SP ENERGY NETWORKS

# Innovation Funding Incentive
# Annual Report

Issue 1 – 31st July 2008

IFI Projects
April 07 – March 08

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

# 1 Foreword

Welcome to the SP Energy Networks' Innovation Funding Incentive (IFI) Annual Report for 2007/08.

It has been another significant year for the energy sector on the national and international scene with heightened pressure on the delivery of $CO_2$ reducing measures to combat global climate change. The EU binding targets for 2020 to reduce greenhouse gas emissions by 20%, and to produce 20% of EU energy needs from renewable energy sources highlight the key role the energy sector has to play in the coming years. The Renewable Energy Strategy consultation issued by HM Government (Jun 08) sets out how the UK aims to meet its targets. This document indicated that of the four key areas (bulk electricity; bulk heat; built environment; transport) it is in electricity, and in particular the use of renewable generation, that significant changes are expected. The radical, seven fold, increase in renewables from 2007 levels to some 30-35% of total energy supply by 2020, from predominantly new windfarms both onshore and offshore, will present significant challenges to connect them to our transmission and distribution networks.

Research, Development and Demonstration (RD&D) remains an important enabler to ensure technical solutions are available to address the range of issues we are managing both now and into the future. In the third full year of the IFI, we have continued to build on our portfolio through new projects and through the adoption of some of our previous IFI endeavours. In particular, we have broadened out our programme to include activities relevant to our transmission licence with the introduction of IFI to SP-Transmission from April 2007. An early success from this programme is the radiometric arc fault location trailer, developed in partnership with Elimpus, for the detection of faulty equipment in transmission outdoor compounds.

Working with our parent company Iberdrola, a well-established player in European R&D, we have successfully developed models for the integration of our development activities between the UK and Spain. In the UK, collaboration through Research & Development has been strengthening between network operators and 2007/08 saw a significant project with involvement right across the sector undertaken by the MET Office to look into the future impact of climate change on the UK electricity system. We hope that the launch of establishments like the Energy Technologies Institute and the Energy Innovation Centre, opened in June 08 by Malcolm Wickes MP, will further build on the development of network-ready technologies for the benefit of the UK as a whole.

In October 07 ScottishPower, together with partners including Scottish & Southern Energy and the University of Strathclyde, sought and achieved approval from Ofgem for the use of the IFI mechanism to establish a demonstration facility to accelerate the development cycle of network technologies.

Alan Bryce
Director
SP Energy Networks

# 2 Introduction & Background

## 2.1 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.

## 2.2 Innovation Funding Incentive (IFI)

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

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

## 2.3 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).

## 3 SP Energy Networks Structure

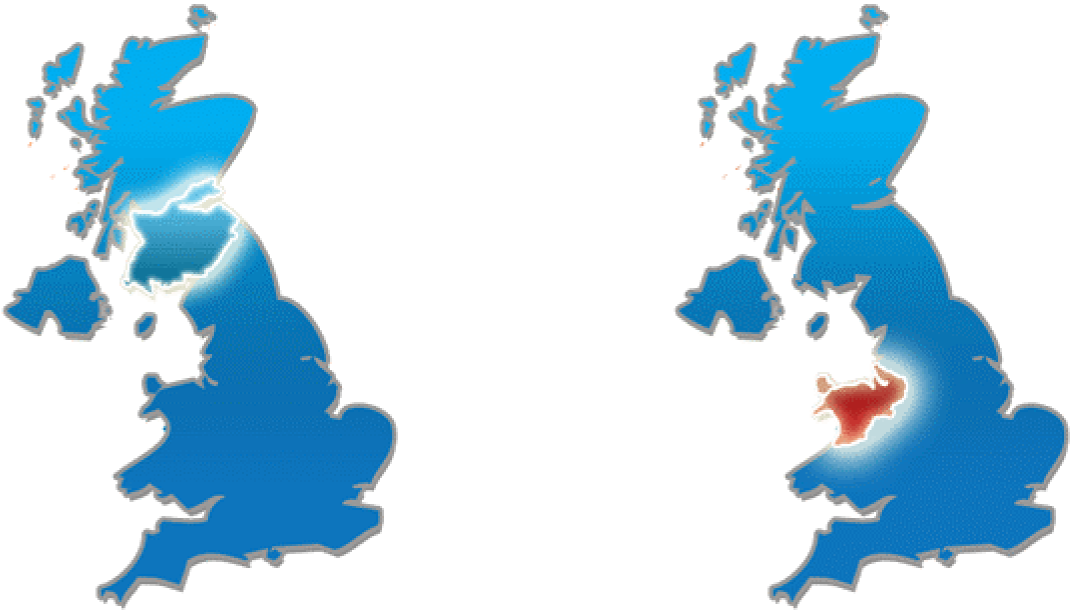
SP Energy Networks (SPEN) is the part of ScottishPower UK Ltd, which owns and operates the electricity transmission and distribution network of southern Scotland and the electricity distribution network of Merseyside and North Wales. Day-to-day operation of our network, approaching 112,000 km, is conducted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

# 4 Overview

## 4.1 IFI

A total of 50 IFI projects are being reported by SP Energy Networks on behalf of the three ScottishPower Network licence areas for the period 1st April 07 – 31st March 08.

At time of writing SPEN has a total of £6.3m 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 2007/08 every £1 of SP IFI money invested in a project was levered by ~£4 from other sources:

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

| SP-D and SP-M | 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 |

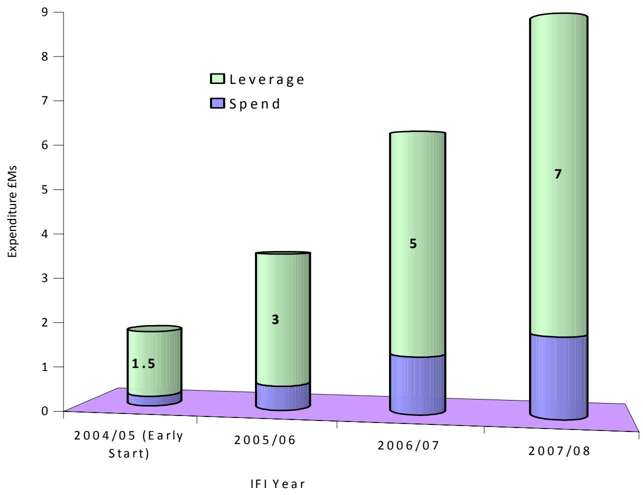


**Figure 2: R&D expenditure growth SPEN (SP-D, SP-M and SP-T) since the introduction of the IFI**

## 4.2 RPZ

No RPZ applications were submitted to Ofgem during 07/08.

Whilst this is the case in SP Distribution and SP Manweb, we have utilized and are continuing to use a number of innovative solutions to connect distributed generation.

**Historic Innovation**

As reported in 06/07 we have several novel control schemes that monitor circuit loading and provide constraining signals to curtail generation to an acceptable level – providing a level of active network management. Some of these constraining schemes have been built up incrementally and have become very complex in the attempt to maintain historic access rights concerned with multiple generators in the same geographical area. This is being addressed within our AuRA-NMS project, funded through IFI (IFI 0532); progress on this project is described elsewhere in this report.

**Pipeline RPZ Applications**

In addition to the significant innovation we are progressing through projects like AuRA-NMS, we are in the process of connecting generation using innovative solutions; two of these projects will form the basis of RPZ applications during 2008:

- An application of the alternative 132kV wood pole line with integral fibre communications and the provision of a generation constraint management scheme in the connection of an offshore windfarm to the network. The new 132kV line design was trialled under the IFI mechanism (IFI 0405) – detailed elsewhere in this report.
- The use of fibre wrap on a 132kV phase conductor for the provision of operational intertripping / constraint signalling for an onshore windfarm. As a part of this RPZ application, SP is planning to couple temperature monitoring to the fibre, providing essential knowledge to our dynamic ratings project (IFI 0513), and potentially facilitate capacity improvements into the future.

SPEN is continuing to investigate the application of innovation in the connection of smaller <1MW generators to the network, e.g. novel voltage control (IFI0511), Ashton Hayes microgrid (IFI0706). If technically / commercially suitable these may form the basis of future RPZ applications.

## 5 Summary Tables

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

**Table B: IFI Summary - SP Distribution Ltd Licence Area 07/08**

| | |
|---|---|
| SP Distribution Ltd Network Revenue | £ 319,630,000 |
| IFI Allowance | £ 1,598,150 |
| Unused IFI Carry Forward to 2007/08 | £ 801,375 |
| Number of Active IFI Projects | 39 |
| Summary of benefits anticipated from IFI projects | Section 7 / Appendix B |
| External expenditure [2007/08] on IFI projects | £ 758,900 |
| Internal expenditure [2007/08] on IFI projects | £ 106,005 |
| **Total expenditure [2007/08] on IFI projects** | **£ 864,905** |
| Benefits actually achieved from IFI projects to date | £2,137,000[1] |

**Table C: IFI Summary - SP Manweb plc Licence Area 07/08**

| | |
|---|---|
| SP Manweb plc Distribution Network Revenue | £ 182,790,000 |
| IFI Allowance | £ 913,950 |
| Unused IFI Carry Forward to 2007/08 | £ 384,550 |
| Number of Active IFI Projects | 45 |
| Summary of benefits anticipated from IFI projects | Section 7 / Appendix B |
| External expenditure [2007/08] on IFI projects | £ 616,274 |
| Internal expenditure [2007/08] on IFI projects | £ 85,307 |
| **Total expenditure [2007/08] on IFI projects** | **£ 701,581** |
| Benefits actually achieved from IFI projects to date | £2,137,000[1] |

**Table D: IFI Summary - SP Transmission Ltd Licence Area 07/08**

| | |
|---|---|
| SP Transmission Ltd Distribution Network Revenue | £ 164,760,000 |
| IFI Allowance | £ 823,800 |
| Unused IFI Carry Forward to 2007/08 | £ 0 |
| Number of Active IFI Projects | 9 |
| Summary of benefits anticipated from IFI projects | To early to quantify |
| External expenditure [2007/08] on IFI projects | £ 212,863 |
| Internal expenditure [2007/08] on IFI projects | £ 14,122 |
| **Total expenditure [2007/08] on IFI projects** | **£ 226,984** |
| Benefits actually achieved from IFI projects to date | Too early to quantify |

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

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[1] 50% of benefits shown in Section 7 – split evenly to maintain confidentiality to connected parties.

## 6 Achievements for 2007/08

At the end of 2007/08 the highlights from the SPEN IFI portfolio included:

- Every IFI project undertaken by SP is taken before a panel of senior experts from across the business. Through this process we have:
    - 50 projects fully authorised, with a further 2 receiving preliminary approval.
    - 15 new projects were authorised during the 2007/08
    - Of the 50 projects, 6 are now complete and either awaiting adoption or formal closure
- Over £7m of leverage obtained
- More than 12 projects achieving Technology Readiness Level (TRL) 7 (network integration) or above with further trials scheduled
- 2 projects formally adopted in business with several more near the final stages of trials
- Development and publication of version 2 of Engineering Recommendation G85 (Dec 07) - SP was heavily involved with ENA member companies in the production of this document.

### 6.1 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.

### 6.2 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.

## 6.3 Identifying the Issues and Developing the Enablers

Further to work initiated in 2005 on the development of a national test and demonstration facility for electricity networks (for further detail see IFI 0515), we achieved several key milestones in 2007/08:

- Consultation with other UK DNOs, which led to active collaboration with Scottish & Southern Energy and a level of financial input.
- Working with Ofgem, we obtained funding approval in principle for the use of IFI monies as the network operators' input to the centre.
- Development of a funding model with Scottish Enterprise compliant with State Aids / IFI rules.

***We still believe such a centre to be of significant importance in the acceleration of technologies for use on the distribution networks and are working with a range of academics, manufacturers and funding bodies to make it a reality.***

The demonstrator uses include:

- **Technology incubator** – a system for identifying new areas for technological developments, giving manufacturers or venture capitalists the ability to see market potential for products in a variety of network topologies.
- **Prototype environment** – a system allowing new products / equipment to be safely connected to a live network and proven, as a means to accelerate product route to market.
- **Simulation Validation** – a system prove the outputs of desktop analysis in a real operational environment, demonstrating the manner by which new and legacy equipment can be operated and will interact. This system would allow complex active control systems to be proven prior to installation on the real network.
- **Simulator** – a tool to demonstrate the widespread implications of given future scenarios on real networks.
- **Training environment** – a tool to train field / control room staff for the range of network configurations and operational parameters.

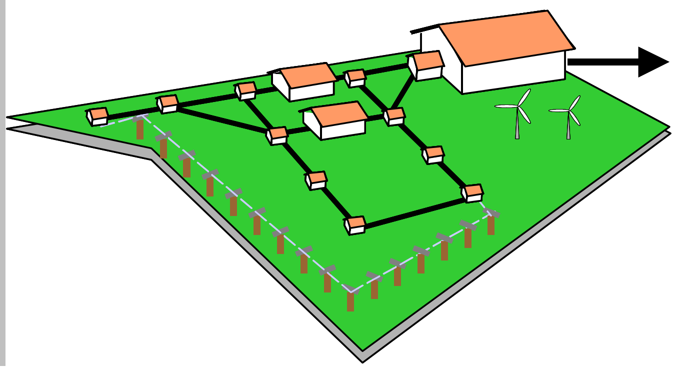


**Figure 3: Pictorial representation of the Demonstration Facility**

## 7 Realised Benefits from IFI Projects

Whilst not all benefits have a direct monitory value, we have indicated the benefits brought to windfarm developers from projects funded under the IFI programme. Having proven the technologies these solutions and benefits will flow into other renewable projects.

### 7.1 Benefits from Adopted IFI Projects

**Case Study application for benefits for IFI Project vs. Traditional method**

| **Project Name** | | **Windfarm 1 (87MW)** | **Windfarm 2 (26MW)** |
|---|---|---|---|
| **Conventional solution** | **Solution 1** | 1a: 132kV trident line<br>1b: 132kV trident line plus 3rd party communications for constraint management | L33 33kV overhead line and 33kV underground cable |
| | **Technology Description** | 6.5km 132kV trident wood pole line with Lynx conductor<br>1a: Unconstrained connection, but peak export capped at 27MW<br>1b: Communications enabling constraint scheme, 89MVA | 10.77km conventional 33kV wood pole line. 200 mm2 AAAC –Poplar<br>• 29.26MVA Summer<br>• 34.12MVA Winter |
| | **Normalised Cost** | 1a: N/A (insufficient capacity)<br>1b: 100% | 100% |
| **IFI Developed solution** | **Solution 2** | 6.5km alternative 132kV wood pole line (four wire design – IFI0405) incorporating communication channel in place of 1b | 10.77km L36 33kV Overhead line (IFI0503) in place of L33 specification |
| | **Technology Description** | Alternative 132kV wood pole line inc. 200mm$^2$ AAAC (Poplar)<br>• 124MVA summer<br>• 140MVA winter<br>Optical fibre communications and earthing provision through underslung Optical Path Ground Wire (OPGW) | High capacity, L36 33kV wood pole line: 300mm$^2$ – AAAC (Upas)<br>• 38.5MVA summer<br>• 45MVA winter<br>Optical fibre communications accommodated via Optical Path Phase Conductor (OPPC) |
| | **Normalised Cost** | 74 % | 57% |
| | **Likely number of installations per annum** | 1* | 1* |
| | **Total benefit resulting from these IFI projects** | £4.274m<br>NB. The costs have been summed for this public document to maintain confidentiality to the connecting parties. | |

*Subject to location of generation and connection type

## 7.2 Benefits from IFI Trials

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

### *IFI 0406 Communicable Fault Passage Indicators (FPI)*

To date, 91 pole-mounted units have been installed in SP-M/SP-D and have started to send information back to the display program (iHost). The conductor-mounted units are in the process of being installed with the majority complete and their reporting features sending back information to a central system. The control engineers both north and south have access to the system and have received training on its use. They know that when there is a fault in the areas where the units are installed, that they can check the information received.

To date the trial has highlighted the following:

- The field technology has been proven to work, with reasonable reliability. Integration to the control room will be the focus for 2008/09 to realise full benefits.
- The ability of the FPIs to detect transient faults during the trial has led to the deployment of disturbance monitors on parts of the network. This will enable SP to find transient faults before they develop into permanent faults, with supply quality improvements to our domestic customers.

### *IFI 0532 - AuRA-NMS*

An internal focus group has been setup for this project with members that possess the expertise and authority to make decisions across the issues addressed in the SPEN application of AuRA-NMS: covering design, operations, control regimes / generation interaction and support. The focus group has acted to steer the research to meet the needs of the business by playing an active role in the development of the project's requirements and functional specifications. In addition to the direct steer to the research, the group has assisted in identifying the strategic / tactical challenges and opportunities relating to the use of Active Network Management on a live network.

The first rollout of AuRA-NMS functionality is due to be released for lab test in July 08. We plan to have close linkage to the project and will act to ensure safeguards and processes (both commercial and technical) are in place to facilitate trials of functionality developed via the AuRA-NMS project on the live network when the time comes.

Our ambition towards the end of the project is a close-loop test of function(s) with signalling from the network feeding into a generator's control system.

### *IFI 0620 - Tower Foundation Assessment*

Trials have taken place in SP-M utilising a non-invasive radar technology to assess the condition of the foundation of 42 towers across the network. One route due for refurbishment by 2008/09, will consider the results from this project to assess whether new towers can be built on top of existing foundations.

The project is now moving towards the final phase which will see foundation digging take place on selected towers to compare the results received from the radar survey against the traditional digging method on pre-selected towers to verify the effectiveness of the radar technique.

## 8 Looking Ahead - Focus for 08/09

Our focus for 2008/09 will continue to build on the foundations laid in the three years of IFI from 2005 with a focus 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 50 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 2008/09 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
- IFI 0508 – REDOX storage device has been delayed by 6-9 months. This has put the installation trial date back to the summer of 2009. Prototype cells have been constructed with positive results.
- IFI 0509 Superconducting Fault Current Limiter - The consortium is at an advanced stage of development of the first limiter with the superconducting elements designed, type tested and full production of all the elements underway.

**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.***

## 9 Project Reports

Summary sheets for each project have been provided in Appendix D. In the interests of efficiency, only one summary sheet has been produced with associated internal / external costs and Net Present Value (NPV) calculations for a whole project (i.e. unless otherwise specified, they are not split by licence area). Further information regarding the calculation of NPV is shown in Appendix C.

There are two formats for the individual IFI reports due to the updated Engineering Recommendation G85 v2 Dec 07. The change encompasses all new reports from December 2007 onward.

The Table of contents and Appendix D have been priorities by current TRL status.

# Appendix A – IFI Highlights for 07/08 submitted to ENA R&D Brochure

## Fault Current Limiter based on Superconducting Materials

A Consortium comprising CE Electric UK, Electricity North West, SP 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.

Fault levels have always been a constraint in the development of electricity networks and have been controlled by increasing source impedance, 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, the pressure to cope with rising fault levels continues and is likely to increase. Compliance with LC25 statements for fault levels has been given new impetus by the increasing emergence of Independent DNOs, a by-product of the desire to extract maximum benefit from the on-site embedded generation requirements of many planning authorities.

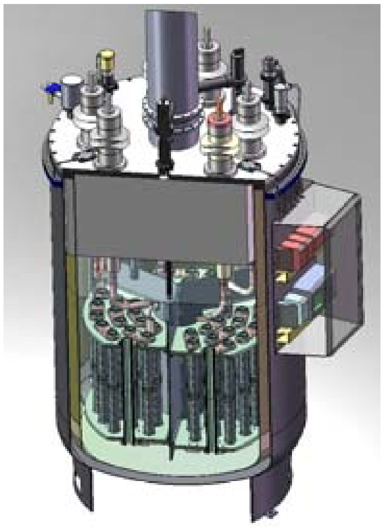


**Figure 1 Fault Current Limiter Schematic (Pilot 1)**

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 Individual Superconducting Elements**

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.

The consortium is at an advanced stage of development of the first limiter. Superconducting elements have been designed and type tested and full production of all the elements is underway. Cryogenic equipment to store and cool the elements is either on order or has been delivered ready for assembly. HV circuit breakers and other items required to support the installation, are on order. Future milestones include the assembly and type testing at an independent test house prior to installation and commissioning towards the end of 2008.

## Radiometric Substation Monitoring SENTINEL v1.0

During the past year SP Energy Networks and Elimpus having been working together to produce a portable device capable of picking up and pin pointing the location of partial discharge. Through the IFI programme the Sentinel v1.0 was developed.

The monitoring system hardware comprises of a trailer, fitted with radiometric PD locating equipment, together with GPRS communications for recorded data transfer.

The system monitors events within the substation and transfers details to the Central Host. The Central Host processes the received data and presents the partial discharge results in the form of time-based activity graphs and plan view partial discharge site locations. The Central Host provides a focal point for system users to access data, monitoring systems to upload data and administrators to manage the system. Users access the system through the Web interface (hosted at the Central Host) and are also able to receive information through SMS messages and email.

A windows desktop application can also be ran in the background. A small icon on the system tray (beside the system clock) changes depending on the overall health of the substations monitored.

The system has the following features:

- Substation recording equipment
- Trailer-based
- Easily transported and commissioned
- Powered by 230 V single phase supply from substation
- Earthing point to prevent build-up of static charge
- GPRS based communications
- Four antenna array allowing PD location
- Reporting mechanism
- All results available via web-site
- Highly secure, password-controlled web-portal
- User specified email-alarming function

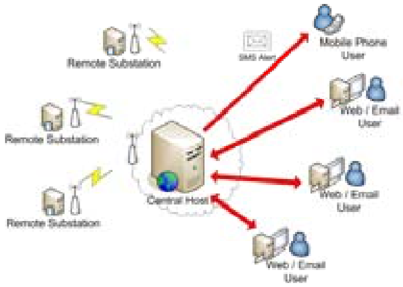


**Figure 1 Schematic of system architecture**

Radiometric Technology

Partial discharge is a phenomenon that results in short impulses (< 1 μs) of current flowing through a site of stressed insulation. Since partial discharge can be the precursor to more serious insulation failure the monitoring of this phenomenon is an important aspect of asset management. Due to the fast rise time of the current impulses, some of the energy in the partial discharge is radiated in the form of radio frequency emissions.

The Sentinel incorporates a sensitive radiometer that can detect partial discharge radiation via purpose designed disk-cone type antenna and wideband digitisation equipment. Additionally, through the use of an array of antennas and sophisticated data processing, the location of the partial discharge site to be located in 2-dimensional space.

The operating range of the PD locator varies according to the severity of the PD; equipment in the early stages of PD can be detected over a few 10s of metres, whereas equipment close to failure is detectable over 150 metres.

**Figure 2 Photographs of the trailer commissioned at a substation**

## Thermal modelling and Active Network Management

Over the last two years, SP Energy Networks has been collaborating with a research consortium comprising of AREVA T&D, PB Power, Imass and Durham University in the design and delivery a new type of generator control system.

The proposed system uses a dynamic thermal rating system for cables, overhead lines, and transformers operating at 132kV.

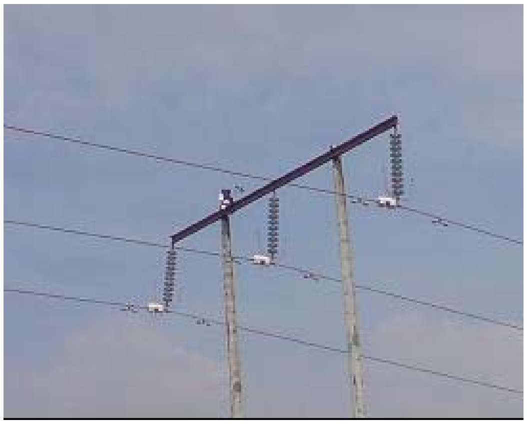
The ratings given to circuits are a function of the temperature by which they operate. The thermal status of a power system component is to be determined by factors such as: current flow, meteorological conditions and component heat transfer characteristics.

A section of the SP-M 132kV network has been made available for the field trials and development of the prototype thermal controller. The site trial network will be used as a source of electrical, thermal and meteorological data using existing and new dedicated measurement equipment.

This project seeks to explore the potential benefits arising from:

- The improved utilization of power system assets through the use of real time knowledge of the thermal status of the power system
- The 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.



Advantages:

- Active network management and exploitation of equipment latent 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 avoidance of reinforcement investments in distribution systems.

The IFI funding has facilitated the level of collaboration required for this project. The trial on the SP-M 132kV network will provide a live implementation in the very near future. It is anticipated that this will result in a commercial product that will provide an alternative to network reinforcement for generation connections, not just for Scottish Power but also for all national DNOs.

## Appendix B – Expenditure Breakdown of Projects between Licences

### 9.1 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.

### 9.2 Cost Breakdown

As SP Energy Networks operate distribution licenses for the SP-D, and SP-M areas, successful developments relating to distribution 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, see Table B1

**Table B1: Cost Breakdown between Licence Areas**

| Licence Area | Annual Turnover (07/08) | Percentage Split |
|---|---|---|
| SP-Distribution | £319.63 million | ~ 60% |
| SP-Manweb | £182.79 million | ~ 40% |

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.

### 9.3 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.

### 9.4 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 08 the status of the 50 projects reported is detailed in Table B2 below.

**Table B2 – IFI Project Status**

| *No.* | *Phase* | *Definition* | *External Cost* |
|---|---|---|---|
| *6* | *Project proposals in development* | *Agreeing scope / objectives, setting up contracts, etc* | *None direct (small external £ associated with management cost)* |
| *38* | *Live projects* | *Projects in progress* | *Yes (if milestones have been met)* |
| *6* | *Completed projects* | *Projects which have completed their trial phase* | *Yes* |

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

## 9.5 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.

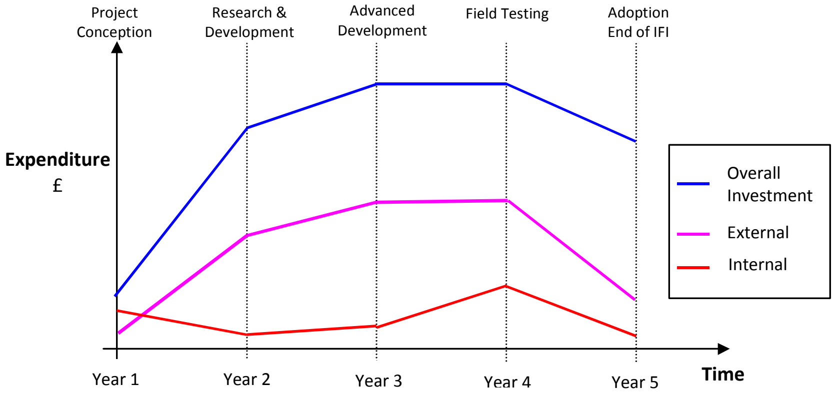


**Figure B1: Example Expenditure Profile for an IFI Project**

Table B3 and B4 are ordered chronologically.

## Table B3: Overview of 07/08 projects showing application between licences

| Project Description | Percentage split | | | £ split | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | SPD | | SPM | | SPT | |
| | SPD | SPM | SPT | External | Internal | External | Internal | External | Internal |
| IFI 0401 - 1: STP Module 2 - Overhead Lines | 60% | 40% | 0% | £25,956 | £2,684 | £17,304 | £1,790 | £0 | £0 |
| IFI 0401 - 2: STP Module 3 - Cable Networks | 60% | 40% | 0% | £31,963 | £3,622 | £21,309 | £2,415 | £0 | £0 |
| IFI 0401 - 3: STP Module 4 - Substations | 60% | 40% | 0% | £22,883 | £2,176 | £15,255 | £1,451 | £0 | £0 |
| IFI 0401 - 4: STP Module 5 - Distributed Generation | 60% | 40% | 0% | £31,543 | £1,936 | £21,029 | £1,291 | £0 | £0 |
| IFI 0402 - LV Voltage Regulator | 60% | 40% | 0% | £34,635 | £8,390 | £23,090 | £5,593 | £0 | £0 |
| IFI 0403 - Reference Network Development | 60% | 40% | 0% | £1,055 | £965 | £703 | £644 | £0 | £0 |
| IFI 0404 - Alternative Insulating Oil Project | 60% | 40% | 0% | £6,377 | £1,980 | £4,251 | £1,320 | £0 | £0 |
| IFI 0405 - New Design for 132kV trident line | 0% | 100% | 0% | £0 | £0 | £60,192 | £5,008 | £0 | £0 |
| IFI 0406 - Fault Passage Indication / GSM | 60% | 40% | 0% | £58,391 | £7,583 | £38,927 | £5,055 | £0 | £0 |
| IFI 0409 - LV Fault Location devices | 60% | 40% | 0% | £14,493 | £2,623 | £9,662 | £1,748 | £0 | £0 |
| IFI 0502 - Fault Level Monitor Project | 60% | 40% | 0% | £1,790 | £1,539 | £1,193 | £1,026 | £0 | £0 |
| IFI 0503 - L36 33kV OHL | 60% | 40% | 0% | £3,235 | £1,645 | £2,157 | £1,097 | £0 | £0 |
| IFI 0504 - Fault Infeed Calculation verific | 60% | 40% | 0% | £1,055 | £1,434 | £703 | £956 | £0 | £0 |
| IFI 0505 - Supergen V | 60% | 40% | 0% | £31,055 | £1,508 | £20,703 | £1,006 | £0 | £0 |
| IFI 0507 - Sensor Networks (Smartdust) | 60% | 40% | 0% | £1,055 | £2,001 | £703 | £1,334 | £0 | £0 |
| IFI 0508 - Redox Energy Storage | 60% | 40% | 0% | £1,055 | £3,394 | £703 | £2,263 | £0 | £0 |
| IFI 0509 - Superconducting Fault Current Limiter | 60% | 40% | 0% | £39,961 | £4,368 | £26,641 | £2,912 | £0 | £0 |
| IFI 0510 - Alt 11kV Prot | 0% | 100% | 0% | £0 | £0 | £1,758 | £2,894 | £0 | £0 |
| IFI 0511 - ACTIV Voltage Control | 60% | 40% | 0% | £22,820 | £2,773 | £15,213 | £1,849 | £0 | £0 |
| IFI 0513 - Thermal State Estimation | 60% | 40% | 0% | £24,760 | £2,560 | £16,507 | £1,706 | £0 | £0 |
| IFI 0514 - Temperature Monitoring on OHL (FMC) | 60% | 40% | 0% | £5,071 | £965 | £3,381 | £644 | £0 | £0 |
| IFI 0515 - Power System Demonstration Network (PSDN) | 60% | 40% | 0% | £1,055 | £1,838 | £703 | £1,225 | £0 | £0 |
| IFI 0517 - Temperature Monitoring for OHL (Grid Sense) | 60% | 40% | 0% | £7,616 | £965 | £5,077 | £644 | £0 | £0 |
| IFI 0518 - Offline Corrosion Monitor | 0% | 100% | 0% | £0 | £0 | £1,758 | £1,609 | £0 | £0 |
| IFI 0520 - Energy Storage for Dist Apps | 60% | 40% | 0% | £7,471 | £2,986 | £4,980 | £1,990 | £0 | £0 |
| IFI 0526 - PD Monitoring of Cables | 60% | 40% | 0% | £28,235 | £3,988 | £18,823 | £2,659 | £0 | £0 |
| IFI 0529 - ESR 21 | 60% | 40% | 0% | £2,855 | £965 | £1,903 | £644 | £0 | £0 |
| IFI 0532 - AURA - NMS | 60% | 40% | 0% | £129,849 | £11,025 | £86,566 | £7,350 | £0 | £0 |
| IFI 0535 - Radiometric Arc Fault Loctn | 60% | 40% | 0% | £31,655 | £1,254 | £21,103 | £836 | £0 | £0 |
| IFI 0540 - MANtIS | 60% | 40% | 0% | £1,055 | £2,802 | £703 | £1,868 | £0 | £0 |
| IFI 0607 - LV Automation | 60% | 40% | 0% | £9,160 | £6,119 | £6,107 | £4,080 | £0 | £0 |
| IFI 0615 - SP Advanced Research Centre | 60% | 40% | 0% | £10,250 | £2,623 | £6,833 | £1,748 | £0 | £0 |
| IFI 0618 - Supergen 1 - Flex Net | 60% | 40% | 0% | £1,055 | £965 | £703 | £644 | £0 | £0 |
| IFI 0619 - Advcd Cabling Technologies Prog | 60% | 40% | 0% | £1,055 | £965 | £703 | £644 | £0 | £0 |
| IFI 0620 - Tower Foundation Assmnt DevTrail | 0% | 60% | 40% | £0 | £0 | £15,575 | £2,866 | £10,383 | £1,911 |
| IFI 0624 - Met Office Climate Change Ph2 | 40% | 40% | 20% | £18,327 | £1,942 | £18,327 | £1,942 | £9,164 | £971 |
| IFI 0625 - Vegetation Management Project | 60% | 40% | 0% | £79,655 | £1,903 | £53,103 | £1,268 | £0 | £0 |
| IFI 0628 - Asset Decisn Support Dashboard | 60% | 40% | 0% | £25,255 | £3,835 | £16,837 | £2,557 | £0 | £0 |
| IFI 0701 - ENA De-minimis Rapper | 60% | 40% | 0% | £1,580 | £965 | £1,053 | £644 | £0 | £0 |
| IFI 0702 - Lattice Tower Protective Coat | 0% | 30% | 70% | £0 | £0 | £7,866 | £613 | £18,354 | £1,430 |
| IFI 0703 - Radio Metric S/S Monitoring | 0% | 0% | 100% | £0 | £0 | £0 | £0 | £82,462 | £2,097 |
| IFI 0704 - 4E Comms Cooling | 0% | 10% | 90% | £0 | £0 | £5,241 | £357 | £47,166 | £3,211 |
| IFI 0705 - Pole Leakage Detection Device | 60% | 40% | 0% | £5,555 | £2,129 | £3,703 | £1,420 | £0 | £0 |
| IFI 0706 - Ashton Hayes Microgrid Devel. | 60% | 40% | 0% | £1,055 | £1,692 | £703 | £1,128 | £0 | £0 |
| IFI 0707 - Wind Turbine Effects-Transmission Lines | 0% | 0% | 100% | £0 | £0 | £0 | £0 | £6,158 | £1,928 |
| IFI 0708 - Health Indices for Ast Mgmt DM | 60% | 40% | 0% | £1,055 | £965 | £703 | £644 | £0 | £0 |
| IFI 0709 - Sub.net monitoring | 35% | 35% | 30% | £25,522 | £563 | £25,522 | £563 | £21,876 | £483 |
| IFI 0710 - GB SQSS Review Studies | 0% | 0% | 100% | £0 | £0 | £0 | £0 | £9,482 | £1,609 |
| IFI 0711 - 3rd Party ROEP Risk Assessment | 35% | 35% | 30% | £9,120 | £563 | £9,120 | £563 | £7,818 | £483 |
| IFI 0712 - BT21CN Protection Solutions | 50% | 50% | 0% | £879 | £804 | £879 | £804 | £0 | £0 |

| | SPD | | SPM | | SPT | |
|---|---|---|---|---|---|---|
| Totals | External | Internal | External | Internal | External | Internal |
| | £758,900 | £106,005 | £616,274 | £85,307 | £212,863 | £14,122 |
| Ratios | 88% | 12% | 88% | 12% | 94% | 6% |

## Table B4: 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% | £85,917 | £51,550 | £34,367 | £0 | * See Note |
| IFI 0401 3 - STP Module 3 - Cable Networks | 60% | 40% | 0% | £82,068 | £49,241 | £32,827 | £0 | * See Note |
| IFI 0401 4 - STP Module 4 - Substations | 60% | 40% | 0% | £63,649 | £38,189 | £25,460 | £0 | * See Note |
| IFI 0401 5 - STP Module 5 - Distributed Generation | 60% | 40% | 0% | £80,744 | £48,446 | £32,298 | £0 | * See Note |
| IFI 0402 - LV Voltage Regulator | 60% | 40% | 0% | £45,198 | £27,119 | £18,079 | £0 | |
| IFI 0403 - Reference Network Development | 60% | 40% | 0% | £191,951 | £115,171 | £76,780 | £0 | |
| IFI 0404 - Alternative Insulating Oil Project | 60% | 40% | 0% | £98,922 | £59,353 | £39,569 | £0 | |
| IFI 0405 - New Design for 132kV trident line | 0% | 100% | 0% | £457,598 | £0 | £457,598 | £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 0503 - L36 33kV OHL | 60% | 40% | 0% | £3,320,668 | £1,992,401 | £1,328,267 | £0 | |
| IFI 0504 - Fault Infeed Calculation verific | 60% | 40% | 0% | -£12,603 | -£7,562 | -£5,041 | £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 0514 - Temperature Monitoring on OHL (FMC) | 60% | 40% | 0% | £110,911 | £66,547 | £44,364 | £0 | |
| IFI 0515 - Power System Demonstration Network (PSDN) | 60% | 40% | 0% | £709,171 | £425,503 | £283,668 | £0 | |
| IFI 0517 - Temperature Monitoring for OHL (Grid Sense) | 60% | 40% | 0% | £243,488 | £146,093 | £97,395 | £0 | |
| IFI 0518 - Offline Corrosion Monitor | 0% | 100% | 0% | £62,000 | £0 | £62,000 | £0 | |
| IFI 0520 - Energy Storage for Dist Apps | 60% | 40% | 0% | -£33,905 | -£20,343 | -£13,562 | £0 | |
| IFI 0526 - PD Monitoring of Cables | 60% | 40% | 0% | £108,661 | £65,197 | £43,464 | £0 | |
| IFI 0529 - ESR 21 | 60% | 40% | 0% | -£16,445 | -£9,867 | -£6,578 | £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 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 0703 - Radio Metric S/S Monitoring | 0% | 0% | 100% | £0 | £0 | £0 | £0 | |
| IFI 0704 - 4E Comms Cooling | 0% | 10% | 90% | £905,595 | £0 | £90,560 | £815,036 | |
| IFI 0705 - Pole Leakage Detection Device | 60% | 40% | 0% | £479,400 | £287,640 | £191,760 | £0 | |
| 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 | |

| | Total NPV | SPD NPV | SPM NPV | SPT NPV |
|---|---|---|---|---|
| Overall NPV | £12,985,288 | £5,337,179 | £4,867,251 | £2,780,858 |

* 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.

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

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

| | |
|---|---|
| **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.

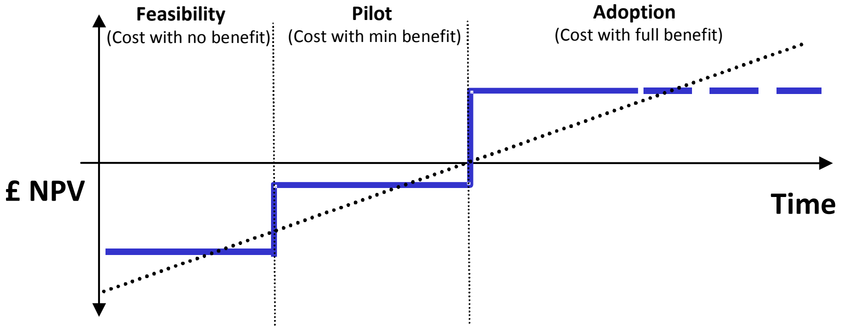


**Figure C1: How project NPV changes over the course of its development**

### 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.

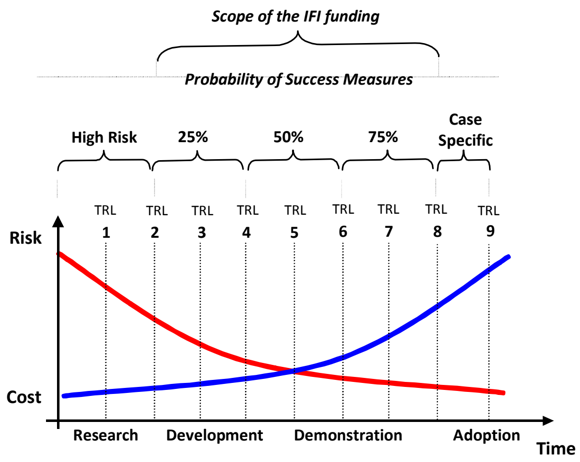
**Table C1: Technology Readiness Level / Probability of Success Definition**

**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% |

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 07 – March 08

### *IFI 0405 - Alternative Design for 132kV Overhead Lines*

<table>
<tr><td>Project Title</td><td colspan="11">Alternative Design for 132kV Overhead Lines</td></tr>
<tr><td>Description of project</td><td colspan="11">The design of a new heavy-duty 132kV wood pole overhead line specification, incorporating an underslung optical path ground wire (OPGW) for counteracting the rise of earth potential issues and for communications purposes.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £5,008<br>External £60,192<br><b>Total £65,200</b></td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £60,643<br>External £266,294<br><b>Total £326,937</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2"><b>£966,321</b></td><td colspan="5">Projected 08/09 costs for SPEN</td><td colspan="4">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">This is a project initiated to combat issues raised for the connection of renewable generation in Wales (SP-SP-M network).<br>Following the development of a specification, this project aims to construct a trial section of the line to identify associated construction or maintenance difficulties.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">There are multiple benefits to this project, including:<br>• Safety: Lower Rise of Earth Potential at substations through the addition of an earth-wire.<br>• Environmental: A higher rated single circuit line may prevent the construction of multiple overhead lines for a given network connection – there is also a significant cost benefit to customers / customer connections associated with this.<br>• Provision of communications: May permit the use of active network management into rural areas with previously poor communications.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">6 months</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" colspan="2">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td>✦</td><td></td><td></td><td></td><td>✦</td></tr>
<tr><td>Project NPV</td><td colspan="8">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£457,598</td></tr>
</table>

| | |
|---|---|
| Project Progress March 08 | The construction of a 5 span (six structure) trial section of the new 132kV wood pole overhead line was completed to investigate the following:<br>• Verification of structure design and line parameters.<br>• Ascertain the construction erection, operation, maintenance and dismantlement techniques.<br>• Monitor line performance under conductor stringing conditions and simulated insulator replacement.<br>• Provide information to satisfy all statutory requirements under the CDM regulations such as construction method statements, health & safety issues, design accuracy reports, resource plans and any other reports/data deemed necessary to fulfil the statutory requirements.<br>• Resource requirements.<br>• Provide a basis for costing.<br>• Monitor line performance for a 6-month period over the winter of 2006/2007.<br>The trial line consisted of two terminal H poles, two angle section H poles, one intermediate H pole and one intermediate single pole. In addition, a failure containment structure was built, off line, on the same site. |
| Potential for achieving expected benefits | Overall, the trial proved successful, fulfilling many of the aims and objectives set at the beginning of the project. In particular, McAlpines (the Principal Contractor) found that the line was quite straightforward to erect and could be carried out using similar techniques to other, lighter designs.<br>The trial has proved that the design is "fit for purpose" and it has been recommended that it should be rolled out to the business as an alternative to existing 132kV line designs.<br>NB. This line design is being be utilized for the Rhyl Flats Windfarm project and is also proposed for a number of other projects both in Scotland and England/Wales. |
| Collaborative Partners | N/A |
| R&D Provider | LSTC and construction contractor Alfred McAlpine |

### *IFI 0703 - Radiometric Substation Monitoring*

| | |
|---|---|
| Project Title | Radiometric Substation Monitoring |
| Description of project | Partial discharge is a phenomena arising as a result of degradation in dielectric strength of insulation. Existing techniques, which are applied within switchgear, are narrow in focus in that they apply to that piece of equipment only. Radiometric techniques have the potential to detect and locate developing discharges across substation sites of many 100s of square metres. Partial discharge is difficult to pin point and existing techniques require close proximity works with the associated safety risks. The radiometric technique is non evasive and has been used with some success mounted on substation buildings and within a test van environment. |

| | | | |
|---|---|---|---|
| Expenditure for financial year | Internal £2,097<br>External £82,8462<br>Total **£84,559** | Expenditure in previous (IFI) financial years | Internal £0<br>External £0<br>Total **£0** |
| Project Cost (Collaborative + external + SPEN) | £84,559 | Projected 08/09 costs for SPEN | Internal £0<br>External £0<br>Total £0 |

| | |
|---|---|
| Technological area and / or issue addressed by project | This proposal considers the development of a portable detection system which would be located where there was cause for concern and for sufficient period to be confident or otherwise that there was the presence of partial discharge activity.<br>The radiometric monitoring will be applied to detect potential failures in CTs, VTs and in particularly XLPE sealing ends. The primary focus being to maximise the safety of the public and staff and take the necessary interventions. |

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

| | |
|---|---|
| Expected Benefits of Project | The interpretation and presentation of the data through this technique will drive new organisation behaviour with respect to safety assessments and investment planning in response to the prediction of failures due to partial discharge activity. |

| | | | |
|---|---|---|---|
| Expected Timescale to adoption | 6-12 months | Duration of benefit once achieved | 10 Years |

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

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

| | |
|---|---|
| Project Progress March 08 | • A radiometric trailer was designed, manufactured and tested to an agreed SP specification with no change to the design apart from some software modifications to improve upon the functionality of some of the applications.<br>• The project ran longer than expected but this was due to software changes that were requested and some trailer design issues that SP were not happy with but were very quickly resolved.<br>• An additional GPS tracking device was fitted at the request of the Transport Section so that SP can monitor its location. |
| Potential for achieving expected benefits | • The Radiometric Trailer will be deployed to sites where there are known problem with partial discharge and to sites where there is a requirement to undertake plant health surveys.<br>• The equipment is currently in use monitoring a batch of suspect 132kV cable sealing ends on the SP-T network. |
| Collaborative Partners | N/A |
| R&D Providers | Elimpus |

## *IFI 0402 - Single Phase LV Voltage Regulators*

<table>
<tr><td>Project Title</td><td colspan="9">Single Phase LV Regulator</td></tr>
<tr><td>Description of project</td><td colspan="9">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 colspan="3">Internal £13,983<br>External £57,724<br>Total <b>£71,708</b></td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £18,141<br>External £115,234<br>Total <b>£133,375</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">c£250,000</td><td colspan="2">Projected 08/09 costs for SPEN</td><td colspan="4">Internal £2,000<br>External £8,738<br>Total <b>£10,738</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">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="2">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">• 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.<br>• 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.<br>• 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 colspan="2"><1 Year</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>✧</td><td>─</td><td>─</td><td>─</td><td>✧</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£45,198</td></tr>
<tr><td>Project Progress March 08</td><td colspan="9">• Some problems with ingress of water into units but was solved by replacing seals. No problems since.<br>• SP is currently working with a 3rd party to monitor the devices, which are providing encouraging results.</td></tr>
</table>

| | |
|---|---|
| Potential for achieving expected benefits | Final report from R&D provider is due mid July 2008 and the decision to fully implement shall be taken then. |
| Collaborative Partners | Phase 1(development): N/A;<br>Phase 2 (trial): Electricity North West, Scottish & Southern Energy |
| R&D Provider | MicroPlanet USA (LV Regulator), GMC Instruments (monitoring) |

### *IFI 0406 - Overhead Line Fault Passage Indicators*

<table>
<tr><td>Project Title</td><td colspan="10">Overhead Line Fault Passage Indicators</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 colspan="2">Internal £12,638<br>External £97,318<br>Total <b>£109,956</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £15,408<br>External £34,494<br>Total <b>£49,902</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£329,794</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="4">Internal £5,000<br>External £35,000<br>Total <b>£40,000</b></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 colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="2">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.<br>• This project focuses on reducing restoration time to rural customers.<br>• 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 colspan="2"><1year</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">10 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50% - Apr 07<br>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="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£297,916</td></tr>
</table>

| | |
|---|---|
| Project Progress March 08 | • Three different types of FPI (2x pole mounted devices, 1x conductor mounted device) have been assessed and approved for installation on the SP 11kV overhead line circuits.<br>• Candidate circuits were selected on the following circuits: SP-SP-M (Holywell – 3 circuits); SP-Distribution (Annan – 5 / Gretna – 1 circuit).<br>• All devices communicate using the GPRS mobile phone (data) network, which is interfaced to a data collector (iHost) located at the manufacturers office in Reading, UK.<br>• The iHost data is accessed through a web-portal, where full interrogation of the live and archived data is available. The Control Rooms are aware of and have been trained on the use of this software.<br>• A fault on one of the Annan circuits was detected soon after installation.<br>• Minor teething problems (alarm nomenclature, spurious alarms, communications issues, data management) have been discovered and are being addressed. |
| Potential for achieving expected benefits | • The project will be reviewed end Aug 08, through it is hoped that the units will experience a fault (e.g. lightening) in the period to Aug 08.<br>• Subject to a successful review in August, a direct interface will be developed between an iHost (or similar) product and the SCADA system. |
| Collaborative Partners | N/A |
| R&D Provider | **Pole Mounted Devices**: Nortech, Bowden Bros.<br>**Conductor Mounted Devices**: FMC Tech |

***IFI 0409 - LV Fault Location Devices***

<table>
<tr><td>Project Title</td><td colspan="10">LV Fault Location</td></tr>
<tr><td>Description of project</td><td colspan="10">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 £ 4,371<br>External £ 24,155<br><b>Total £ 28,526</b></td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £20,419<br>External £45,434<br><b>Total £65,853</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td><b>£184,800</b></td><td colspan="5">Projected 08/09 costs for SP-EN</td><td colspan="4">Internal £7,100<br>External £20,000<br><b>Total £27,100</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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 colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="4">Radical</td></tr>
<tr><td>No</td><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="4">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">Preliminary use of the device for fault location on persistent LV faults is expected to:<br>• Reduce the number of repeated fuse replacements<br>• Minimise the number of joint holes<br>• Remove the fault from the system in a shorter timescale than traditional ‘cut-and-test’ methods</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">Typically 8-10 years depending on technology development</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">£349,240</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">• GPRS communication has been completed successfully and is ready to be rolled out to other units. This has required 10 units to have their modems replaced with compatible GPRS units.<br>• Auto polling has been completed and can be accessed by using iHost webserver.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">• Further work to be carried out to embed software in iHost system. This will provide an easier and quicker interface with the TP22, fault locator.<br>• A deployment programme for roll-out has been put in place for 2008.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Phase 1: N/A; Phase 2: EDF-Energy; Electricity North West</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Kehui (UK) Ltd, Nortech</td></tr>
</table>

### ***IFI 0503 - L36 33kV Overhead Line Spec inc. OPPC***

<table>
<tr><td>Project Title</td><td colspan="10">L36 33kV Overhead Line Spec incorporating OPPC</td></tr>
<tr><td>Description of project</td><td colspan="10">Development of trial section of 33kV overhead line (L36) incorporating Optical Path Phase Conductor (OPPC) optical fibres for circuit communications.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £2,742<br>External £5,392<br><b>Total</b> <b>£8,135</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £22,624<br>External £5,493<br><b>Total</b> <b>£28,117</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">£50,000</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="3">Internal £0<br>External £0<br><b>Total</b> <b>£0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">A number of recent generation connections have led to a necessity to use circuits with a connection capacity over and above the existing 33kV ratings of c. 20MVA. Within the design the opportunity has been taken to introduce optical fibres into the phase conductors of the new specification as a robust / economic means of communication.<br><br>Following the development of a specification, this project aims to construct a trial section of the line to identify associated construction or maintenance difficulties. This installation will also be used as a training facility to investigate potential O+M difficulties associated with fibre optics in phase conductors.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Safety: Potential avoidance of unnecessary construction work associated with traditional methods of providing communications and hence reduction in the number of accidents.<br>• Financial: Without this specification an existing connection above 20MVA would require either the provision of two 33kV circuits or a 132kV connection. Communications are an additional requirement that is becoming increasingly important.<br>• Quality of Supply: The L36 design is compliant with BS EN 50341:2001. This factors in some degree of failure containment, giving the ability to perform in a severe weather environment and ensure a more reliable means of connection.<br>• Environmental: Potential reduction in the need for cable track excavations consequently limiting the impact of the connection works on the environment.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><1 year</td><td colspan="6">Duration of benefit once achieved</td><td colspan="3">20 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td>✦</td><td>—</td><td>—</td><td>✦</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="7">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£3,320,668</td></tr>
</table>

| | |
|---|---|
| Project Progress March 08 | The trial line (still outside the Dealain House as of Apr 08), has been deemed a technical success (mechanically), though:<br>• Some concerns were raised by the linesmen involved in the installation with regards to the structural integrity of the design when stringed with such a heavy conductor<br>• Trials of the fibre for temperature monitoring remain to be proven, however the general specification has been approved for use on the network.<br>• The L36 specification has now been released to the business (part of OHL-03-099 – Issue 1) and is currently being utilised for proposed wind farm connections. |
| Potential for achieving expected benefits | • Whilst the build specification has now moved out of development, SP intend to trial real time temperature monitoring of the line conductor on the first live build of this or a similar circuit type, consents permitting.<br>• It is recognized that the above development can only be tested with the circuit ‘on-load’ |
| Collaborative Partners | N/A |
| R&D Providers | Design Phase: Lumpi Conductors (Austria) |

### *IFI 0704 - 4energy Low Carbon Comms Cooling*

<table>
<tr><td>Project Title</td><td colspan="10">4energy Low Carbon Comms Cooling</td></tr>
<tr><td>Description of project</td><td colspan="10">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.<br>This project will develop, test and install innovative low carbon solutions to cool 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>Internal £3,567<br>External £52,406<br><b>Total £55,974</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£62,500</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £4,000<br>External £21,000<br><b>Total £25,000</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">• Currently 10 out of 19 sites utilise traditional air-conditioning.<br>• It is proposed to trial 4energy's cabinet cooling solution in all our 19 existing sites.<br>• 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>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">Operational Telecoms equipment needs to be available at all times, specifically avoiding any unplanned downtime because of thermal issues.<br>The implications of this thermal stress are two fold:<br>• Telecommunications with grid sites may be compromised if no solutions are installed.<br>• 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>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">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"><b><u>£905,595</u></b><br>based on comms room cooling only</td></tr>
</table>

| | |
|---|---|
| Project Progress March 08 | • 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.<br>• Successful off-line testing was completed with results circulated in the RFI cabinet cooling technical report (4e-QR014-015) dated March 2007. Following this an on-line test was successfully started on the 6th December 2007 at Strathaven, with 4 other sites selected to demonstrate installation procedures.<br>• 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 |
| 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.<br>• This equipment is currently being installed in 19 sites throughout the network but this could be extended to over 100 sites over the next 3 to 5 years.<br>• The key driver of power savings is using energy efficient techniques to allow temperatures in rooms to vary as now, but ensure that the high temperatures experienced in the Cisco equipment (or any other subsequently introduced sensitive equipment) is avoided. The installation of this solution will avoid having to use refrigerated air conditioning and will save 20% versus assumed costs of traditional air conditioning systems. |
| Collaborative Partners | N/A |
| R&D Providers | 4Energy |

### *IFI 0518 - Offline Corrosion Monitoring (towers)*

<table>
<tr><td>Project Title</td><td colspan="9">Offline Corrosion Monitoring (towers)</td></tr>
<tr><td>Description of project</td><td colspan="9">Capcis, working with Eve and National Grid has developed a macro level system “CARE” that can show degradation of towers based on MET office data for the last 40yrs, pollution information and locality.<br>This project is a trial of the analysis package and assessment of its application to Distribution assets and suitability for wider adoption. A key objective is to confirm whether the software can be used for 132kV towers, which are older than the 400kV structures on which the software was based.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £1,609<br>External £1,758<br><b>Total £3,367</b></td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £2,396<br>External £27,944<br><b>Total £30,340</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3"><b>£31,300</b></td><td colspan="3">Projected 08/09 costs for SP-EN</td><td colspan="3">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">Using a combination of triangulated geographical location, year of installation and painting records a detailed assessment can be made on the likely impact of corrosion for each tower on a given route.</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">• Ability to quantify the threats on a geographical basis through a robust and auditable process.<br>• Optimum prioritisation of tower replacement. Further benefits may arise if the modelling can credibly identify the worst condition assets on a route, and a variety of refurbishment strategies, potentially reducing outage periods and improving network security.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">2 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="3">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>✦</td><td>—</td><td>✦</td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£62,000</td></tr>
<tr><td>Project Progress March 08</td><td colspan="9">• 2x 132kV circuits in SP-SP-M were successfully modelled and reported in 2006/07.<br>• No further work of significance was carried out on this project in 2007/08 as a result of organisational changes.<br>• There is an intention to progress this work further to correlate ‘loss of section’ caused by corrosion to the residual strength of a tower.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="9">The work to date demonstrates how corrosion differs along a circuit route, and that this can be modelled to some degree of accuracy in a desktop environment. In order to take the full benefits from the project the correlation between corrosion and tower strength needs to be completed</td></tr>
<tr><td>Collaborative Partners</td><td colspan="9">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="9">Capcis</td></tr>
</table>

### *IFI 0701 - ENA IFI Projects*

<table>
<tr><td>Project Title</td><td colspan="10">ENA IFI Projects</td></tr>
<tr><td>Description of project</td><td colspan="10">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). These include those detailed in SP’s 06/07 IFI Annual Report:<br>1. IFI 0536: ENA Earthing Project<br>2. IFI 0537: ENA Lightning Protection<br>NB. The Fault Level Monitor project carried out with ENA member companies is reported separately (IFI0502) in line with SP process for ‘larger’ projects.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £1,609<br>External £2,633<br>**Total £4,242**</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £5,951<br>External £3,921<br>**Total £9,872**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">c£30,000</td><td colspan="3">Projected 08/09 costs for SP-EN</td><td colspan="4">Internal £1,500<br>External £2,000<br>**Total £3,500**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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.<br>• **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.<br>• **SG17 Lightning Protection** – Completion of a new Engineering Technical Report on lightning protection to include:<br>o Background information on lightning density across the UK, annual variations and effect of topography.<br>o Catalogue and provide a view on current practices and procedures.<br>o Determine and advise on equipment protection levels.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• **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.<br>• **SG17 Lightning Protection** – Identification of required lightning protection application will reduce equipment failure and faults due to lightning. This will improve performance and reduce fault costs.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 - 10 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 – 40 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25 - 75%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>✦</td><td>—</td><td>—</td><td>—</td><td>—</td><td>✦</td><td></td><td></td></tr>
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|---|---|---|
| Project NPV | (Present Benefits x Probability of Success) – Present Costs | £255,876<br>**Note** – Project costs include implementation and have been calculated by the ENA assuming a typical distribution license area. |
| Project Progress March 08 | • **SG14 Earthing Project** - Has been completed.<br>o Part 1 (Investigation at Test Facility) report delivered in 2007.<br>o Part 2 `Investigation at two live substations'<br>Both stages of the project have revealed the previously unknown effect that the LV electrode system can have on the shape of the HV voltage contours in the soil | |
| 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. | |
| Collaborative Partners | UK Distribution Network Operators (DNOs) | |
| R&D Providers | **SG17 Lightning Protection** – External Consultant<br>**SG14 Earthing Project** – Strategy & Solutions | |

### *IFI 0514 - Remote Line Temperature Monitor*

<table>
<tr><td>Project Title</td><td colspan="10">Remote Line Temperature Monitor</td></tr>
<tr><td>Description of project</td><td colspan="10">The project currently focuses on developing a system for monitoring temperature on 11kV overhead line networks. The delivered prototype will be a temperature monitor that can be installed, assessed and evaluated in a number of locations throughout the network.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1,609<br>External £8,452<br><b>Total £10,061</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £5,672<br>External £39,842<br><b>Total £45,514</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£57,991</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Fault and load monitor devices enhanced with temperature sensing capabilities implemented in order to utilise the true capacities of overhead line for use with generation connection schemes at 11kV.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Knowledge of the thermal properties of a line may allow the release of additional capacity reducing the cost of a generation connection to 11kV. This could have a significant effect on targeting capital spent reduce environmental impact.<br>• Using the FPI will give greater visibility of network faults potentially leading to a reduction in Customer Minutes Lost (CML).</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>✦—</td><td>—</td><td>—</td><td>—✦</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="7">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£110,911</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">• In June 2007 FMC-Tech demonstrated successful results of live trial on ESB Ireland MV network. At this stage they were approached to become technology partner on IFI 0513 Dynamic Thermal Ratings project. This effectively halted this workstream at the R&D stage with the proposed field trial being undertaken under IFI 0513</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">• This project has completed and SPEN are using the technology on two other projects, IFI 0513 – Thermal State Estimation and IFI 0406 – Fault Passage Indication.<br>• Overall the project was a success with two other projects successfully using the technology developed.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="10">FMC Tech</td></tr>
</table>

## ***IFI 0526 - PD Monitoring of Cables (11 & 33kV)***

<table>
<tr><td>Project Title</td><td colspan="4">PD Monitoring of Cables (11 & 33kV)</td></tr>
<tr><td>Description of project</td><td colspan="4">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:<br>• Long term monitoring to identify the degradation of the cable which signals the increase in risk of failure; and<br>• PD mapping which pinpoints the location of any discharge along the route of the cable.<br>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.<br><br>This project will develop a portable PD monitoring product that can be moved around the network, as tool in the prioritisation in cable replacement.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £6,647<br>External £47,058<br>Total **£53,705**</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £0<br>External £0<br>**Total £0**</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£160,000</td><td>Projected 08/09 costs for SPEN</td><td colspan="2">Internal £5,000<br>External £42,650<br>**Total £47,650**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">This project will develop partial discharge monitoring hardware which will initially be tested on the SP 11kV network with the following aims:<br>• 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.<br>• 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.<br>• 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.<br>It is planned that the test results will be collated in a database, which, in conjunction with results from the testing carried out by other UK DNOs, will allow for advancements in the knowledge rules for future PD testing technology.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>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">• 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.<br>• Anticipated key benefits will be in the area of CML and CI improvements and cost savings through targeted cable section replacement programmes.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1-2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">5 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>✦</td><td>─</td><td>─</td><td>✦</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="4">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="6">£108,661</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">• As of March 2008 IPEC had developed the prototype portable partial discharge monitor as per the project specification. Testing had commenced in the SP-M area in January following the authorisation of the IPEC engineering team to work within SP substations.<br>• Testing to date has not been as successful as expected due to many SP-M area substations not having suitable access to cable earths to carry out the PD monitoring. However, IPEC have agreed to carry out the testing as outlined in the project plan in SP-D where cable earths are more commonly accessible for testing.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">• The potential for achieving expected benefits is still high – although based on findings to date the technology may be more appropriate for deployment in SP-D as opposed to SP-M.<br>• IPEC will commence a program of testing in various primary substations in Scotland, which have already been surveyed for suitability in May 2008. The testing period is estimated to last 4-6 weeks at which point IPEC will compile a report on the performance of cables tested.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="10">IPEC High Voltage Ltd (IPEC HV)</td></tr>
</table>

### *IFI 0625 - Vegetation Management - ADAS*

<table>
<tr><td>Project Title</td><td colspan="4">Vegetation Management – ADAS</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.<br>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.<br>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 £3,171<br>External £132,758<br><b>Total £135,929</b></td><td>Expenditure in previous (IFI) financial years</td><td>Internal £0<br>External £0<br>Total <b>£0</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2"><b>£1,744,000</b></td><td>Projected 08/09 costs for SP-EN</td><td>Internal £8,000<br>External £41,000<br>Total <b>£49,000</b></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.<br>• It will involve cuts made to 2000 sample areas across the identified zones to a common specification, followed by monitoring to confirm growth.<br>• The output is expected to lead to modelling software that can portray different cut cycles.<br>• 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.<br>• 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).<br>• Improved targeting of OPEX may be realised through proactive cutting and extending the cutting cycle in high and low growth areas respectively.</td></tr>
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<table>
<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 08</td><td colspan="10">• ADAS have set up the research sites and obtained consent from the relevant landowners to take part in the experiment.<br>• ADAS surveyors have taken the initial measurements of Utility Space and this data has been provided to ScottishPower. Vegetation on the sites will be allowed to grow and will be re-measured during October and November.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Progress to set up the sites has been good and the project has a high potential for achieving the expected benefits. Initial results from the model will be available for March 2009.</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>

### *IFI 0702 - Lattice Steel Tower Protective Coatings*

<table>
<tr><td>Project Title</td><td colspan="10">Lattice Steel Tower Protective Coatings</td></tr>
<tr><td>Description of project</td><td colspan="10">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.<br>Once a prototype has been accepted trials would be undertaken in an acceleration chamber in parallel with field trail application.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,043<br>External £26,220<br><b>Total £28,263</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £0<br>External £0<br><b>Internal £0</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£60,000</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £4,000<br>External £33,500<br><b>Total £39,500</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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.</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">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">The main business benefit of a safe one coat epoxy paint system will be as follows:<br>• Reduced exposure to falls during tower access/egress<br>• Reduced exposure to falls as painters and inspectors spend less time working at heights<br>• Application costs are anticipated to be 25% for the same degree of protection<br>• Outage duration times are expected to be reduced by 33%.<br>• More towers can be painted during outage window</td></tr>
<tr><td>Expected Timescale to adoption</td><td>April 2009</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">Unlimited</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>✦—</td><td>—</td><td>—</td><td>—✦</td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£1.6m</td></tr>
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| Project Progress March 08 | • 4 new paint systems have been developed with reduced irritants.<br>• Site trials will take place in May 2008 and if successful the new systems will be sent to EATL for extensive testing. |
| Potential for achieving expected benefits | Potential will not be known until extensive testing is complete (expected October 2008) |
| Collaborative Partners | N/A |
| R&D Providers | Chemco International |

## ***IFI 0709 - Sub.net Monitoring***

| | | | | | |
|---|---|---|---|---|---|
| Project Title | Network Monitoring Using Web Based Systems | | | | |
| Description of project | 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.<br>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. | | | | |
| Expenditure for financial year | Internal | £ 72,920 | Expenditure in previous (IFI) financial years | Internal | £ 0 |
| | External | £ 1,609 | | External | £ 0 |
| | **Total** | **£ 74,529** | | **Total** | **£ 0** |
| Total Project Costs (Collaborative + external + SPEN) | **£ 130,000** | | Projected 08/09 costs for SPEN | Internal | £ 26,000 |
| | | | | External | £ 27,000 |
| | | | | **Total** | **£ 53,000** |
| Technological area and / or issue addressed by project | 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. | | | | |
| Type(s) of innovation involved | Incremental | | Project Benefits Rating | Project Residual Risk | **Overall Project Score** |
| | | | 13 | -1 | **14** |
| Expected Benefits of Project | The project aims to offer improvements in system operation, performance and safety:<br>• Reductions in CML and consequent penalty savings will be achieved by timely fault location and appropriate restoration<br>• Monitoring of protection systems ensure that protection settings are optimised and voltage dip durations are minimised<br>• Safety and performance improvements realised by monitoring operating times of circuit breakers and substation battery supplies<br>• 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<br>• Web Access negates the requirement for a base station to dial in/out and offers roving accessibility. No polling and central processing requirements | | | | |
| Expected Timescale to adoption | 1 Year | | Duration of benefit once achieved | 20 Years | |

| | | | |
|---|---|---|---|
| Probability of Success | 70 % | Project NPV = (Present Benefits x Probability of Success) – Present Costs | No NPV calculated for this limited trial |
| Potential for achieving expected benefits | • Work has been continuing on substation health monitoring, with alarms, substation battery voltages and automatic trip coil timing.<br>• Further work is to be carried out to develop an algorithm to automatically calculate distance to fault using impedance mapping. | | |
| Project Progress **March 2008** | • 20 Units have been ordered with the view of installing 10 units in SP-D and 10 units in SP-M.<br>• Low power requirements mean that units connect to any substation battery (no 240V ac requirement).<br>• Communication has been proven between the trial unit and the server.<br>• Harmonic logging reports are now available<br>• CB trip coil currents / trip timing can be derived. | | |
| Collaborative Partners | None | | |
| R&D Provider | Embedded Monitoring Systems (eMS). | | |

### *IFI 0711 - 3rd Party ROEP Risk Assessment*

| | | | | |
|---|---|---|---|---|
| Project Title | IFI 0711 - 3rd Party ROEP Risk Assessment | | | |
| Description of project | The development of a Stage II probabilistic-based risk assessment, which includes the use of historical operational clearance times for managing Rise of Earth Potential (REOP) in substations.<br>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 £ 1,609<br>External £ 26,058<br>Total **£ 27,667** | Expenditure in previous (IFI) financial years | Internal £ 0<br>External £ 0<br>**Total £ 0** | |
| Total Project Costs (Collaborative + external + SPEN) | £62,000 | Projected 08/09 costs for SPEN | Internal £ 2,000<br>External £ 29,000<br>**Total £ 31,000** | |
| Technological area and / or issue addressed by project | This software package will allow SPEN to assess current sites to determine whether or not there is a touch/step issues within the substation and a danger of third party exposure to ROEP. | | | |
| Type(s) of innovation involved | Incremental | Project Benefits Rating | Project Residual Risk | **Overall Project Score** |
| | | 7 | -3 | **10** |
| Expected Benefits of Project | • System fault levels have been increasing due to the significant amounts of renewable generation that has been (or is planned to be) connected to the network. If current system fault level techniques 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.<br>• 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.<br>• 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. | | | |
| Expected Timescale to adoption | 1 Year | Duration of benefit once achieved | 4 Years | |
| Probability of Success | 75% | Project NPV = (Present Benefits x Probability of Success) – Present Costs | £ 15,562 | |

| | |
|---|---|
| Potential for achieving expected benefits | The theoretical studies to develop a Stage II probabilistic-based risk assessment are now under development at Cardiff. |
| Project Progress **March 2008** | The trial of Stage one has been completed with the ability to reclassify substations into low/high risk categories. This has allowed a quick and easy quantification of risk in relation to the ALARP levels at site. |
| Collaborative Partners | National Grid |
| R&D Provider | Cardiff University High Voltage Energy Systems Research Group |

### *IFI 0403 - Reference Networks Phase 2*

<table>
<tr><td>Project Title</td><td colspan="3">Reference Networks - Phase 2</td></tr>
<tr><td>Description of project</td><td colspan="3">The project will produce a practical software tool to create optimum disaggregation groups and analyse existing networks and proposed performance improvement strategies.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £0<br>External £1,758<br><b>Total</b> <b>£1,758</b></td><td>Expenditure in previous (IFI) financial years</td><td>Internal £8,724<br>External £61,144<br>Total <b>£69,868</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td><b>£341,200</b></td><td>Projected 08/09 costs for SPEN</td><td>Internal £0<br>External <b>£0</b><br>Total <b>£0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">A framework is being developed that will enable network performances to be objectively compared, the differences to be understood and explained, and cost and benefits of alternative distribution network investment strategies to be evaluated.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3"><table><tr><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr><tr><td>Yes</td><td>No</td><td>No</td><td>No</td></tr></table></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">• Ensuring that capital expenditure on improving the performance of the network will be optimised both in respect of applying the expenditure to circuits where the greatest benefit can be obtained.<br>• The financial benefits of greater understanding of network performance drivers, and improved regulation are difficult to quantify but have the potential to be extremely large.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 years</td><td>Duration of benefit once achieved</td><td>5 years</td></tr>
<tr><td>Probability of Success</td><td>50%</td><td colspan="2"><table><tr><td colspan="9">TRL Development (Start – Current)</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td></td><td></td><td></td><td>✧</td><td>—</td><td>✧</td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td>£191,951</td></tr>
<tr><td>Project Status March <b>08</b></td><td colspan="3">This report is now closed with final project report to be delivered.<br>SPEN have withdrawn from this project due to data compatibility problems.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">This project is now closed with report due July 08</td></tr>
<tr><td>Collaborative Partners</td><td colspan="3">Electricity North West, Central Networks, PB Power, CE Electric</td></tr>
<tr><td>R&D Providers</td><td colspan="3">Imperial College London</td></tr>
</table>

### *IFI 0517 - GridSense LineTracker FPI (Conductor Temperature)*

<table>
<tr><td>Project Title</td><td colspan="11">GridSense LineTracker FPI (Conductor Temperature)</td></tr>
<tr><td>Description of project</td><td colspan="11">The LineTracker is a fault and load monitor device from which data is downloaded wirelessly to a control centre at 33kV.<br>The key aims are to add conductor and ambient temperature to LineTracker and increase voltage withstand for operation at 132kV.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal<br>External<br><b>Total</b></td><td>£1,609<br>£12,693<br><b>£14,302</b></td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal<br>External<br><b>Total</b></td><td colspan="3">£3,663<br>£54,019<br><b>£57,682</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£140,000</td><td colspan="3">Projected 08/09 costs for SPEN</td><td colspan="3">Internal<br>External<br><b>Total</b></td><td colspan="3">£0<br>£0<br><b>£0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">Fault and Load Monitor devices enhanced with temperature sensing capabilities implemented in order to utilise the true capacities of OH Line for use with generation connection schemes at 33kV</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="2">Significant</td><td colspan="4">Technological substitution</td><td colspan="4">Radical</td></tr>
<tr><td>Yes</td><td colspan="2">No</td><td colspan="4">No</td><td colspan="4">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">Knowledge of the thermal properties of a line may allow the release of additional capacity reducing the cost of a generation connection at 33kV. This could have a significant effect on targeting capital spent reduce environmental impact.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</td><td colspan="3">Duration of benefit once achieved</td><td colspan="6">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="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">£243,458</td></tr>
<tr><td>Project Progress March 08</td><td colspan="11">• Development and integration of temperature monitoring to GridSense's existing GSM FPI was successfully completed in 06/07.<br>• SP encountered technical problems prior to installation. Despite these problems being investigated with the manufacturer, SP chose not to proceed with a network trial.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="11">Lessons learned from this project have been incorporated into IFI 0513 (Thermal estimation) and IFI 0406 (Fault Passage Indicators)</td></tr>
<tr><td>Collaborative Partners</td><td colspan="11">Electricity North West</td></tr>
<tr><td>R&D Providers</td><td colspan="11">GridSense CHK</td></tr>
</table>

### *IFI 0705 - Pole leakage detection device – Phase 1-3*

<table>
<tr><td>Project Title</td><td colspan="10">Pole leakage detection device – Phase 1-3</td></tr>
<tr><td>Description of project</td><td colspan="10">The project aims to develop of a small, insulated, hand-held unit that will detect earth leakage current, and either flag a traffic light and / or an audible alarm. It is envisaged that line patrollers will use such a device as both a safety measure and to identify potential issues e.g. cracked insulators, before they develop into faults.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £2,687<br>External £9,258<br><b>Total £11,945</b></td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3"><b>£78,500</b></td><td colspan="3">Projected 08/09 costs for SP-EN</td><td colspan="4">Internal £2,500<br>External £15,000<br><b>Total £17,500</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">• Primary driver: Identification of damaged / cracked insulators from ground level before they develop into a fault.<br>• Secondary driver: Development of a tool for assessing safety risks associated with wooden poles<br>• Tertiary driver: Assessment of safety risk associated with low pole leakage through measurement</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• The project was initiated to address a safety issue, however cost benefits could be available, associated with early detection of faulty insulators, reducing complete failures where customer’s supplies are interrupted.<br>• A quick method of testing for damaged insulators could therefore yield significant benefits in terms of both CI and CML.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">1-2 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">15 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">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">£479.4k</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">• Project established with Poletecs, having identified several key stages and target price / speed of operation for final devices.<br>• Stage 1 commenced Dec 07, with outcomes expected Apr 08.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">As of Mar 08, SP were awaiting stage 1 report to be released, which would be reviewed with the R&D Provider prior to determine whether to proceed.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Poletecs</td></tr>
</table>

### *IFI 0404 - Alternative Insulating Oils – Phase 1*

<table>
<tr><td>Project Title</td><td colspan="10">Alternative Insulating Oils Project – Phase 1</td></tr>
<tr><td>Description of project</td><td colspan="10">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 £3,299<br>External £10,628<br><b>Total £13,928</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £5,188<br>External £18,884<br><b>Total £24,072</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td><b>£142,290</b></td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £3,000<br>External £16,400<br><b>Total £19,400</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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>Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Reduced environmental risk associated with oil spills.<br>• Potential to up-rate transformers at strategic sites.<br>• 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>4 years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">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">£98,922</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">• The original project aim was to determine if ester based transformer oils would be suitable for use in large power transformers (already in use in smaller distribution transformer). From the research and analysis undertaken it would appear that these alternative oils perform in a similar manner to traditional mineral oil with respect to electrical characteristics and dielectric properties.<br>• Indications are promising that ester based oils will be a suitable replacement or alternative to mineral oils. The FR3 ester oil is only suitable for sealed transformers as the oil would oxidise and sludge in a free breathing environment.<br>• Testing to date would indicate the ester-based oils are not detrimental to the integrity of the paper insulation of the windings.</td></tr>
</table>

| | |
|---|---|
| Potential for achieving expected benefits | • 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.<br>• 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 collaborative partners in order to gain confidence in their application.<br>• A second phase to this project has consequently been proposed. As part of our support to this project SPEN have offered an obsolete 5MVA 25kV power transformer to the University of Manchester to enable them to do further research work. |
| Collaborative Partners | National Grid, Electricity North West, EDF Energy, Areva T&D, TJH2B, M&I Materials |
| R&D Provider | University of Manchester |

## ***IFI 0510 - Innovative Protection Solutions***

<table>
<tr><td>Project Title</td><td colspan="10">Innovative Protection Solutions</td></tr>
<tr><td>Description of project</td><td colspan="10">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>Expenditure for financial year</td><td colspan="3">Internal £2,894<br>External £1,758<br><b>Total £4,652</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £3,939<br>External £1,144<br><b>Total £5,083</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3"><b>£150,000</b></td><td colspan="4">Projected 08/09 costs for SP-EN</td><td colspan="3">Internal £10k<br>External £35k<br><b>Total £45k</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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.<br><br>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 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 colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="3">Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Reducing the size protection zones CI and CML figures<br>• Reducing time multiplier, protection clearance times should be improved<br>• Resolving sympathetic tripping of adjacent breakers</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">1 year (assuming successful trial)</td><td colspan="4">Duration of benefit once achieved</td><td colspan="3">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">75%</td><td colspan="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">£50,000</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">• VTs to polarise fault current have been found and can be fitted to new switchgear and some old types.<br>• Testing of relays and VTs is progressing, with promising results</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">There are indications that the new relay and VTs will be able to be integrated into the network, with trials to take place in 2008/09.</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>

### ***IFI 0624** - **Impact of Climate Change, Energy (Phase 2) - MET Office***

<table>
<tr><td>Project Title</td><td colspan="4">Impact of Climate Change, Energy (Phase 2) - MET Office</td></tr>
<tr><td>Description of project</td><td colspan="4">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.<br>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.<br>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.<br>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.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £4,855<br>External £45,819<br><b>Total £50,673</b></td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td><b>£450,000</b></td><td colspan="2">Projected 08/09 costs for SP-EN</td><td>Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.<br>• Understand the potential impact of climate change to network assets will ensure the network built today is fit for purpose into the future.<br>• Create methodology for prediction of gas and electricity demand using climate models (dealing with limitations in spatial and temporal resolution).<br>• Assess the importance of temporal resolution to the calculation of energy demand.<br>• Investigate the differences of modelling demand using: climate model output, new climate model diagnostics, and weather generated output.</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>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="10">The expected benefits of project are:<br>• Probabilistic understanding of likely future electricity and gas demand;<br>• Model for projecting meteorologically driven demand suitable for inclusion in climate model or for application to climate model output;<br>• Demand from 'Energy' climate model simulation;<br>• Reporting of the affect of temporal and spatial resolution on the demand calculation, and recommendations for projecting demand from UKCIP08 when available; and<br>• Recommendations for improvements in demand modelling approach if necessary.<br>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.</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">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>—</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">Not Calculated</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">Final executive summary and summary report is being drafted. Results of the study will be presented to SP on 17th June at Bellshill.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Project is expected to deliver on all the initial objectives as well as an additional piece of work, funded out of unused contingency, to establish the relationship between severe weather and network performance.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">**Networks Only:** C.E. Electric, National Grid, Electricity North West, Western Power Distribution<br>**Networks, Generation & Supply:** E.ON, EDF Energy, Northern Ireland Electricity, Scottish & Southern Energy, ScottishPower<br>**Generation & Supply Only:** Centrica, RWE, npower</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Met Office</td></tr>
</table>

### *IFI 0620 - Tower Foundation Radar*

<table>
<tr><td>Project Title</td><td colspan="4">Tower Foundation Radar</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.<br><br>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 £2,000<br>External £1,144<br><b>Total</b> <b>£3,144</b></td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £0<br>External £0<br><b>Total</b> <b>£0</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td><b>£51,400</b></td><td>Projected 07/08 costs for SPEN</td><td colspan="2">Internal £2,500<br>External £48,900<br><b>Total</b> <b>£51,400</b></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.<br><br>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>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Ability to survey all tower foundations along a route<br>• Survey times are dramatically reduced and cheaper<br>• Proven portable equipment, allowing easier access to sites with reduced environmental damage<br>• Ability to make a comparison between techniques</td></tr>
<tr><td>Expected Timescale to Adoption</td><td>1 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="3"><table><tr><td colspan="9">TRL Development (Start – Current)</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td>✦</td><td>✦</td><td></td><td></td></tr></table></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">£14,220</td></tr>
<tr><td>Project Progress March 08</td><td colspan="4">• Radar survey complete with results received and analysed.<br>• Digging phase of project to be carried out in May to compare the results obtained from radar technology.</td></tr>
</table>

| | |
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| Potential for achieving expected benefits | • Results from radar survey do not appear to offer a great insight into the condition of tower foundations underground.<br>• Received radar report mainly highlights issues above ground such as percentage steel loss and noticeable cracks in tower foundations above ground.<br>• Comparison between the digging phase on selected towers and the radar report will prove the effectiveness of the radar technique. |
| Collaborative Partners | None |
| R&D Providers | Sterling Geophysical Surveys Ltd |

### ***IFI 0628 - Asset Decision Support Dashboard***

| | |
|---|---|
| Project Title | Asset Decision Support Dashboard |
| Description of project | 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.<br>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. |

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| Expenditure for financial year | Internal £6,392<br>External £42,092<br>**Total £48,484** | Expenditure in previous (IFI) financial years | Internal £0<br>External £0<br>**Total £0** |
| Project Cost (Collaborative + external + SPEN) | **£98,391** | Projected 08/09 costs for SPEN | Internal £15000<br>External £80000<br>**Total £95000** |

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| Technological area and / or issue addressed by project | 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.<br>• 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.<br>• Phase 2 applies to further AIS information and other databases to provide asset performance history and trending.<br>• 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. |

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

| | |
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| Expected Benefits of Project | 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. |

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| Expected Timescale to adoption | 1 Year | Duration of benefit once achieved | 10 Years |

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

| | | |
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| Project NPV | (Present Benefits x Probability of Success) – Present Costs | £163,235 (based on all 3 phases being developed) |

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| Project Progress March 08 | • A five-day workshop was held at SP's Bellshill office in December '07. DS&S held structured interviews with SP staff from across the business to capture requirements and obtain the data required to support the dashboard.<br>• The outcome of the workshop was the requirement for a dashboard to measure, track and forecast the risk that SP is exposed to from its E-Hazard population. There is the potential to gain value from linking the E-hazard population to system performance.<br>• There have been several follow-up teleconferences and meetings at Bellshill to discuss project progress, seek further clarification of requirements, discuss information sources and discuss the risk associated with each individual E-hazard category.<br>• DS&S created a spreadsheet that will form the basis of the dashboard. The logic contained in this spreadsheet was discussed with SP investment strategy staff in May '08 and feedback sent to DS&S. |
| Potential for achieving expected benefits | • Phase 1 of the Asset Decision Support Dashboard is expected to be complete by October 2008.<br>• Progress to phases 2 and 3 will be dependent on further discussions. |
| Collaborative Partners | N/A |
| R&D Providers | Data Systems & Solutions (DS&S) |

### *IFI 0707 - Wind Turbine Effects on Transmission Lines*

<table>
<tr><td>Project Title</td><td colspan="3">Wind Turbine Effects on Transmission Lines</td></tr>
<tr><td>Description of project</td><td colspan="3">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.<br><br>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 £1,928<br>External £6,158<br><b>Total £8,086</b></td><td>Expenditure in previous (IFI) financial years</td><td>Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td><b>£70,000</b></td><td>Projected 08/09 costs for SP-EN</td><td>Internal £7,000<br>External £55,000<br><b>Total £62,000</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">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 colspan="3"><table><tr><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr><tr><td>Yes</td><td>No</td><td>No</td><td>No</td></tr></table></td></tr>
<tr></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">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>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td>Duration of benefit once achieved</td><td>20 years</td></tr>
<tr><td>Probability of Success</td><td>50%</td><td colspan="2"><table><tr><td colspan="9">TRL Development (Start – Current)</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td></td><td></td><td></td><td></td><td>✦</td><td>✦</td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Project NPV</td><td colspan="2">(Present Benefits x Probability of Success) – Present Costs</td><td>£835,466</td></tr>
<tr><td>Project Progress March 08</td><td colspan="3"><b>Stage 1 :</b> A review of previous literature and tests carried out on this phenomenon has been completed. This has identified further work, which is to be carried out in stage 2 of this project.</td></tr>
</table>

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| Potential for achieving expected benefits | **Stage 2:** The proposed work programme includes:<br>• Wind tunnel studies at Milan Polytechnic – to be carried out during the first week of July with final report due summer 08.<br>• Low frequency and vibration monitoring of SP overhead lines.<br>• Co-operation with Hydro Quebec to evaluate effects of eddies on overhead line conductors.<br>• Continuation of an investigation through Cigré working groups |
| Collaborative Partners | N/A |
| R&D Providers | Milan Polytechnic and Hydro Quebec |

### *IFI 0712 - BT 21st Century Protection Solutions (BT21CN)*

<table>
<tr><td>Project Title</td><td colspan="4">BT 21st Century Protection Solutions (BT21CN)</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.<br><br>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 colspan="2">Internal £ 1,609<br>External £ 1,758<br><b>Total £ 3,367</b></td><td>Expenditure in previous (IFI) financial years</td><td>Internal £ 0<br>External £ 0<br><b>Total £ 0</b></td></tr>
<tr><td>Total Project Costs (Collaborative + external + SPEN)</td><td colspan="2"><b>£114,000</b></td><td>Projected 08/09 costs for SPEN</td><td>Internal £ 15,000<br>External £ 43,000<br><b>Total £ 58,000</b></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:<br>• Power Line Carrier combining protection and SCADA signalling<br>• Small development works to facilitate intra-substation communications<br>• IP based protection signalling mediums and associated security implications<br>• Options for alternative communication channels for shared services<br>• 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>
</table>

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|---|---|---|---|
| Expected Benefits of Project | There are many sites in SP-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.<br>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; PLC is more cost effective in all cases. 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. | | |
| Expected Timescale to adoption | 1.5 Year | Duration of benefit once achieved | 15 Years |
| Probability of Success | 50% | Project NPV = (Present Benefits x Probability of Success) – Present Costs | £951,763 |
| Potential for achieving expected benefits | In areas of the network for signalling for protection cannot be deliver via PLC or Radio and fibre is prohibitively expensive, leased communications are the only option. Should a suitable leased be unavailable then significant investments in fibre optic installation will be required. | | |
| Project Progress March 2008 | • Existing (and potentially future) inter-substation communications equipment and interfaces examined.<br>• The deployment of radio equipment on non L-O-S links has been examined currently without success.<br>• Initial works carried out on an IP network test-bed to assess the feasibility of running TDMoIP protection signalling. | | |
| Collaborative Partners | N/A | | |
| R&D Provider | RFL / THUS / Radius / others TBC | | |

### *IFI 0520 - Energy Storage Devices for Distribution Networks*

<table>
<tr><td>Project Title</td><td colspan="9">Energy Storage Devices for Distribution Networks</td></tr>
<tr><td>Description of project</td><td colspan="9">This project aims to investigate the feasibility of using different type of energy storage devices on the distribution network as a means of balancing distributed generation outputs with load demands.<br><br>The project will investigate a range of primary asset technologies (energy storage, VAr compensation, dynamic circuit ratings) and their application to two identified case studies. Within each case study the driver is to maximise generation output while minimising conventional assets, namely overhead lines.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £4,976<br>External £12,451<br><b>Total £17,427</b></td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £8,100<br>External £26,525<br><b>Total £34,625</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3"><b>£30,000</b></td><td colspan="3">Projected 08/09 costs for SP-EN</td><td colspan="3">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">The project aims to investigate technologies which will make distributed generation connections make feasible by helping to resolve some of the issues they cause on distribution network</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">No</td><td colspan="3">No</td><td colspan="2">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">• Distributed generation connections could be made more feasible by lowering/negating the need for reinforcements.<br>• Identification of most effective locations of storage as an infrastructure asset on a given network.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">3 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="3">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="8">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>✦</td><td>─</td><td>─</td><td>✦</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="3">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="6">-£33,905<br>Unable to detail the benefits case for storage without this work, hence –ve NPV.</td></tr>
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| Project Progress March 08 | • A study on 2 networks was completed and reported in 2006/07, concluding that use of a storage unit would be useful in enabling further connections of distributed generation in that network<br>• A second stage was completed in 07/08, accurately costing several available (TRL 6+) storage technologies. The project concluded that although technically suitable, the £/kW cost differential for storage is significantly higher than network infrastructure, which, even with the support of IFI and RPZ would be difficult to justify in the current Regulatory Distributed Generation Incentive Mechanism (DGIM)<br>• SP have since been seeking alternative funding sources to develop a proof of concept on the live network |
| Potential for achieving expected benefits | • A significant reduction in capital costs is required in order to make energy storage above 1MW commercially viable in the short term<br>• SP are working with project partners to develop bids to funding parties including the Energy Technologies Institute (ETI) to progress this project from a desktop exercise to a live trial / RPZ facilitating small levels of generation |
| Collaborative Partners | N/A |
| R&D Providers | PB plus several storage manufacturers |

### ***IFI 0513 - Thermal modelling and Active Network Management***

<table>
<tr><td>Project Title</td><td colspan="10">Thermal modelling and Active Network Management</td></tr>
<tr><td>Description of project</td><td colspan="10">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>£4,266</td><td colspan="3" rowspan="3">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal</td><td colspan="3">£9,534</td></tr>
<tr><td>External</td><td>£41,267</td><td colspan="2">External</td><td colspan="3">£1,709</td></tr>
<tr><td>Total</td><td><b>£45,533</b></td><td colspan="2">Total</td><td colspan="3"><b>£11,243</b></td></tr>
<tr><td rowspan="3">Project Cost (Collaborative + external + SP-EN)</td><td colspan="2" rowspan="3"><b>£903,000</b></td><td colspan="4" rowspan="3">Projected 08/09 costs for SP-EN</td><td colspan="2">Internal</td><td colspan="2">£15,000</td></tr>
<tr><td colspan="2">External</td><td colspan="2">£71,000</td></tr>
<tr><td colspan="2">Total</td><td colspan="2"><b>£86,000</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">• 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.<br>• This project seeks to explore the potential benefits arising from:<br>o Improved utilisation of power system assets through the use of real time knowledge of the thermal status of the power system.<br>o 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.<br>• 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>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">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• 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.<br>• 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>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="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£301,867</td></tr>
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| Project Progress March 08 | • Standard-based component thermal models of overhead lines, underground cables and power transformers, have been validated<br>• Thermal state estimation algorithm (TSEA) is under development<br>• Computational fluid dynamic models of the above components are being validated<br>• Algorithms for the control of DG based on TSEA are under development<br>• Target hardware development platforms have been identified<br>• A service-oriented software development approach has been adopted<br>• Trial site identified and site visits undertaken<br>• Thermal instrumentation of the trial site has been specified and commissioned.<br>• Work is being disseminated through two IET journal submissions and six national and international conference publications<br>• Hardware for the field trials is under development, using similar Areva hardware to a similar project in Skegness, but adapted to include transformer and cable ratings.<br>• The hardware architecture is under development, and will be based on multiple MiCOM relays and a high-level host controller. |
| Potential for achieving expected benefits | This project is progressing on target, with network data gathering from the instrumented network scheduled for August 2008. Open loop trials of the TSEA and control algorithm are expected to begin in late 08/early 09 |
| Collaborative Partners | TSB (via Technology Programme), Durham University, Imass, Areva T&D, PB |
| R&D Providers | PB (project manager), as above |

## ***IFI 0509 - Superconducting Fault Current Limiter***

<table>
<tr><td>Project Title</td><td colspan="12">Superconducting Fault Current Limiter</td></tr>
<tr><td>Description of project</td><td colspan="12">This project aims to design, develop and trial three 12kV Superconducting Fault Current Limiting (SFCL) devices on three different UK networks.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £7,279<br>External £66,601<br>**Total £73,881**</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £13,264<br>External £38,644<br>**Total £51,908**</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">**£2,345,967**</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £10,000<br>External £49,187<br>**Total £59,187**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The development of a non-linear ‘high-temperature’ superconducting ceramic in series with a circuit breaker for the clamping and clearance of fault energy.<br><br>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.<br><br>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.<br><br>Three devices (one per DNO) will be constructed and installed covering a range of applications: transformer tails, bus section, interconnected network connection. The successful completion of this project is likely to pave the way for higher voltage devices.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">To develop, understand and address the issues associated with the connection of an 11kV fault current limiting device to the network.<br><br>Successful trials will result in the development of commercially available devices that are capable of clamping fault levels to within network design limits. Once proven, this will open up another option for tackling network fault level, potentially providing an alternative to network reinforcement.</td></tr>
<tr><td>Expected Timescale to Adoption</td><td colspan="3">3 years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="3" rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>✦</td><td></td><td>✦</td><td></td><td></td><td></td><td></td></tr>
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<table>
<tr><td>Project NPV</td><td>(Present Benefits x Probability of Success) – Present Costs</td><td>£-267,191<br>Project NPV is negative due to the low TRL / high costs upon commencement</td></tr>
<tr><td>Project Progress March 08</td><td colspan="2">• Superconducting elements have been designed and type tested and full production of all the elements is underway.<br>• Cryogenic equipment to store and cool the elements is either on order or has been delivered ready for assembly.<br>• HV circuit breakers and other items required to support the installation, are on order.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="2">• The consortium is at an advanced stage of development of the first FCL.<br>• Future milestones include the assembly and type testing at an independent test house prior to installation and commissioning towards the end of 2008.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="2">Electricity North West, CE Electric UK, Applied Superconductors Ltd</td></tr>
<tr><td>R&D Providers</td><td colspan="2">Applied Superconductors Ltd</td></tr>
</table>

## *IFI 0507 - Sensor Networks (Smart Dust) – Phase 2*

<table>
<tr><td>Project Title</td><td colspan="4">Sensor Networks (Smart Dust) – Phase 2</td></tr>
<tr><td>Description of project</td><td colspan="4">“Smartdust” is a concept developed by the University of California that is based on a self-configuring wireless sensor network, capable of transmitting low bandwidth information in a series of short hops. Data acquired and transmitted from sensors is relayed through a gateway for data interpretation. ScottishPower led a feasibility study into the use of this technology for detecting the passage of fault currents on 11kV overhead line networks.<br><br>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 £3,335<br>External £1,758<br>**Total £5,094**</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £6,922<br>External £14,950<br>**Total £21,872**</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>Phase 1 = £16k<br>Phase 2 = £191k</td><td>Projected 08/09 costs for SPEN</td><td colspan="2">Internal £7,500<br>External £50,000<br>**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.<br><br>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:<br>• Allows a much higher percentage of locations of be monitored economically than any other option, across all price points and time savings<br>• Offers SP a much higher NPV than any other option<br><br>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="10">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 colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>✧</td><td>✧</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="5">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£554.5k</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">Phase 2 progress<br>The project has been put together between several manufacturers combining expertise from sensing (To Be Finalised), communication platform (Willow). It is proposed to be project managed by E.ON Power Technology.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">• A new project has been worked up during 2007/08 for commencement in 08/09.<br>• The new project will start at a TRL 5 (sub-system validation in a relevant environment) and will aim to complete at a TRL 8 (System completed and qualified through test and demonstration)</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Central Networks</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Willow, E.ON Power Technology</td></tr>
</table>

## *IFI 0706 - Ashton Hayes Microgrid*

<table>
<tr><td>Project Title</td><td colspan="4">Ashton Hayes Microgrid</td></tr>
<tr><td>Description of project</td><td colspan="4">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 colspan="2">Internal £2,819<br>External £1,758<br><b>Total £4,578</b></td><td>Expenditure in previous (IFI) financial years</td><td>Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="2">£56,500</td><td>Projected 08/09 costs for SPEN</td><td>Internal £8,000<br>External £40,000<br><b>Total £48,000</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The proposed project aims to develop a route map of the integration of small-scale generation into legacy networks.<br>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>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>No</td><td>Yes</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The impact on adjacent parts of the network and the implications of legacy equipment will be taken into account.<br>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.<br>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>Duration of benefit once achieved</td><td>20 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td colspan="2"><table><tr><td colspan="9">TRL Development (Start – Current)</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td></td><td></td><td></td><td>✦</td><td>✦</td><td></td><td></td><td></td><td></td></tr></table></td></tr>
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| | | |
|---|---|---|
| Project NPV | (Present Benefits x Probability of Success) – Present Costs | £7,549 |
| Project Progress March 08 | Monitoring equipment has been deployed onto the network to establish the demand characterises of the existing customers. Initial consideration as been given to the perceived network issues that can be tested against the Ashton Hayes networks. | |
| Potential for achieving expected benefits | • The provision of solution for incremental design changes, as penetration of small-scale generation increased in legacy networks will allow simple, efficient connection designs to be produced in a timely manner.<br>• The project is on target to deliver the benefits. | |
| Collaborative Partners | Ashton Hayes village | |
| R&D Providers | EA Technology | |

### *IFI 0708 - Health Indices for Asset Management Decision Making*

<table>
<tr><td>Project Title</td><td colspan="4">IFI 0708 - Health Indices for Asset Management Decision Making</td></tr>
<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.<br>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:<br>• Network Performance (CMI & CI), Safety, Financial and Environmental<br>• Criticality is expressed as a multiplication factor and is the importance or significance of an individual asset relative to other assets in the group.<br>• 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 £ 1,609<br>External £ 1,758<br><b>Total £ 3,367</b></td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £ 0<br>External £ 0<br><b>Total £ 0</b></td></tr>
<tr><td>Total Project Costs (Collaborative + external + SPEN)</td><td><b>£</b> 50,000</td><td>Projected 08/09 costs for SPEN</td><td colspan="2">Internal £ 6,000<br>External £40,000<br><b>Total £46,000</b></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).<br>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<br>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.<br>• Ability to define and defend spending requirements<br>• Ability to advance age assets to help determine possible future condition, performance and risk<br>• Assess impact of different investment intervention strategies and ‘do nothing’ option<br>• A quantification, risk based approach to CAPEX investment with a clear audit trail</td></tr>
</table>

| | | | |
|---|---|---|---|
| Expected Timescale to adoption | 2 Years | Duration of benefit once achieved | 5 Years |
| Probability of Success | 50% | Project NPV = (Present Benefits x Probability of Success) – Present Costs | To be considered pending outcome of trial. |
| Potential for achieving expected benefits | • Updating and adding to CBRM spreadsheets is currently a relatively complex, manual process which will be addressed by a software tool under development<br>• While the CBRM methodology has been used by other DNOs the concept of measuring future risk (in monetary terms) with and without specific investment programmes is new to most companies<br>• The future wider application of these techniques to other non-load asset areas will be determined along with the suitability to develop these techniques to other investment areas (load/ reinforcement etc.) | | |
| Project Progress **March 08** | • The trial will provide SPEN with a good appreciation of this CBRM process and its relevance to future investment planning in the context of existing asset management and planning process.<br>• The outputs and methodology of this trial will be compared with those of the Asset Decision Support Dashboard project (IFI 0628), in order to recommend the best way forward for the Business. | | |
| Collaborative Partners | N/A | | |
| R&D Provider | EA Technology Limited | | |

***IFI 0710 - GB SQSS Review Studies***

<table>
<tr><td>Project Title</td><td colspan="4">GB SQSS Review Studies</td></tr>
<tr><td>Description of project</td><td colspan="4">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.<br><br>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 £ 1,609<br>External £ 9,482<br>Total <b>£ 11,090</b></td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £ 0<br>External £ 0<br>Total <b>£ 0</b></td></tr>
<tr><td>Total Project Costs (Collaborative + external + SPEN)</td><td><b>£ 60,000</b></td><td>Projected 08/09 costs for SPEN</td><td colspan="2">Internal £ 4,000<br>External £ 18,000<br>Total <b>£ 22,000</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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">Incremental / Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td><b>Overall Project Score</b></td></tr>
<tr><td>11</td><td>-7</td><td><b>18</b></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• 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.<br>• The new MITS planning rules will help to defend investment decisions in future Transmission Price Control Reviews<br>• The role and impact of wind generation on the transmission network will be better understood, with all generation treated on an equal basis.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>60%</td><td>Project NPV = (Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">No NPV as unable to quantify analysis outcomes.</td></tr>
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| Potential for achieving expected benefits | • This project is near completion with a consultation document issued on the 09th January 2008.<br>• Public workshops and consultations are taking place this year with results and feedback due early 2009. |
| Project Progress **March 2008** | The working group considered five candidate approaches, which could form the basis of a methodology for determining transmission capability requirements. The working group engaged Strathclyde University and TNEI Services Limited to carry out some analysis on some of the candidate approaches:<br>• The current GB SQSS approach<br>• Security' supplemented by cost benefit analysis<br>• Membrane' supplemented by cost benefit analysis<br>• Generation equal access' supplemented by cost benefit analysis<br>• Pure cost benefit approach<br>The pure cost benefit approach was subsequently dropped on the grounds of considerable lack of transparency, consistency and repeatability. |
| Collaborative Partners | National Grid Electricity Transmission plc and Scottish Hydro Electric Transmission Limited. |
| R&D Provider | TNEI Services Ltd, Strathclyde University |

***IFI 0511 - Voltage Control ACTIV (EATL)***

<table>
<tr><td>Project Title</td><td colspan="10">Voltage Control – ACTIV (EATL)</td></tr>
<tr><td>Description of project</td><td colspan="10">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 £4,622<br>External £38,033<br><b>Total £42,655</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £1,566<br>External £1,144<br><b>Total £2,710</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td>£254,206</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £6,000<br>External £69,369<br>Total <b>£75,369</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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 colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="2">No</td><td colspan="3">No</td></tr>
<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;<br>• Improving the voltage profile of supply;<br>• Reducing the requirement for network extensions or reinforcement and increasing the capacity for the connection of distributed generation; and<br>• 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>✧</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">£67,445</td></tr>
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| Project Progress March 08 | The relay and monitoring equipment were installed at the first site in Elland (part of CE Electric UK's network) between the 17th and 19th March. The site has 2 transformers, presently using a master, follower system, and a landfill generator is connected on one feeder that is also supplying load. The relay has been installed open loop initially. The following values have been recorded:<br>• Real and reactive current and voltage from the generator.<br>• Real and reactive current and voltage through one transformer.<br>• Real and reactive current on the feeder.<br>• Real and reactive generator current estimated by the relay.<br>• Tap change events.<br>• Tap change signals from the relay.<br>• Voltage at the remote end of the feeder with the greatest voltage drop.<br>From the start date of December 2007, the project is currently on schedule. Likewise, the budget spent both in terms of materials and person hours are on schedule.<br>Initial results show that the estimation follows the generator output well for a landfill gas generator with a steady output. It was able to estimate significant changes in output. |
| Potential for achieving expected benefits | With one trial site installed with promising initial results and a further two identified, there is a high probability that the expected benefits will be achieved. |
| Collaborative Partners | Central Networks, Scottish & Southern Energy, Electricity North West |
| R&D Providers | EATL, Fundamentals |

***IFI 0607 - LV Network Automation***

<table>
<tr><td>Project Title</td><td colspan="9">LV Network Automation – Phase 2</td></tr>
<tr><td>Description of project</td><td colspan="9">EATL has developed a patented automation system for single-phase 660V ac rail signalling circuits called "SignalSure". Phase 1 of the LV Network Automation project investigated how the technology might be applied to the LV distribution networks and the issues that could arise from the transfer of the "SignalSure" automation system concept to the SP-D / SP-M LV distribution networks. The LV distribution network application is referred to as "LVSure". Phase 1 is now complete and Phase 2 will seek to develop the project for the application of LVSure on the SP LV distribution network.<br><br>In addition, Phase 2 will consider a proposal by Radius that would utilise existing Radius automation architecture.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £10,199<br>External £15,266<br><b>Total £25,465</b></td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £2,631<br>External £18,698<br><b>Total £21,329</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3"><b>£257,775</b></td><td colspan="3">Projected 08/09 costs for SP-EN</td><td colspan="3">Internal £15,000<br>External £70,000<br><b>Total £115,000</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">The Low Voltage networks contribute ~11% CI and ~15.5% CML between the SP-D / SP-M networks (taken from 2003/04 NaFIRs report).<br>• 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.<br>• Application will be to focus on high customer density, worst performing LV circuits.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="2">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">Application of the technology should provide the following benefits:<br>• Reduction of CMLs on the LV network<br>• Increased asset life of circuit elements by the reduction of both fault currents and stresses during fault location<br>• Reduced cost and time of fault location through rapid identification of faults location<br>• Elimination of repeated intermittent faults</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">3 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="3">10 Years</td></tr>
<tr><td rowspan="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>
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| Project NPV | (Present Benefits x Probability of Success) – Present Costs | £526,7k |
| Project Progress March 08 | <u>Phase 1 (working with EATL)</u><br>• Output from phase 1 delivered three detailed reports<br>• LV Sure applications & benefits<br>• Technical constraints & financial implications<br>• Safety & operational implications<br><br><u>Phase-2 (Radius / EATL)</u><br>Radius (magnetic device)<br>o The feasibility of designing a miniature LV vacuum switch has been investigated, which would be controlled by a miniature magnetic actuator and would be housed so that it could be placed into a fuse holder or link box.<br>o This housing would also accommodate a CT for fault current detection and power line carrier inducer for the signalling.<br>o It is proposed that Radius further design a module that would directly replace the RF module on their range of RNO and RNI radios. This would allow identical signalling to be used on the LV network and would provide a migration path for equipment currently used on the HV network to be used on the LV network.<br>EATL (power electronic device)<br>• In contract discussions (partnership with other DNOs) | |
| Potential for achieving expected benefits | Initial indications are positive.<br>SP is hopeful that the EATL project will commence in the short term. | |
| Collaborative Partners | Potential for Phase 2: EDF-Energy, Scottish & Southern Energy, Electricity North West | |
| R&D Providers | EATL, with collaborative support from Scottish & Southern Energy (possibly EDF-Energy) and Radius with SP input only. | |

### *IFI 0504 - Fault Infeed Calculations*

<table>
<tr><td>Project Title</td><td colspan="10">Fault Infeed Calculations</td></tr>
<tr><td>Description of project</td><td colspan="10">A part funded project through the Technology Strategy Board (TSB) Technology Programme (K/EL/00352/00/00) this aims to improve the quality of fault current calculations in commercial load flow software packages.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,390<br>External £1,758<br><b>Total £4,148</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £4,021<br>External £1,144<br><b>Total £5,165</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td><b>£116,500</b></td><td colspan="4">Projected 08/09 costs for SP-EN</td><td colspan="5">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The methods for calculating fault current contribution in commercial load flow packages vary from vendor to vendor. This project aims to assess the currently available solutions to assess best practice and define new algorithms to improve the quality of output.</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 current can have a significant bearing on reinforcement spend. As switchgear does not have an overload capability for fault level, when exceeded (either through load growth, motor infeed or generation connections), investment is required to replace for higher rated units.<br>Improved understanding at design stage would ensure investment is targeted at optimum times, and on the most appropriate circuits. It is noted, that new methodologies could increase the levels of investment in a given network, however this would give rise to safety and equipment longevity improvements in the long term.</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">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">-£12,603<br>The NPV of this project is negative, as it is at a too early stage to assess</td></tr>
</table>

| | |
|---|---|
| Project Progress March 08 | The key conclusions from the comparison of the fault calculation methods are the following:<br>• Peak make results are similar between all four methods<br>• Break results can be quite different depending on the representation of AC decay<br>• DC component decay can be sensitive to assumptions and equipment representation<br>• Care is required when comparing methods to ensure that the underlying assumptions or options are equivalent<br>All fault calculations are based on fitted models rather than explicit representation of the underlying mechanisms. Therefore, the same approach is perfectly reasonable to apply to the new technologies.<br>The primary issue with respect to the new technologies is that they are highly configuration and controller dependent rather than based purely on physical characteristics such as with synchronous machines. Therefore, it may be necessary to provide more detailed fault current curves based on a range of standard faults to help the end-user ensure that their representation of the technology is sufficient.<br>It is reasonably straightforward to create 'brute force' iterative algorithms to determine the maximum connectable generation due to fault current contribution. However, for other than trivial networks, the simple algorithms require significant computer time such that they are impractical to use. |
| Potential for achieving expected benefits | Further research is required on the representation of new technologies to help define a standard model. Also, to develop a standard data submission for equipment suppliers in a similar fashion to those available for synchronous generation and induction machine manufacturers. This is an activity that could be lead by the ENA, IEC or a similar organisation.<br>The investigation has also shown that it is possible to develop a maximum connectable generation tool. Further development could lead to a commercial application that would have useful benefits for DNOs in terms easily identifying areas of potential generation access or network stress. |
| Collaborative Partners | Electricity North West, Central Networks, TSB (via Technology Programme) |
| R&D Providers | TNEI Ltd |

### *IFI 0505 - Supergen V AMPerES*

<table>
<tr><td>Project Title</td><td colspan="12">Supergen V (AMPerES)</td></tr>
<tr><td>Description of project</td><td colspan="12">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>Expenditure for financial year</td><td colspan="3">Internal £2,514<br>External £51,758<br>Total **£54,272**</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £5,460<br>External £26,144<br>Total **£31,604**</td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">**£2,800,000**</td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £5,000<br>External £25,000<br>Total **£30,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">SUPERGEN V proposal is aimed at:<br>WP 1: Programme delivery, outreach and implementation<br>WP 2: Enhanced network performance and planning<br>WP 3: New protection and control techniques that adapt to changing networks<br>WP 4: Infrastructure for reducing environmental impact<br>WP 5: Ageing mechanisms<br>WP 6: Condition monitoring techniques</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">The expected aims of the project are:<br>• To deliver a suite of intelligent diagnostic tools for plant<br>• To provide platform technologies for integrated network planning and asset management<br>• To progress plans to develop and implement improved and reduced environmental impact networks<br>• To develop models and recommendations for network operation and management</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">5 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="3" rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>✦</td><td>✦</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£150,000</td></tr>
</table>

| | |
|---|---|
| Project Progress March 08 | • The project is now fully resourced in all universities.<br>• More physical demonstrators are being built at both distribution and transmission substations. The initial evaluation of techniques is complete and machine-learning techniques have been selected for implementation.<br>• The more fundamental work on ageing of plant, which is necessary to underpin the more applied activities, is on target.<br>• High-level work to develop optimal asset replacement and network expansion methodologies is progressing well.<br>To date 14 reports and 38 publications have arisen from this work, 27 of these since last year. The following is a list of reports from the period 07/08:<br>• Loss of Mains Detection and Amelioration on Networks<br>• Loss-of-Mains detection by differential ROCOF Protection using internet protocol.<br>• Interim report on protection and control of distribution networks with synchronous islands.<br>• Reducing the Environmental Impact of Electrical Plant - Annual report<br>• First report on use of high temperature conductors on distribution networks.<br>• Final report on high temperature low sag conductors.<br>• Report on ICSD 2007<br>• Report on literature on non-power frequency ageing in dielectrics<br>• Condition monitoring -State of the art report vs. 2 |
| Potential for achieving expected benefits | 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.<br>For further details see www.supergen-amperes.org |
| Collaborative Partners | National Grid, ScottishPower, Scottish and Southern, Electricity North West, Western Power Distribution, Central Networks, CE Electric, NIE, Advantica & EDF Energy Networks. |
| R&D Providers | EPSRC selected universities – Manchester, Strathclyde, Liverpool, Southampton, Edinburgh, Queens University Belfast |

### *IFI 0508 - Development of Redox flow battery for energy storage*

<table>
<tr><td>Project Title</td><td colspan="10">Development of Redox flow battery for energy storage</td></tr>
<tr><td>Description of project</td><td colspan="10">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 colspan="3">Internal £7,498<br>External £1,144<br><b>Total £8,642</b></td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £2,995<br>External £0<br><b>Total £2,995</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3">£965,567</td><td colspan="3">Projected 07/08 costs for SPEN</td><td colspan="4">Internal £3,500<br>External £30,000<br><b>Total £33,500</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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 colspan="2">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="2">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• 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.<br>• 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.<br>• As a replacement for current lead-acid batteries, this technology has a low environmental impact.<br>• 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 <b>March 08</b></td><td colspan="10">• Site identified for the installation of the Redox unit<br>• Point of electrical connection to the SP-D 11kV network agreed<br>• Prototype design of Redox cell complete<br>• Construction programme in place</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Project is currently behind schedule (between 6/9 months)</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>

## *IFI 0515 - Power System Demonstration Network (PSDN)*

| | | | | |
|---|---|---|---|---|
| Project Title | Demonstration Network | | | |
| 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.<br>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 £3,063<br>External £1,758<br>**Total £4,821** | Expenditure in previous (IFI) financial years | Internal £23,648<br>External £21,692<br>**Total £45,340** | |
| Project Cost (Collaborative + external + SPEN) | **£7,200,000** | Projected 08/09 costs for SPEN | Internal £10,000<br>External £42,500<br>**Total £52,500** | |
| Technological area and / or issue addressed by project | In partnership with collaborators, this project aims to:<br>• Provide a demonstration network to allow the testing of new technologies on a ‘real’ network<br>• Offer a real network that will incorporate 11kV and low voltage equipment, containing real loads, real generation and test real technologies<br>• Create a facility which will be open to Academia, R&D Establishments, Manufacturers, and Network Operators<br>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.<br>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:<br>**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.<br>**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.<br>**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></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">£709,171</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10"><b>Development of proposal</b>: The detailed proposal has been further developed between SP and project partners consisting of:<ul><li>Comprehensive market survey lead by Scottish Enterprise to determine potential users of the demonstration network</li><li>Specific market survey carried out by ScottishPower on behalf of Ofgem to determine UK Distribution Network Operator/Transmission System Operator appetite for such a facility</li></ul>Exploration of funding opportunities:<ul><li>Several funding models have been proposed and reviewed over the course of the project. Changes within Scottish Enterprise has resulted in a further review of funding provisions.</li><li>Scottish & Southern Energy has subsequently become a collaborative partner.</li></ul>Working with Ofgem:<ul><li>On-going dialogue has been maintained with Ofgem in the development of the project and they have subsequently confirmed outline agreement to the eligibility of project under IFI rules.</li></ul></td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Whilst significant challenges have been overcome, delays have been encountered that have resulted in Rolls Royce withdrawing funding from the project. Consequently alternative industrial parties have been sought. Albeit that they have withdrawn funding Rolls Royce has indicated their interest in using of the Demonstration Network.<br><br>In 2008/09 the proposal and costs will be revisited and consideration given to other possible funding models. Additional funding partners will also be considered.</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>

### *IFI 0540 - MANtIS (Managing Active Networks through Intelligent Systems)*

<table>
<tr><td>Project Title</td><td colspan="10">MANtIS (Managing Active Networks through Intelligent Systems)</td></tr>
<tr><td>Description of project</td><td colspan="10">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 £4,371<br>External £17,083<br><b>Total £21,454</b></td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £1,770<br>External £1,144<br><b>Total £2,914</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td><b>£2,453,030</b></td><td colspan="5">Projected 08/09 costs for SPEN</td><td colspan="4">Internal £4,000<br>External £16,500<br><b>Total £20,500</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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 colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>Yes</td><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Development of techniques to ensure operation in interconnected and islanded-modes, including load shedding<br>• Provision of fault ride-through capabilities by control of fault current limiting devices.<br>• Availability of proven enabling technologies should anticipated levels of DG be realised.<br>• 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="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)<br>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>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">To be determined once a suitable enabling technology has been aligned to a specific network application.</td></tr>
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| Project Progress March 08 | • A workshop was held in October 07 at SP’s offices in Bellshill. All project partners attended the workshop along with SP staff from across the business. The discussions covered SP’s fault level issues, the solutions that might be provided by Mantis, protection issues, safety concerns, the requirement for type testing, implementation and the business case.<br>• There have been several follow-up discussions from the workshop, in particular between Strathclyde University staff and SP’s network designers and switchgear experts. As part of these discussions a requirement was identified to study a network where fault level issues have caused problems for a DG connection. SP identified a recent example and provided technical and financial parameters to be used in the Mantis studies. The financial parameters will allow the Mantis project to study the costs of the alternative technologies and create a business case. |
| Potential for achieving expected benefits | The project is on target. |
| Collaborative Partners | Rolls-Royce, Manchester and Strathclyde University, TSB (via Technology Programme) |
| R&D Providers | Rolls-Royce, Manchester and Strathclyde University |

### *IFI 0502 - Fault Level Monitor Project*

<table>
<tr><td>Project Title</td><td colspan="10">Electricity Supply Fault Level Instrument</td></tr>
<tr><td>Description of project</td><td colspan="10">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.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,566<br>External £2,983<br><b>Total £5,549</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £4,902<br>External £9,144<br><b>Total £14,046</b></td></tr>
<tr><td>Project Cost (Collaborative + external + [DNO])</td><td><b>£190,000</b></td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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.</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">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">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:<br>• Provide a real-time and consistent estimation of fault level<br>• Accurately take into account all connected network elements (e.g. Motors);<br>• Facilitate the connection of distributed generation by providing a standardised methodology for the assessment of network fault levels<br>• Enable an ongoing assessment of the effects of connected distributed generation to be made;<br>• 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="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">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>✦</td><td>✦</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£92,045</td></tr>
</table>

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|---|---|
| Project Progress to March 08 | A number of activities have been pursued by both EA Technology and the University of Strathclyde in the progression of this project. These are summarised as:<br>• **Experiment & Laboratory Investigation** – The performance of the previous Fault Level Monitor was tested against the known parameters of the University of Strathclyde's microgrid. In general a reasonable level of agreement was achieved.<br>• **Algorithm Validation** – The algorithms from the Fault Level Monitor coded within Matlab were tested using a network model in Matlab/Simulink to provide the sampled data to the algorithm. The results were compared to values of source infeed and motor infeed calculated directly from the parameters of the disturbances used. This resulted in an assessment of the potential accuracy of the instrument under a variety of load and disturbance conditions. At the power factor and load disturbance conditions that were most likely to be experienced in a real power system the results were not within the required accuracy band.<br>• **Comparison of Real Site** – In contrast to the results obtained under the algorithm validation section, comparison of measurements made on a real network with the Fault Level Monitor exhibited a much closer agreement with the results expected |
| Potential for achieving expected benefits | Proposals are being prepared for consideration to carry out further work to resolve questions about the apparent differences in performance of the existing Fault Level Monitor and the Fault Level Monitor Algorithms implemented in Matlab.<br>To progress to stage 2 of the project as originally defined the results obtained from stage 1 had to support a statement that it was technically feasible to develop a Fault Level Measuring Instrument capable of deriving answers within ±5% of the actual Source and Motor Infeed values.<br>As the results of Stage 1 do not support an unequivocal statement that it is technically feasible to develop a Fault Level monitor with the required degree of accuracy this project will conclude at Stage 1. |
| Collaborative Partners | National Grid, Scottish & Southern Energy, CE Electric UK, Electricity North West, Central Networks, Western Power Distribution, EDF-Energy Networks |
| R&D Providers | University of Strathclyde, EA Technology |

### ***IFI 0532 - AURA-NMS***

<table>
<tr><td>Project Title</td><td colspan="4">AURA-NMS (Automated Regional Active Network Management System)</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 £18,375<br>External £216,415<br><b>Total £234,790</b></td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £8,081<br>External £155,442<br><b>Total £163,523</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td><b>£5,962,636</b></td><td colspan="2">Projected 08/09 costs for SPEN</td><td>Internal £15,000<br>External £176,823<br><b>Total £320,000</b></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.<br>• Distributed Generation and demand side management to facilitate the connection of DG to the network;<br>• Develop a controller that will monitor electricity networks, isolate faults quickly and allow distributed generation to remain connected and operating.<br><br>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:<br>• Overcoming complexity of existing hard-wired intertripping schemes<br>• Determining a solution for managing multiple generation connections in a given locality<br>• Developing and implementing a system that can work in harmony with existing SCADA infrastructure<br>• 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:<br>• Development of a constraint management solution with relevant experts<br>• Implement solution and prove concept<br>• Potential to create Registered Power Zone for additional revenue on the DG incentive<br>• Maximisation of the contribution of DG to the electricity network;<br>• Reduction in carbon emissions and help towards the UK governments climate change targets;<br>• Reduction in network losses by having the source of generation close to the load;<br>• Improvement in quality and security of supply;<br>• Improvement in network resilience; and<br>• Reducing the current market failures to increase network capacity for DG.</td></tr>
</table>

<table>
<tr><td>Expected Timescale to adoption</td><td>7 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">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<br>The figure is negative as this is a costly project starting from a low TRL</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">• Significant progress has made by the AuRA-NMS WP1 (System Design) with regard to voltage control, thermal ratings and restoration functionality. At this stage of the research development work its highly targeted and aligned with DNO needs. The first AuRA-NMS function suite is on target for release for initial testing WP0 (Testing/Implementation Strategy) on July 08<br>• AuRA-NMS WP2 (Communications design) and WP3 (Business Case work) is being driven from the outputs of WP1 and is well underway.</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.<br>• The integration works requirements are currently under discussion with ABB. Should the required functionality be developed and the necessary provisions be made possible by the integration works, SP is keen to develop project outputs into a closed – loop trial as soon as possible</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>
</table>

## *IFI 0535 - Radiometric Arc Fault Location*

<table>
<tr><td>Project Title</td><td colspan="10">Radiometric Arc Fault Location</td></tr>
<tr><td>Description of project</td><td colspan="10">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 colspan="3">Internal £2,090<br>External £52,758<br><b>Total £54,848</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £2,677<br>External £1,144<br><b>Total £3,821</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">£292,000</td><td colspan="4">Projected 08/09 costs for SP-EN</td><td colspan="3">Internal £2,500<br>External £12,500<br><b>Total £15,000</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The principle of the technology is:<br>• There is a correlation between RF discharges and network faults on overhead lines<br>• The RF signal can be picked up by a radio antenna up to around 70km away<br>• If antennae are spread across the network, a mesh is formed – in a similar manner to the GSM network<br>• 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)<br>• If this information is linked to GIS / SCADA data a more accurate fault location can be obtained</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">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="3">3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="3">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">£45,787</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">Project was further delayed by 4 months with work beginning in the first quarter or 2008. Progress so far:<br>• 4 sites have been selected within the SPD area, with planning permission being sought,<br>• Approved contractor contacted and negotiations in progress</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Delays in negotiating the commercial terms and conditions have resulted in significant deadline slippage for the commencement of this project. Since the contract was signed in Dec 07, the project has progressed ahead of schedule.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Western Power Distribution, Scottish & Southern Energy, Central Networks, Electricity North West, CE Electric UK</td></tr>
<tr><td>R&D Providers</td><td colspan="10">University of Strathclyde</td></tr>
</table>

### *IFI 0615 - ScottishPower Advanced Research Centre (SPARC)*

| | |
|---|---|
| Project Title | ScottishPower Advanced Research Centre (SPARC) – University of Strathclyde |
| Description of project | Three workstreams have been proposed:<br>• ***Asset Engineering***: Field based activities, concentrating on the technologies used to gather and interpret data then control and manage individual assets.<br>• ***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).<br>• ***System Development***: Forward looking network design activities considering the connectivity between the assets. It should consider both the medium term (5 years) and longer-term trends (>10 years), which will affect the design of the network (e.g. load, generation, standards, regulations, Ofgem incentives/penalties).<br>A number of related projects will be developed within each workstream. |

| | | | | | |
|---|---|---|---|---|---|
| Expenditure for financial year | Internal<br>External<br>**Total** | £4,371<br>£17,083<br>**£21,454** | Expenditure in previous (IFI) financial years | Internal<br>External<br>**Total** | £2,409<br>£76,161<br>**£78,570** |
| Project Cost (Collaborative + external + SP-EN) | **£460,083** | | Projected 08/09 costs for SP-EN | Internal<br>External<br>**Total** | £15,000<br>£98,000<br>**£113,000** |

| | |
|---|---|
| Technological area and / or issue addressed by project | • Asset Engineering research stream focuses on methods and technologies that enable better use of individual assets.<br>• Asset Strategy research stream focuses on methods and tools that enable better management of populations of assets.<br>• System Development research stream focuses on analytical techniques that provide SP with better capability to plan and design the power system. |

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

| | |
|---|---|
| Expected Benefits of Project | 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. |

| | | | |
|---|---|---|---|
| Expected Timescale to adoption | 3 Years | Duration of benefit once achieved | 10 Years |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Probability of Success | Varies per project | TRL Development (Start – Current) | | | | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | | | ✦ | ✦ | | | | | | |

| | | |
|---|---|---|
| Project NPV | (Present Benefits x Probability of Success) – Present Costs | TBC<br>In development for the core projects in each workstream |

| | |
|---|---|
| Project Progress March 08 | • Key areas of interest identified by SP, with more detailed project proposals developed for the three workstreams.<br>• Core operating principles (meeting frequency / agenda items, deliverables and Key Performance Indicators) successfully developed.<br>• 2x PhD students and 1x RA successfully recruited and background research undertaken on projects. |
| Potential for achieving expected benefits | • The core principle of SPARC is the linkage of several smaller applied research projects in a given topic, which will bridge the gap associated between research outputs and company policy / strategy.<br>• The active and regular engagement between SPARC programme managers from both University of Strathclyde and SP Energy Networks should ensure successful transition into the business. |
| Collaborative Partners | N/A |
| R&D Providers | University of Strathclyde |

### ***IFI 0619 - Advanced Cable Technologies***

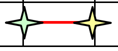
<table>
<tr><td>Project Title</td><td colspan="12">Advanced Cable Technologies</td></tr>
<tr><td>Description of project</td><td colspan="12">Advanced Cabling Technologies Programme wrapper for a discrete programme of related IFI cabling projects with a de minimus expenditure level of £40k per annum. 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 colspan="3">Internal £1,609<br>External £1,758<br><b>Total £3,367</b></td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="6">Internal £1,566<br>External £1,144<br><b>Total £2,710</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td colspan="3"><b>c£30,000</b></td><td colspan="3">Projected 08/09 costs for SPEN</td><td colspan="6">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The programme addresses cabling technologies and associated issues. The example project considers the following.<br>• 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.<br>• 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="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">A range of project benefits is expected under this programme. For the example project benefits expected would include the following.<br>• Enhanced reliability of cable joints, with reduced likelihood of jointing installation error<br>• Smaller cable joints enabling reduced excavation and reinstatement costs and quicker jointing times</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">2 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="6">3 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="3" rowspan="3">Projects with various probabilities of success will be considered</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>✦</td><td>✦</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project NPV</td><td colspan="6">(Present Benefits x Probability of Success) – Present Costs</td><td colspan="6">£90,726</td></tr>
<tr><td>Project Progress <b>March 08</b></td><td colspan="12">Agreement with R&D provider regarding schedule of work and project completion dates confirmed. Sample cable ordered for deliver to joint manufacturer.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="12">Cable supplied for type testing; type testing completed and trial joints in the ground – target End December 2008.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="12">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="12">Bound under confidentiality</td></tr>
</table>

### *IFI 0529 - ESR network ESR 21*

<table>
<tr><td>Project Title</td><td colspan="10">ESR network (ESR 21)</td></tr>
<tr><td>Description of project</td><td colspan="10">The ESR Network is an academia / industry exchange to identify and link university funded projects to key industry stakeholders.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1,609<br>External £4,758<br><b>Total £6,367</b></td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £3,947<br>External £7,144<br><b>Total £11,091</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SPEN)</td><td><b>£126,000</b></td><td colspan="4">Projected 08/09 costs for SPEN</td><td colspan="5">Internal £0<br>External £0<br><b>Total £0</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">ESR Network, the successor to ERCOS (Electricity Research Co-funding Scheme), acts as a data exchange between industry and academia for research activities. This network covers the majority of the UK universities and monitors all electricity related research activities funded by EPSRC, TSB (Technology Programme), etc.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="4">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td colspan="3">Yes</td><td colspan="4">No</td><td colspan="2">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Monitoring of selected publicly-funded research grants of specific interest to the industrial membership<br>• Preparing R&D strategy papers on areas determined by the Panel<br>• Network of academic / industrial contacts</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Ongoing linkage to academia</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">3 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">-£16,445</td></tr>
<tr><td>Project Progress March 08</td><td colspan="10">ScottishPower have withdrawn from this project for resource reasons.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">This project has now closed</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10"><b>Industrial:</b> SP Generation, QinetiQ, National Grid, BNFL, Magnox Generation, SERCO Assurance, VATECH Reyrolle, ABB Switzerland Ltd, RWE Innogy Plc, ALSTOM Power, AREVA T&D (Technology Centre), E-ON UK<br><b>Academic:</b> Brunel University, Cranfield University, Glasgow Caledonian University, Imperial College London, Loughborough University, Queen's University of Belfast, The University of Birmingham, The University of Nottingham, University of Bath, University of Birmingham, University of Bristol, University of Kent, University of Leeds, University of Manchester, University of Southampton, University of Strathclyde, University of Sussex, University of Wales Swansea, University of Cambridge<br><b>Government:</b> TSB, EPSRC</td></tr>
<tr><td>R&D Providers</td><td colspan="10">See above academics</td></tr>
</table>

## *IFI 0618 - Supergen 1 – FlexNet*

| | | | | |
|---|---|---|---|---|
| Project Title | Supergen 1 - FlexNet | | | |
| Description of project | 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.<br>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 | | | |
| Expenditure for financial year | Internal £1,758<br>External £1,609<br>**Total £3,367** | Expenditure in previous (IFI) financial years | Internal £1,566<br>External £1,144<br>**Total £2,710** | |
| Project Cost (Collaborative + external + SP-EN) | **£7.6m** | Projected 08/09 costs for SP-EN | Internal £5,000<br>External £20,000<br>**Total £25,000** | |
| Technological area and / or issue addressed by project | **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.<br>Some of the key issues to be addressed by the programme include:<br>• How can we judge the degree of flexibility needed?<br>• How can flexibility be achieved?<br>• How much flexibility should come from primary plant giving margin and how much from secondary plant giving enhanced controllability?<br>• 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? | | | |
| Type(s) of innovation involved | Incremental | Significant | Technological substitution | Radical |
| | No | No | No | Yes |
| Expected Benefits of Project | • Understanding of flexible network requirements able to cost-effectively deal with a wide range of possible futures<br>• Develop networks that can 'think' for themselves<br>• Engagement with stakeholders in progressing the research ideas toward deployment<br>• Research that forms the basis of policy advice<br>• Inputs to the UK government's Energy Review, the UKERC assessment of Intermittency, evidence to select committees of parliament and submissions to OFGEM consultations. | | | |

<table>
<tr><td>Expected Timescale to adoption</td><td>5 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 colspan="9"></td></tr>
<tr><td>Project NPV</td><td>(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 08</td><td colspan="10">Some of the consortium members who produced the results of Supergen I - FutureNet are continuing to participate in FlexNet. It is expected that the quality of work will continue. The input of the industrial partners will be able to enrich the research with their own experiences.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The project started on the 1 October 2007. Since then the academic partners have recruited PhD students and research assistants to undertake the research.<br>The project management and steering groups have been established to manage and govern the progress of the project. Some of the work-streams are already producing some useful results.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Those involved in <b>FutureNet</b> where<br><b>Academic:</b> University of Bath, University of Birmingham, University of Cambridge, University of Edinburgh, University of Hull, Imperial College London, University of Manchester and University of Strathclyde.<br><b>Industrial</b>: ABB Switzerland Ltd, Alstom T&D Ltd, The Carbon Trust, Corus Research & Development, The Countryside Agency, Department of Trade and Industry, Econnect Ltd, EDF Energy – Networks, Edison Mission Energy, Garrad Hassan and Partners Ltd, ICF Consulting, INREB Faraday Partnership, The National Grid Company plc, New and Renewable Energy Centre, Regenesys Rolls-Royce plc, ScottishPower - Power Systems, Scottish Renewables Forum, Scottish and Southern Energy plc, Toshiba International (Europe) Ltd and Electricity North West plc</td></tr>
<tr><td>R&D Providers</td><td colspan="10">As academic institutions above</td></tr>
</table>

### ***IFI 0401 - 1: STP Module 2 - Overhead Lines***

<table>
<tr><td>Project Title</td><td colspan="12">Strategic Technology Programme (STP): Module 2 - Overhead Networks</td></tr>
<tr><td>Project Description</td><td colspan="12">This describes a collection of Overhead Line projects under development at EA Technology SPEN has invested in these projects as part as a collective of DNOs</td></tr>
<tr><td>Expenditure for (IFI) financial year</td><td colspan="4">Internal £4,474<br>External £43,259<br>**Total £47,733**</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £12,350<br>External £94,894<br>**Total £107,245**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="4">**£318k**</td><td colspan="4">Projected 08/09 costs for SP-EN</td><td colspan="4">Internal £4,000<br>External £45,000<br>**Total £49,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The STP overhead network programme for budget year 2007/8 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. The currently active projects within the programme include:<br>• S2126_3 – Completion of long-term monitoring of conductor temperature by obtaining and analysing 12 months trial data.<br>• S2126_4 – Monitoring overhead line conductor temperature at two trial sites at constant current.<br>• S2136_3 – Continued participation in European Project COST 727: Measuring and forecasting atmospheric icing on structures.<br>• S2140_2 – Field trials of techniques for checking the foundations of newly installed poles.<br>• S2143_2 – Feasibility study to detect in-situ degradation of aluminium overhead line conductors.<br>• S2146_2 – Undertake torsion testing to evaluate possible limits for composite tension insulators.<br>• S2148_1 – Re-appraisal of ACE104 methodology<br>• S2150_1 – Evaluation of TDR for assessment of tower foundations using actual field data.<br>• S2151_1 – Investigate alternatives to wood poles.<br>• S2152_1 – Evaluate performance of ice recording solution at severe weather test site.<br>• S2154_1 – Experimental investigation of ice loading of novel conductors.<br>• S2155_1 – Comparative performance of available pole-top shrouds.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">Yes</td><td colspan="3">Yes</td><td colspan="3">No</td></tr>
</table>

| | | | |
|---|---|---|---|
| Expected Benefits of Project | 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:<br>• 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;<br>• reduce levels of premature failure of assets;<br>• provide more cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults;<br>• confidently extend the service life of towers and reduce potential levels of tower failures;<br>• reduce lifetime costs by the appropriate use of alternative materials. | | |
| Expected Timescale to adoption | Range 1-5 years<br>Dependent on project | Duration of benefit once achieved | Range 3-10 years<br>Dependent on project |
| Probability of Success | Range 1-10%<br>Dependent on project | Project NPV | **£85,917**<br>NPV developed by EATL on behalf of DNOs – not using SP methodology |
| Project Status<br>**March 08** | • The second phase of monitoring overhead conductor temperatures at steady rated current was carried out. Phase two monitored two different-sized conductors of the same type (so different design temperatures for the same current) simultaneously at two very different locations, one near sea level and one high up in the Scottish Highlands. Phase 1 found that daytime ratings could probably be increased; it is hoped that analysis of Phase 2 data will provide confirmation of this and possibly find other location-dependent benefits.<br>• An experimental investigation of live-line jumper cutting was carried out to determine whether or not it was acceptable to cut 11kV jumpers carrying load.<br>• A study of alternatives to wood poles for HV OH lines, looking at the advantages and disadvantages, and the practical applicability within UK DNOs, indicated that there were significant benefits to be gained from using concrete poles in certain situations. A test rig has been designed to investigate the practical problems of erecting and working on such lines. | | |
| Potential for achieving expected benefits | Deliverables of interest within SPEN from 2007/08 programme<br>• Live-line jumper cutting: An assessment into the magnitude of load on an 11kV circuit that can be removed when live-line cutting.<br>• Development of an in-situ test method to monitor degradation of Al conductor: This project, working with the manufacturers of CORMON©, is looking to develop a modern version of the tool for AAAC overhead line conductors. | | |
| Collaborative Partners | CE Electric, Central Networks, Electricity North West, Western Power Distribution, Scottish & Southern Energy, EDF Energy, NIE | | |
| R&D Providers | EA Technology Ltd | | |

### ***IFI 0401 - 2: STP Module 3 - Cable Networks***

<table>
<tr><td>Project Title</td><td colspan="4">Strategic Technology Programme (STP): Module 3 - Cable Networks</td></tr>
<tr><td>Project Description</td><td colspan="4">This describes a collection of Underground Cable projects under development at EA Technology. SP-EN has invested in these research projects as part as a collective of DNOs</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £6,037<br>External £53,272<br><b>Total £59,259</b></td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £13,525<br>External £122,394<br><b>Total £135,920</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td><b>c. £367k p.a.</b></td><td colspan="2">Projected 08/09 costs for SP-EN</td><td>Internal £4k p.a.<br>External £46k p.a.<br><b>Total £50k p.a.</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The STP cable network programme for budget year 2007/8 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. The projects undertaken within the programme during 2007-08 aimed to:<br>• S3132_10 – Further development in cable ratings to address gas compression cables.<br>• S3132_12 - Further development in cable ratings<br>• S3140_3 – Develop best practice for the installation of Ducted Cable systems.<br>• S3144_2 & 3 – Comparison of processes for the treatment of redundant fluid filled cables.<br>• S3151_1, 2 & 3 – Understanding and controlling thermo-mechanical forces in cable systems.<br>• S4152 – Separable connectors and cable compartments in 11kV switchgear.<br>• S3159_1 - Investigation of current ratings of triplexed cable in plastic ducts.<br>• S3157_1 – PD testing of MV cable systems to provide asset risk management data.<br>• S3163_1 – On-going testing of sensors for cable fluids.</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>Yes</td><td>No</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:<br>• Offset future increases in CAPEX and OPEX;<br>• CI/CML savings per connected customer;<br>• Increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
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| Expected Timescale to adoption | Range 1-3 years - dependent on project | Duration of benefit once achieved | Range 2-7 years - dependent on project |
| Probability of Success | Range 2-50% - dependent on project | Project NPV | **£82,068**<br>NPV developed by EATL on behalf of DNOs – not using SP methodology |
| Project Progress March 08 | • In 2007/08 projects were completed to allow the calculation of current ratings of crossing cables (S3132_7), gas compression cables (S3132_10) and dynamic ratings (S3132_12. The outputs are of particular benefit in solving difficult multi-circuit problems. Without them there are risks of overloading the circuits.<br>• The cable rating work is being extended to the accurate modelling and calculation of technical losses in cable networks. The S3148 project has delivered a tool for comparing the merits of cross-bonding and solid bonding of MV polymeric cable systems, including outputs of annualized energy losses, as well as current ratings, circulating currents and elementary section length.<br>• Work is ongoing to assess the mechanical and thermal integrity of plastic ducts (S3155).<br>• Trials have been arranged to compare the effectiveness of three different processes for the treatment of oil filled cables at end-of-life. | | |
| Potential for achieving expected benefits | Deliverables for 2007/08 and utilisation within SPEN<br>• *Further developments of the CRATER cable rating software* have broadened it's usefulness to Design and Engineering staff. It has proved particularly useful in assessing designs for 33kV windfarm connections where these are installed by Independent Connection Providers (ICPs) and intended for adoption by SPEN.<br>• User Specification for cable ducts. This project was facilitated under STP3 and drew together Manufacturers and users to achieve a Nationally agreed and much needed revision of ENA TS 12-24 Specification for Ducting for Power Cables. The new National document has been utilised in a recent Tender exercise which resulted in a new bulk supply contract for SPEN beginning in April 2008.<br>• Further testing of fire retardant coatings for cables. This project has identified the most appropriate coatings and tapes to give a retrofit solution where a risk assessment has identified the need to improve the fire performance of cables in an existing installation (basement substation etc). | | |
| Collaborative Partners | Central Networks, CE Electric, Electricity North West, Western Power Distribution, Scottish & Southern Energy, EDF Energy | | |
| R&D Provider | EA Technology Ltd | | |

### *IFI 0401 - 3: STP Module 4 - Substations*

<table>
<tr><td>Project Title</td><td colspan="4">STP Module 4 –Substations</td></tr>
<tr><td>Description of project</td><td colspan="4">This describes a collection of Substation projects under development at EA Technology. SP-EN is an invested in these research projects as part as a collective of DNOs</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,627<br>External £38,138<br><b>Total £41,765</b></td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £13,416<br>External £94,894<br><b>Total £108,320</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td><b>£299k</b></td><td>Projected 08/09 costs for SP-EN</td><td colspan="2">Internal £4,000<br>External £40,000<br><b>Total £44,000</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The programme of projects which were approved for funding from the STP substations module budget and were undertaken in 2007/08 encompass both developing new innovative asset management processes and practices and developing innovative diagnostic techniques. The aim is 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. Eighteen new projects were approved during the year and they aimed to:<br>• S4164_4 – On load tap changer monitor – develop and install trial systems<br>• S4176_3 – Assessment and inspection of substation earthing systems<br>• S4181_2 - Transformer post mortems.<br>• S4185_2 - AM forum membership.<br>• S4212_1 - Dissemination seminar to ensure wider appreciation of STP module outputs<br>• S4219_1 – Management of substation batteries<br>• S4220_1 – Management of 145kV disconnectors<br>• S4221_1 – Investigate out of phase switching<br>• S4222_1 – Explore alternatives to ENATS 35-1 Transformers<br>• S4223_1 – Review of underground substation design<br>• S4225_1 – Assessment of BS148 and IEC60296 insulating oils<br>• S4228_1 - Investigate alternative measuring techniques for insulation materials<br>• S4234_1 - Exploration of ferroresonance issues</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Due to the age profile of the current system assets it is inevitable that unless significant new technology is used to extend asset life, CAPEX and possibly OPEX will need to increase significantly to maintain the present level of network reliability and safety.<br><br>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 benefits including:<br>• Offset future increases in CAPEX and OPEX</td></tr>
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| | • Increased safety of staff and public by reducing the number of accidents/incidents;<br>• Both preventing disruptive failures of oil-filled equipment to reduce land contamination and avoiding unnecessary scrapping of serviceable components will alleviate environmental impact. | | |
| Expected Timescale to adoption | 1-3 years - dependent on project | Duration of benefit once achieved | 2-7 years - dependent on project |
| Probability of Success | 5-40% - dependent on project | Project NPV | **£63,649**<br>NPV developed by EATL on behalf of DNOs – not using SP methodology |
| Project Progress March 08 | The majority of projects have not only resulted in essential knowledge transfer, they have enabled skills to be developed between STP 4 Members and also European partners. Key examples of this were the participation in the AM Forum, (S4185_3), the sponsoring of the Ferro-Resonance Seminar, (S4234_1), the Out Of Phase Workshop, (S4221_1) and the Substation Maintenance Seminar, (S4212_1). Each of which has contributed significantly to developing better understanding of electrical plant, its application, utilisation, performance and life cycle. These projects have resulted in the creation of further supplementary projects for 2008/2009. | | |
| Potential for achieving expected benefits | Deliverables for 2007/08 and utilisation within SPEN<br>• Assessment of Oil Bunds and Intelligent Pumps: The project has reviewed the success or otherwise of large transformer oil bunding systems and intelligent pumps. The outcome of this work confirmed that SPEN approach to bunding and water separation was amongst the most reliable. The final report contained a number of recommendations, which are currently under review with the view of implementing some of the maintenance recommendations.<br>• Tap Changer Diagnostics (TASA): Condition based sampling technique where oil from the tap changer is sampled after six years and thereafter sampled or changed as determined by test results carried out by EATL. This results in time and oil cost savings.<br>• Live Tank Oil Sampling (LTOS): Following trials in 07/08 SPEN has adopted LTOS as part of the condition based maintenance regime. This is currently being rolled out to SP-D and SP-M. The primary benefit is in the utilisation of resources in that live tank oil sampling allows one man to complete six to eight Ring Main Unit (RMU) samples per day compared to a two man team completing one to two RMU's per day under outage conditions.<br>• Review of 145kV Disconnectors: Knowledge capture exercise where information on all aspects of disconnectors has been derived from numerous sources including senior practitioners across the utilities. The final report is now being reviewed with regard to current maintenance practices and asset replacement. | | |
| Collaborative Partners | Central Networks, CE Electric, Electricity North West, Western Power Distribution, Scottish & Southern Energy, EDF Energy | | |
| R&D Provider | EA Technology Ltd | | |

### *IFI 0401 - 4: STP Module 5 - Distributed Generation*

<table>
<tr><td>Project Title</td><td colspan="4">Strategic Technology Programme (STP): Module 5 - Distributed Generation</td></tr>
<tr><td>Description of project</td><td colspan="4">This describes a collection of Distributed Generation projects under development at EA Technology. SP-EN is an invested in these research projects as part as a collective of DNOs</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,227<br>External £52,572<br><b>Total £55,799</b></td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £11,540<br>External £94,894<br><b>Total £106434</b></td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td><b>£379k</b></td><td colspan="2">Projected 08/09 costs for SP-EN</td><td>Internal £4,000<br>External £53,000<br><b>Total £57,000</b></td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The projects undertaken through budget year 2007/8 were aimed at enabling cost effective connections and ensuring techniques are in place to plan, operate and manage networks with significant amounts of generation. Most projects also had positive impacts on safety and environmental performance. The projects all addressed real problems that had bee n identified by the module steering group members as significant and which required technical investigation and development.  Fifteen new project stages were approved during the year:<br>• S5147_4/5 – Monitoring of microgenerator Clusters<br>• S5142_4 – Generator Data and Structure for DG Connection Applications<br>• S5151_4 – Network Risk Modelling<br>• S5152_3/4 – Latest developments in the connection of DG<br>• S5157_3 – Evaluation of small scale reactive power compensators<br>• S5161_2 – Standard risk assessment approach to DNO protection<br>• S5167_1 – Assessment of enhanced ratings for ohl connecting windfarms<br>• S5170_1 – Explore low cost options for connecting DG to ohl networks<br>• S5171_1 - Investigate inverter connected DG to alleviate fault level<br>• S5172_1 - Optimum power factor to support a low carbon economy<br>• S5173_1 - Alternative techniques for temperature connected demands<br>• S5174_1 – Assessment of the potential for DSM from small customers<br>• S5176_1 – Impact of high penetration micro-generation to ugc networks<br>• S5182_1 – Treatment of distribution network losses<br>• S5185_1 - Assessment of the potential for DSM from larger customers<br>• S5186_1/2 –  Network impact of proposed ban on incandescent light bulbs</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">With government policy driving significant increases in generation connection to distribution networks the members need a range of innovative solutions to connection and network operation issues that are cost effective and which maintain the present level of network reliability and safety.<br><br>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:<br>• Reducing the probability of voltage supply limit excursions resulting from increased distributed generation</td></tr>
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| | • Improving quality of supply and reducing risk of component failure (by understanding the effect and optimising use of impedance in the system);<br>• A better understanding of the risk presented by the distribution assets when considered as a network rather than discrete components;<br>• Greater use of distributed generators to meet current DNO obligations (by assessing, from a DNO perspective, the implications of pending Distribution Code provisions relating to distributed generation);<br>• Reducing the amount of reinforcement needed (by use of dynamic ratings to allow network components to be used to their full capability) - the use of dynamic circuit ratings is a vital step in the move towards active management of networks. | | |
| Expected Timescale to adoption | 1-5 years - dependent on project | Duration of benefit once achieved | 1-7 years - dependent on project |
| Probability of Success | 5-30% - dependent on project | Project NPV | **£80,744**<br>NPV developed by EATL on behalf of DNOs – not using SP methodology |
| Project Status **March 08** | • During 2007/08, Northern Ireland Electricity joined the Module, bringing the number of full members to eight A total of thirteen reports and briefing papers were delivered during the year, including a review of CIRED 2007 for all Modules; this was an efficient and cost-effective means of disseminating information and trends from the event, enabling STP members to identify areas of future research and development relevant to the UK context.<br>• The year also saw the completion of twelve months monitoring of the microgenerator cluster in Manchester, a network with a high penetration of microgeneration where the houses are new build (i.e. well insulated with a relatively low heating requirement).<br>• Laboratory tests on compact fluorescent light bulbs were undertaken to examine the network effects of the proposed ban on incandescent bulbs and a follow-on stage was approved to monitor whole house performance under typical mixed loads with measurements concentrating on the harmonic effects. | | |
| Potential for achieving expected benefits | Deliverables for 2007/08 and utilisation within SPEN<br>• Non-firm connections for load customers: This project assesses the risks, barriers and implications associated with load shedding for large load customers. The project has been established following a recognised inequality between generation connections (which can be designed as non-firm, using secondary control schemes) and load connections (which are always designed as a firm connection with primary infrastructure).<br>• EAVCat: Further developments of a tool for assessing different voltage control strategies for generation connections. SPEN is currently looking into using this tool to underpin AVC modernisation plans for DPCR5. | | |
| Collaborative Partners | Central Networks, CE Electric, Electricity North West, Scottish & Southern Energy, EDF Energy, ESB and Manx Electricity Authority | | |
| R&D provider | EA Technology Ltd | | |