality phenomenon.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 7,189
External £ 25,049
Total £ 32,238</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £ 72,920
External £ 1,609
Total £ 74,529</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SPEN)</td><td colspan="2">£ 130,000</td><td>Projected 08/09 costs for SPEN</td><td>Internal £ 26,000
External £ 27,000
Total £ 53,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">There is a continuing business need to improve system performance. By processing data in as near real time as possible and disseminating necessary information to the appropriate staff, corrective action can be taken in the most expedient manner.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>-1</td><td>14</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The project aims to offer improvements in system operation, performance and safety:
• Reductions in CML and consequent penalty savings will be achieved by timely fault location and appropriate restoration
• Monitoring of protection systems ensure that protection settings are optimised and voltage dip durations are minimised
• Safety and performance improvements realised by monitoring operating times of circuit breakers and substation battery supplies
• Down stream fault clearance times and circuit breaker operating times would be sent direct to protection and maintenance engineers respectively in thus reduce CML and CI by prevention
• Web Access negates the requirement for a base station to dial in/out and offers roving accessibility. No polling and central processing requirements</td></tr>
</table>

<table>
<tr><td>Expected Timescale to adoption</td><td>1 Year</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">70%</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">No NPV calculated for this limited trial</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Currently developing in-house automatic impedance mapping to identify fault location quicker</td></tr>
<tr><td>Project Progress March 2008</td><td colspan="10">• All units have now been installed, with embedded impedance maps within the sub.net unit to calculate distance to fault installed
• Trip oil timing – If trip or close time is out with limits for particular circuit breaker, automatic emails are sent to maintenance to highlight possible problems.
• There have been some issues with firmware and communications but these are well on the way to being resolved.
• We have been able to identify transient faults and remedy the problem and also found slow or ‘sticky’ breakers before they develop into problems</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">None</td></tr>
<tr><td>R&D Provider</td><td colspan="10">Embedded Monitoring Systems (eMS).</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="6"><i>IFI 0710 - GB SQSS Review Studies</i></td></tr>
<tr><td>Description of project</td><td colspan="6">The three GB transmission licensees have been involved in research work to look at how the Main Interconnected Transmission System (MITS) planning rules in Section 4 of the GB Security and Quality of Supply Standards (GB SQSS) should be adapted or changed to make provision for the increasing volume of wind generation connected to the network.

The aim of Phase 1 of this project is to carry out further studies to ensure that the proposed planning method is robust. Also, further work in Phase 2 is to be carried out to consider the implications of the rule on generation market access and facilitation of competition in this market.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£ 3,502
£ 10,707
£ 14,208</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal
External
Total</td><td>£ 1,609
£ 9,482
£ 11,091</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SPEN)</td><td colspan="2">£ 60,000</td><td colspan="2">Projected 09/10 costs for SPEN</td><td>Internal
External
Total</td><td>£ 4,000
£ 18,000
£ 22,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">At this stage it is very important to test the proposed planning rule thoroughly, as it could have a considerable impact on the level of transmission capital expenditure by the transmission licensees if it is adopted for the GB SQSS.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2" colspan="2">Incremental / Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>11</td><td>-7</td><td colspan="2">18</td></tr>
</table>

Expected Benefits of Project	• The project will develop a common, well tested, set of rules based on a number of generation/demand scenarios that will be adopted by the collaboration partners to ensure a consistent approach between the three transmission licence areas. • The new MITS planning rules will help to defend investment decisions in future Transmission Price Control Reviews • The role and impact of wind generation on the transmission network will be better understood, with all generation treated on an equal basis.

Expected Timescale to adoption	2 Years	Duration of benefit once achieved	10 Years

		TRL Development (Start – Current)								
Probability of Success	60%	1	2	3	4	5	6	7	8	9
							→	→		

Project NPV	(Present Benefits x Probability of Success) – Present Costs	No NPV as unable to quantify analysis outcomes.

Potential for achieving expected benefits	Despite the project being in a very advanced stage, it was decided to conduct a more fundamental review of the SQSS. A new MITS working group was set up and work continues, using the results achieved so far as a basis.
Project Progress **March 2009**	The new MITS working group is now developing cost-benefit models that consider transmission investment cost (T), operational costs (O) and the cost of unprovided energy (X) over a number of years (T+O+X model). This model will provide information, not only on the treatment of wind, but also on other SQSS aspects such as the use of appropriate contingencies in planning studies. The development of the TOX model is in an advanced stage and testing continues.
Collaborative Partners	National Grid Electricity Transmission plc and Scottish Hydro Electric Transmission Limited.
R&D Provider	TNEI Services Ltd, Strathclyde University, Imperial College (SEDG)

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	£ 4,074	Expenditure in previous (IFI) financial years	Internal	£ 1,609
	External	£ 4,458		External	£ 26,058
	Total	**£ 8,532**		Total	**£ 27,667**

<table>
<tr><td>Total Project Costs (Collaborative + external + [company])</td><td colspan="2">£62,000 (National Grid contribution £31,000)</td><td>Projected [next year] costs for [company]</td><td>Internal £ 2,000
External £ 29,000
Total £ 31,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">e.g. Incremental
Tech Transfer
Significant
Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>7</td><td>-3</td><td>10</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</td><td>Duration of benefit once achieved</td><td>4 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">75%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 15,562</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">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>Project Progress March 09</td><td colspan="4">First stage of this project is completed and demonstrator software was developed for determining hot zones within substations taking into account parameters such as grid size, mesh density, earth resistivity and body resistance.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">National Grid</td></tr>
<tr><td>R&D Provider</td><td colspan="4">Cardiff University High Voltage Energy Systems research group (Manu Haddad & Huw Griffith).</td></tr>
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<table>
<tr><td>Project Title</td><td colspan="4"><i>IFI 0712 - BT 21st Century Protection Solutions (BT21CN)</i></td></tr>
<tr><td>Description of project</td><td colspan="4">The change of BT’s network to an IP based system (BT21CN) is posing some significant risks to the performance reliability of the SP-M and SP-D electricity networks. In particular SP-M relies heavily on 3rd Party leased services from BT as the communications for the 33kV network protection in rural areas. The strategy to mitigate the problem has been developed based on the utilisation of a range of communications solutions (fibre, radio, power line carrier in addition to technically/commercially suitable BT services) in a coordinated manner. Whilst this strategy has been agreed in principle, there are several technical challenges associated with several of the solutions.
This project aims to provide the detailed and engineered communications channels that underpin the toolbox of solutions to mitigate the problems associated with BT21CN.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 30,531
External £ 69,031
Total £ 99,562</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £ 1,609
External £ 1,758
Total £ 3,367</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SPEN)</td><td>£114,000</td><td>Projected 08/09 costs for SPEN</td><td colspan="2">Internal £ 15,000
External £ 43,000
Total £ 58,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">This project aims to access the feasibility of using alternative communications solutions to mitigate the problems associated with BT21CN. Scope currently under consideration includes:
• Power Line Carrier deployment at 33kV combining protection and SCADA signalling
• Small development works to facilitate intra-substation communications
• IP based protection signalling mediums and associated security implications
• Options for alternative communication channels for shared services
• Implications for the network in no cost effective solutions are realised</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant / Technology Transfer</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>21</td><td>2</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">There are many sites in SP-M where there is no Line-of-Site for radio communications and fibre installations are extremely expensive due to excessive circuit lengths. In such sites Power Line Carrier (PLC) or Leased services are the only feasible communication medium for protection signalling. PLC is typically deployed at higher voltage levels, additionally some development work facilitated in a trial would be required to accommodate protection and SCADA data on the same link however this could deliver a more cost effective alternative to fibre or BT SDH leased services. Power Line Carrier although a viable solution has some limitations, which restrict its use on the network, mainly mid-circuit transitions (OHL – Cable), which cause the signals to reflect. Where PLC cannot be deployed alternative will require consideration.

Leased services (or no communications at all) are the only alternatives to expensive infrastructure at some sites. SDH services can be expensive in terms or both CAPEX and OPEX. BT are likely to offer IP based products in the future (products not currently used with protection). If development is carried out to facilitate the use of IP based products for signalling purposes factoring in security considerations then it may be possible to leases services at significantly reduced CAPEX and OPEX costs.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1.5 Year</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" 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 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="4">£951,763</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="11">In areas of the network where protection signalling cannot be delivered via channels currently considered for use with protection devices without significant expense, leased communications are the only option. Should a suitable leased or alternative communication bearer be unavailable then significant investments in fibre optic installation will be required.</td></tr>
<tr><td>Project Progress March 2008</td><td colspan="11">• Inter-substation communications equipment between legacy protection equipment and new equipment achieved with the aid of sub-rate MUX used developed to SP requirements.
• The trialling of radio technology for use on non L-O-S links (marginal links) with protection devices is underway. If trial successful an alternative potentially cheaper communication for use with protection with CAT 1 signalling channel requirements may be available for deployment of a number of sites where communications provision is difficult/expensive
• Works carried out on an IP network test-bed to assess the feasibility of running TDMoIP protection signalling, work underway to trial this solution in a substation environment.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="11">N/A</td></tr>
<tr><td>R&D Provider</td><td colspan="11">RFL / C & W / Radius / Tait / others TBC</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="3"><i>IFI 0801 - IEC 61850 Application in SP - Transmission</i></td></tr>
<tr><td>Description of project</td><td colspan="3">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 £15,589
External £37,333
Total £52,922</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SPEN)</td><td>£455,000</td><td>Projected 09/10 costs for SPEN</td><td>Internal £15,000
External £80,000
Total £95,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">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,</td></tr>
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<tr><td></td><td colspan="10">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 are 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 rowspan="2">Significant</td><td colspan="3">Project Benefits Rating</td><td colspan="3">Project Residual Risk</td><td colspan="3">Overall Project Score</td></tr>
<tr><td colspan="3">17</td><td colspan="3">-7</td><td colspan="3">24</td></tr>
<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></td><td></td><td colspan="2">➡</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">£1,729,410</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">This project is on track with Project 1 to be completed late 2009</td></tr>
<tr><td>Project Progress 09</td><td colspan="10">We have now successfully recovered data using MODBUS over TCP/IP from the fault recorder and are in the process of putting this online at Busby 275kV before moving on to the IEC61850 part of the development.
Several meetings with Microsol to discuss technical issues and also a kick off meeting to scope out project requirements with Microsol and Qualitrol</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 Provider</td><td colspan="10">Manchester University</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4">***Strategic Technology Programme: Overhead Network Module 2***</td></tr>
<tr><td>Description of project</td><td colspan="4">A DNO research & development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 6,952
External £ 43,802
Total £ 50,754</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £16,824
External £131,143
Total £154,967</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£310,102 + DNO</td><td>Projected 09/10 costs</td><td>Internal £6,000
External £45,629
Total £51,629</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The Module 2 programme for budget year 2008/9 aimed to reduce costs and improve performance of overhead networks by increasing understanding of issues that have a negative impact on costs and performance. The programme is expected to also have a positive impact on safety and environmental performance. The projects all address real problems that have been identified by the module steering group members as significant and which require technical investigation and development.
Updated information can be found at:- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>15</td><td>-9</td><td>24</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects in this module will significantly increase the safety and reliability of the network. In certain cases the asset life may also be extended.
If these projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain benefits including:
• Cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults;
• Reduce levels of premature failure of assets and so avoid of risk of injury or loss of life or damage to property as a result of falling overhead lines;
• Avoid redesign, reconstruction or refurbishment of overhead lines where this is driven by a perceived need to increase ratings or strengthen lines, and is required to conform with existing standards but which may be unnecessary;
• Co-operation between European countries in the development of forecasting methods of atmospheric icing and for the exchange of forecasting tools;
• Comparison of new covered conductor with known performance of older types
• Extend the service life of towers and reduce potential levels of tower failures;
• Review alternatives to wood poles;
• Reduce lifetime costs by the appropriate use of alternative materials;
• Give Members a better understanding of novel conductors for new-build or re-conductoring 132kV wood pole lines that gives lower capital cost, minimum visual impact, environmental acceptance than other methods of improving power transfer.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Range 2-5 years dependent on project</td><td>Duration of benefit once achieved</td><td>Range 2-10 years dependent on project</td></tr>
<tr><td>Probability of Success</td><td colspan="2">Range 10-50% - dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£64,624</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it’s’ inception.
Projects Still In Progress (March 09):-
S2110_4 Extend OHRAT to include User Defined Covered Conductor
S2136_4 & 4A European Project COST 727: Measuring and forecasting atmospheric</td></tr>
</table>

	icing on structures, including Czech ice meter trial; S2143_3 Develop in-situ degradation monitor for Al OHL conductors - Stage 3 Instrument Development; S2147_2 Increasing vibration limit of CCs to 20%UTS using multiple std or single Hi-mass SVDs S2151_2 Alternatives to wood poles - Stage 2: Erection and fitting trials on concrete poles S2154_2 Experimental investigation of novel conductors at Deadwater Fell – Stage 2: Vibration; S2157_1 Novel conductors for 132kV wood pole lines;
Project Progress to March 09	Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year. **Completed Projects (March 09):-** S2126_4 Monitoring conductor temperature at fixed current – at Cashlie and Queensferry; S2132_2 Validation of ice accretion models using Deadwater Fell; S2136_3 Continued involvement with European Project COST 727; S2138_2 Investigation of live-line jumper-cutting limitations; S2143_2 Develop in-situ degradation monitor for aluminium OHL conductors – Stage 2: Feasibility study; S2146_2 Torsion tests on composite insulators - Stage 2: Effect of torsion on tension insulators; S2149_2 High durability OHL fittings - Stage 2: Costing for testing prototype high durability fitting; S2150_1 Evaluation of TDR for assessment of tower foundations; S2152_1 Evaluate performance of Czech Icemeter at Deadwater Fell; S2153_1 Suitability of hand-held PD detector for condition assessment of pole-top equipment; S2154_1 Experimental investigation of novel conductors – Stage 1: Icing; S2156_1 Build Three Prototype Field Pole Leakage Current Detectors; S2159_1 LV shrouding - review of current practices and standards
Collaborative Partners	All DNOs
R&D Providers	EA Technology

Project Title	***Strategic Technology Programme: Cables Module 3***		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £ 6,952 External £ 53,681 Total £ 60,733	Expenditure in previous (IFI) financial years	Internal £19,562 External £175,666 Total £195,228
Project Cost (Collaborative + external + [DNO])	£375,767 + DNO	Projected 09/10 costs: £387,037	Internal £6,000 External £55,291 Total £61,291
Technological area and / or issue addressed by project	The STP cable network programme for budget year 2008/9 aimed at identifying and developing opportunities to reduce the costs of owning cable networks. The reduction of whole life cost through greater reliability and improved performance of cables and associated accessories comes under the remit of Module 3. Where appropriate, Module 3 worked with other Modules to achieve common goals. **Completed Projects (March 09):-** S3132_12 & 15: CRATER Near Real time Determination & functionality development; S3148_4 Requirements for earthing and bonding of single core MV power cables: feasibility of earthing and bonding of single core MV cable systems ; S3151_1 Understanding and controlling thermo-mechanical forces in cables systems: Study to assess work carried out on thermo-mechanical forces in cable systems;		

<table>
<tr><td></td><td colspan="4">S3152_1 Separable connectors and cable compartments in 11 kV switchgear;
S3153_1 & 2: Economics and environmental impacts of distribution cable losses: Model development including CO_2 burden calculation ;
S3168_1 & 2: Comparing future designs of HV and EHV polymeric cables: Review of current specifications and designs and study to determine the interaction between resin and semi-conducting layers;
S3169_1: Further studies on the retraction of insulation and over-sheath of cables;
S3171_1: Jointing on to wet cables.

Projects Still In Progress (March 09):-
S3132_16: CRATER annotation;
S3144_2: Comparison of processes for the treatment of redundant fluid filled cables: Comparative field trials;
S3151_2 & 3 Understanding and controlling thermo-mechanical forces in cables systems: Modelling of thermo-mechanical forces in cable systems;
S3155_1 Trial testing of triplexed cable in plastic ducts;
S3157_1 Partial discharge testing of MV cable systems to provide asset risk management data;
S3164_1: Develop fluid filled cable design tool;
S3165_1: Performance ageing tests on polymeric terminations
S3166_1 & 2: Performance of cold- and heat-applied accessories under resin: Assessing interaction between resin and semi-conducting layer;
Updated information can be found at:- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">e.g. Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>-8</td><td>21</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO Member of the programme to gain the following benefits, including:
• offset future increases in CAPEX and OPEX;
• CI/CML savings per connected customer;
• Reliable, safe and easy to use method of detecting excess moisture in paper insulation of cables;
• Reduce excavation required in locating leaks from fluid-filled cables, reduce the times and costs of leak location, and also reducing outage times;
• Reduce cable purchase costs;
• Reduce design costs.
• Increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Range 1-3 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 2-10 years - dependent on project</td></tr>
<tr><td>Probability of Success</td><td colspan="2">Range 15-50% - dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£87,318</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it's' inception.</td></tr>
<tr><td>Project Progress to March 09</td><td colspan="4">Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">Other DNOs</td></tr>
<tr><td>R&D Providers</td><td colspan="4">EA Technology</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5"><i>Strategic Technology Programme: Substations Module 4</i></td></tr>
<tr><td>Description of project</td><td colspan="5">A DNO research & development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 6952
External £ 40014
Total £ 46,966</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £17,043
External £133,032
Total £150,075</td></tr>
<tr><td>Project Cost (Collaborative + external + [DNO])</td><td colspan="2">£313,784 (08/09)</td><td>Projected 09/10 costs: £323,200</td><td colspan="2">Internal £7,000
External £40,400
Total £47,400</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The aim of the 08/09 Substation Programme was to develop already well established themes such as life extension of aged assets within legal and heath and safety constraints, examination of new technologies, developing an understanding of, and innovative solutions for, the impact on substation assets of increasing levels of distributed generation on networks and condition monitoring techniques.

The majority of projects have not only resulted in essential knowledge transfer, they have enabled skills to be developed between STP 4 Members and European partners. Key examples of this were the participation in the AM Forum, (S4185_4), reviewing how transformers are connected within Europe (S4221 _2) Each of which has contributed significantly to developing better understanding of electrical plant, improving safety implications, utilisation, performance and life cycle. Some of these projects have resulted in the creation of further supplementary projects for 2009/2010.

Completed Projects (March 09):-
S4164_5: Tap changer monitor stage 5;
S4178_2: Impedance Testing of Substation Batteries;
S4181_3: Ongoing Programme Of Transformer Post Mortems;
S4209_2: Post Maintenance Testing: Project Workshop Jan 09;
S4222_2: Alternatives to ENATS 35-1 Transformers: Extension 315KVA Ground Mounted Transformers;
S4233_1: 145kV Earthing switch Asset Management Manual;
S4235_1: Researching New Techniques for Optimising Plant Maintenance Policies;
S4237_1: Battery Cabinet Temperature Control;
S4238_1: Module 4 Information Dissemination;
S4239_1: Research and Testing of Electrical Contact Cleaning Products;
S4241_1: Study of Circuit Breaker Timing Measurements & Methods;
S4244_1: Review of methods to dissipate pressure in Substations during equipment failure;

Projects Still In Progress (March 09):-
S4164_5: Tap changer monitor stage 5;
S4178_2: Impedance Testing of Substation Batteries;
S4185_4: European AM Forum Membership 08/09;
S4221_2: Out Of Phase Modelling Report;
S4224_1: X/R Extrapolation of 12kV Vacuum circuit Breakers;
S4226_1: Environmental Corrosion, Specification, Testing of Plant & Equipment;
S4230_1: Optimisation of Operational Support and Response for Electrical Plant & Equipment;
S4236_1: Aquagen recombination system;
S4245_1: Switchgear – Effect of Low Power Factor Switching. (Joint Investigation with STP5: S5181_1).

Updated information can be found at:- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Tech Transfer, Significant, Radical</td><td colspan="2">Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td colspan="2">14</td><td>-9</td><td>23</td></tr>
</table>

Expected Benefits of Project	If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO Member of the programme to gain the following benefits, including: • offset future increases in CAPEX and OPEX; • CI/CML savings per connected customer; • Preventing disruptive failures of oil-filled equipment, tapchangers, earth switches increasing safety and avoid unnecessary scrapping of serviceable components will alleviate environmental impact. • Liaison with European Utilities to share new technology and failure modes; Increased safety of staff and public by reducing the number of accidents / incidents.		
Expected Timescale to adoption	Range 1-5 years - dependent on project	Duration of benefit once achieved	Range 2-8 years - dependent on project
Probability of Success	Range 10-100% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£67,777
Potential for achieving expected benefits	A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it's' inception.		
Project Progress to March 09	Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year.		
Collaborative Partners	Other DNOs		
R&D Providers	EA Technology		

Project Title	***Strategic Technology Programme: Distributed Energy Resources Module 5***		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £ 6952 External £ 53,063 Total £ 60,016	Expenditure in previous (IFI) financial years	Internal £14,767 External £147,566 Total £162,333
Project Cost (Collaborative + external + SPEN)	£435,001 + DNO	Projected 09/10 costs	Internal £7,000 External £54,358 Total £61,358
Technological area and / or issue addressed by project	During the budget year 08/09, Module 5 has consolidated the work programme by clustering much of the work around a number of key issues of relevance in the planning, design and operation of networks for distributed energy resources; namely, fault level management, network losses, load related investment, circuit ratings, power quality and microgrids. Most of the projects aim to increase network performance and reduce risk whilst having a positive impact on DNOs' environmental performance. **Completed Projects (March 09):-** S5169_1 Route plan to transform networks from passive to active networks S5161_2 Standard Risk Assessment Approach to DNO protection requirements S5183_1 Communications for active network management S5187_1 Module 5 participation in ENARD Annex II DG System Integration S5188_1 & 2 Latest developments in issues associated with low carbon network designs S5189_1 Techniques for assessing harmonic distortion from generation plant S5193_1 Fault level management S5194_1 Load related investment - Feasibility study S5195_1 Network Losses - Feasibility study S5197_1 & 2 Power Quality Issues - voltage dips and swells S5198_1 Microgrids - Feasibility study		

<table>
<tr><td></td><td colspan="4">S5200_1 LV Fuse Reach
S5201_1 Distribution Network Losses – Loss Reduction Initiatives

Projects Still In Progress (March 09):-
S5147_8 Microgenerator clusters - Stage 8 - extension of monitoring / analysis
S5151_5 Network Risk Modelling - Stage 5
S5181_1 Effect of low power factor switching
S5190_1 Whispergen output characteristic monitoring
S5204_1 Monitoring and impact of domestic heat pumps
S5205_1 Fault level management - Feasibility Study.

Updated information can be found at:- https://www.stp.uk.net</td></tr>
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<tr><td>9</td><td>-10</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects within this module have been cost effective and help improve reliability and safety of generation connection in distribution networks in line with government policy.

If the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain benefits including:

• Contributing to the achievement of Government white paper aims of introduction of significant numbers of micro-CHP units to the UK homes by 2010 and greater numbers beyond then;
• Paving the way for more actively controlled networks in support of a move to a lower carbon economy;
• Enhancing the knowledge and awareness of overseas best practice in DG system integration, which can be applied, as appropriate in the UK;
• Reduction in the cost of connections for developers seeking to connect load and distributed generation;
• Understanding of the potential to use the Synergy / IMASS connection modelling tool to simplify / reduce the cost of providing indicative connection costs;
• Developing a more consistent, knowledgeable and auditable application of LV fuse reach across the network, hence a more reliable network reducing CML/CI;
• Being better placed to assess the possibilities for real reductions in losses on DNO networks to reduce GB GHG emissions;
• Understanding how to accommodate energy saving technologies such as heat pumps into distribution network design.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-7 years - dependent on project</td><td colspan="2">Duration of benefit once achieved</td><td>Range 1-15 years - dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 5-60% - dependent on project</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£89,367</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. However, STP has delivered a number of notable innovations since it’s’ inception.</td></tr>
<tr><td>Project Progress to March 09</td><td colspan="4">Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year.</td></tr>
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