ScottishPower
EnergyNetworks

Innovation Funding Incentive

Annual Report

Issue 1 - 31st July 2007

IFI Projects
April 2006 - March 2007

For SP Distribution Ltd and SP Manweb plc

1 Foreword

Welcome to the ScottishPower EnergyNetworks' Innovation Funding Incentive (IFI) Annual Report for 2006/07.

The energy sector has once again been under the spotlight over the last year, as changes occur on both a national and international stage. Examples of this include the revised EU Energy Policy in March 07, seeking to introduce binding targets for a 20% share of renewable energies in overall consumption by 2020. The publication of the UK Government's Energy white paper "Meeting the Energy Challenge" re-emphasises the key long-term challenge of enabling low carbon energy supplies coupled with supply security. Whilst focusing predominantly on changes to the generation and demand side, the white paper has rightly recognised the need for networks to adapt in order to meet different operating requirements in the future.

Research, Development and Demonstration (RD&D) is an important enabler to ensure technical solutions are available to address the issues, and Ofgem's Innovation Funding Incentive (IFI) mechanism is starting to show promise for UK networks businesses. Over the second full year of the IFI, we have continued to build on the foundations laid in 2005/06, developing a broad range of projects, offering both direct benefits to our company and wider benefits to the UK in general. We welcome Ofgem's introduction of IFI to Transmission companies as well as modifications to the Distribution IFI mechanism earlier this year; in particular, the removal of the internal cap on expenditure and the extension to IFI beyond a single Price Control period. This will provide stability to R&D in the sector out to 2015.

In 2005/06 ScottishPower EnergyNetworks has been successful in bringing some projects through to adoption. These range from plant related developments (e.g. high capacity 132kV overhead lines which have particular application in the connection of new generation), through to ancillary equipment (e.g. solid-state air conditioning units which will extend the battery life of equipment deployed on our 11kV network).

We recognise the value of collaboration in our R&D portfolio, developing generic industry solutions as well as bespoke solutions to specific problems. Therefore, where appropriate we will continue to work with other UK network operators in areas of common interest.

We also recognise the importance of working with academic institutions. From a strategic perspective we have completed a study with the University of

Strathclyde, which assesses the impact that high penetrations of 11kV and LV connected generation, will have on electricity distribution networks. The resulting analysis led to a proposal for a demonstration facility, which is currently under consideration with partners including Scottish Enterprise, Rolls-Royce and University of Strathclyde. In a separate development Energy Networks is establishing a partnership with the University of Strathclyde to form the ScottishPower Advanced Research Centre (SPARC). The centre will fund a minimum of 3 researchers and undertake targeted applied research in the areas of asset engineering, asset strategy and network development, fulfilling immediate technological gaps.

Finally, 2006/07 saw the launch of the 7th European Union Framework Platform for R&D, with significant aspirations for network developments. With ScottishPower now part of the Iberdrola group, one of the world's largest utility companies, we are looking to leverage the group's participation in wider European research within our business here in the UK.

Alan Bryce
Director
ScottishPower Energy Networks

2 Introduction & Background

2.1 Context

As part of the most recent Distribution Price Control Review (DPCR) from 2005-2010, Ofgem introduced two new incentive mechanisms: the Innovation Funding Incentive (IFI) and Registered Power Zone (RPZ). They were consulted on as an integral part of the DPCR proposals and were widely supported by a large majority of consultees.

The primary aim of these two new incentives is to encourage the DNOs 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 DNO’s 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 distributed generation at all distribution 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 networks, up to and including 132kV, to deliver value (i.e. financial, supply quality, environmental, safety) to end consumers. IFI projects can embrace any aspect of the distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning. The detail of the IFI mechanism is set out in the Special Licence Condition C3 and the DG Regulatory Instructions and Guidance (RIGs).

IFI has since been extended to the UK transmission licences for the period 2007-2012, commencing April 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 in the next five years. 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

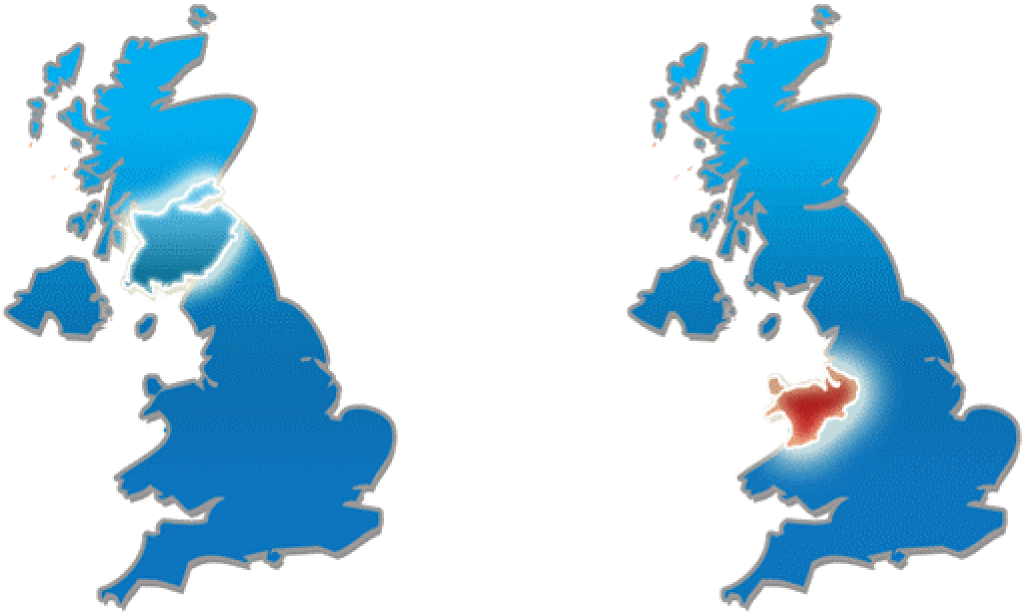
SP Energy Networks (SPEN) owns and operates the electricity transmission and distribution network of southern Scotland and the electricity distribution network of Merseryside and North Wales. Day-to-day operation of our network, approaching 112,000 km, is conducted by SP Power Systems Ltd (PowerSystems),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

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

- SP Transmission: The electricity network of 132kV and above in southern Scotland
- 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

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



(a) (b)

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

4 Overview

4.1 IFI

A total of 41 IFI projects are being reported by ScottishPower EnergyNetworks on behalf of both the SP Distribution Ltd and SP Manweb plc Licence areas for the period 1st April 06 – 31st March 07.

At time of writing SPEN has a total of £5m external cost authorised over 35 live IFI projects, representing a levered portfolio cost 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 as described below:

Table 1: R&D growth in SPEN (both SP-D and SP-M) since the introduction of the IFI

SP-D and SP-M	Expenditure (internal + external)	No. of Reported Projects	Programme Leverage
2004/05 (Early Start)	£223k	12	c. £1.5m
2005/06	£546k	36	c. £3m
2006/07	£1,282k	41	c. £5m

4.2 RPZ

No RPZ applications were submitted to Ofgem during this period.

Whilst this is the case in SP Distribution and SP Manweb, we have in the recent past utilised a number of innovative solutions to connect distributed generation. These include novel control schemes that monitor circuit loading and provide constraining signals to curtail generation to an acceptable level – providing a level of active 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 the IFI AuRA-NMS (IFI 0532) project, which is in the early stages of development in looking to provide an integrated and repeatable solution to these complex constraining schemes.

5 Summary Tables

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

Table 2: IFI Summary - SP Distribution Ltd Licence Area 06/07

IFI Allowance (0.5% of 2006/07 turnover)	£1,602,734
Unused IFI from 2005/06 carried forward to 2006/07	£807,700
Number of Active IFI Projects	37
NPV of costs and anticipated benefits from committed IFI projects	£3,624,342
Summary of other benefits anticipated from IFI projects	See Appendix D
External expenditure on IFI projects	£529,284
Internal expenditure on IFI projects	£91,555
Total expenditure on IFI projects	**£620,839**
Benefits actually achieved from IFI projects to date	See section 7
Unused IFI Carry Forward to 2007/08	£801,367

Table 3: IFI Summary - SP Manweb plc Licence Area 06/07

IFI Allowance (0.5% of 2006/07 turnover)	£1,034,526
Unused IFI from 2005/06 carried forward to 2006/07	£530,468
Number of Active IFI Projects	41
NPV of costs and anticipated benefits from committed IFI projects	£2,957,765
Summary of other benefits anticipated from IFI projects	See Appendix D
External expenditure on IFI projects	£566,397
Internal expenditure on IFI projects	£82,074
Total expenditure on IFI projects	**£648,471**
Benefits actually achieved from IFI projects to date	See section 7
Unused IFI Carry Forward to 2007/08	£386,055

5.1 Summary Table Notes

During 2005/06 and in 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 Appendices B and C.

5.2 Cost Breakdown

As ScottishPower EnergyNetworks operates both the SP-Distribution and SP-Manweb areas, successful developments undertaken in one part of the business will equally apply to both licences. In line with this, costs have been split against each licence based on the turnover and hence size of each network area.

Table 4: Cost Breakdown between Licence Areas

Licence Area	Annual Turnover (06/07)	Percentage Split
SP-Distribution	£320.5 million	~ 60%
SP-Manweb	£206.9 million	~ 40%

Therefore, for projects with an equal application between both SP-D and SP-M, costs have been apportioned on a 60% / 40% split (respectively). Projects identified as only applying to one licence, or ones that apply in favour of one licence have been scaled accordingly (see Table B1).

5.3 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.

5.4 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.

6 Achievements for 2006/07

At the end of 2006/07, the highlights from the SPEN IFI portfolio included:

- 25 projects fully authorised, with 15 receiving approval in 06/07 and several more receiving preliminary approval
- Over £5m of leverage obtained
- More than 9 projects achieving system prototype in an operational environment (Technology Readiness Level 7 or above) with further trials scheduled
- 2 projects adopted in business with several more near the final stages of trials

6.1 Development of Partnerships

We have continued to lever our IFI portfolio by proactively engaging in a number of externally funded and collaborative projects. This gives not only uplift to our own budget, but also direction and steer to academia and manufacturers with, we believe, net benefits to UK plc. The current programme consists of:

- Engineering & Physical Science Research Council (EPSRC) – 1x strategic partnership: AuRA-NMS
- EPSRC – 3x industry roles in Supergen programmes: Supergen 1 - Flexnet; Supergen 3 - Highly Distributed Power Systems; Supergen 5 - AMPerES
- Dept Business Enterprise & Regulatory Reform (DBERR) / Dept Trade & Industry (DTI) – 4x 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 – 17x 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.

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.

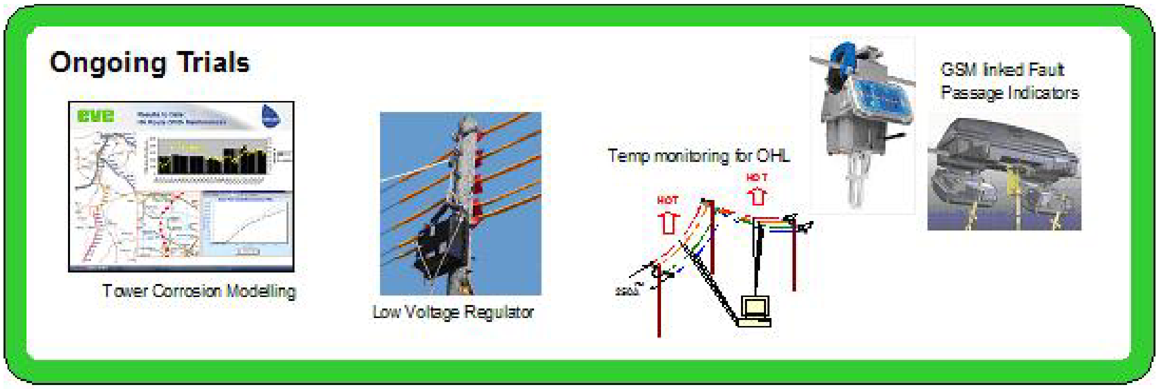


Figure 2: Pictorial Examples of Ongoing Trials from SPEN's IFI Programme

Figure 3: Pictorial Examples of Completed Trials from SPEN's IFI Programme

6.3 Identifying the Issues and Developing the Enablers

Further to our work with the University of Strathclyde, Rolls-Royce and ITI Energy (IFI 0515 - reported 2005/06), we have continued to explore the potential impact both 11kV and LV connected generation could have on our distribution networks, if deployed in large but credible penetrations. Resulting from this work for 2006/07 has been the development with partners of a proposal for a UK demonstration network at our training facility in Cumbernauld, Lanarkshire (for further detail see IFI 0515).

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.

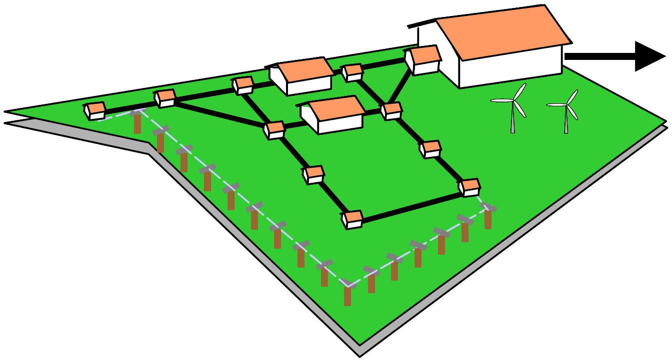


Figure 5: Pictorial representation of the Demonstration Facility

7 Realised Benefits from IFI Projects

7.1 Benefits from Adopted IFI Projects

Examples are provided below on successful developments made in or before 2006/07 and how they are providing benefits to SPEN.

IFI 0407 – Kelman circuit breaker intelligence analysis (commenced [at low level] 2003, completed 2006)
The Kelman equipment is extensively used in the ScottishPower networks as a pre and post-fault maintenance tool, offering accurate information on the speed (and therefore reliability) of circuit breaker operation. Since this development was completed in 2006, it has been rolled out to all 11kV and 33kV circuit breakers in SP-D.

Developments with University of Strathclyde provided further data analysis through a sophisticated intelligent management system, for a substantial quantity of 11kV circuit breaker types. In working with the university, SP fed into an IEEE Transactions paper on Power Delivery "Providing Decision Support for the condition-Based Maintenance of Circuit Breakers through Data Mining of Trip Coil Current Signatures", University of Strathclyde, ScottishPower (published 06). The development is proving to be a useful risk management tool in identifying potentially ‘sticky’ circuit breakers, with associated CI/CML benefits to customers.

IFI 0501 – IED Radio (commenced 2005, completed 2006)
The developed RNO501 radio interacts directly with the Intelligent Electronic Device (IED) of the Novexia Soule Auguste Pole Mounted Gas Switch, and the NOJA Pole Mounted Auto-Recloser. Having this functionality precludes the need to install a Remote Telemetry Unit (RTU). This has an immediate benefit with space saving within the control enclosures, and also simplifies the installation and commissioning.

SPD are installing 2500 network controllable points with c.30% are on the overhead line network, equating to 750 units that will utilise this developed product. To date SPEN has installed some 200 Soule switches and 50 Noja's between SPD and SPM.

IFI 0613 – Battery Air Conditioning (commenced 2006, completed 2007)
Valve Regulated Lead Acid (VRLA) batteries have become an industry standard for standby power systems. As critical systems can often be reliant on them performing to design it is essential that they are used and stored correctly, as per the manufacture’s recommendations. Where the battery maximum ambient temperature is declared to be nominally 20^{o}C, any increase above this will affect the battery life and jeopardise its performance. For example; should the ambient rise to over 40^{o}C, a 10-year battery life can be reduced to less than 2 years.

The 4Energy device uses the Peltier thermoelectric effect, coupled with an innovative heat exchanger, to maintain this type of battery at its optimum operating temperature and thus maximises its performance. In addition to enhancing reliability and lifespan, this also has an environmental benefit of not having to frequently replace expired batteries. Following a successful development process working in partnership with the manufacturer, SP successfully negotiated for the purchase of units upon adoption for rollout across the network.

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 0402 – Low Voltage Regulator (commenced 2005, ongoing project)
Three single-phase LV voltage regulators have been successfully installed as part of the network trial at a golf club near Edinburgh. The original circuit is fed from a long 3-phase LV service cable with an old electromechanical ground mounted voltage regulator close to the point of supply. No technical information / maintenance history was available for the original voltage regulator and the golf club was experiencing voltage fluctuations indicating that the existing regulator was no longer functioning as intended. The standard solution was for extensive 11kV network reinforcement, which was deemed unacceptable with both safety and environmental implications; the most suitable alternative was for the installation of a long run of large cross sectional area LV cable at a minimum cost of £25k. Following discussions with both the manufacturers of the LVR and design staff approval was given to the installation of three units in December 06, at a total installed cost of less than £8k. The units will continue to be monitored for a full 12months, in order to assess their suitability and longevity, but appear to be working successfully.

IFI 0409 – T-P2x – Online LV Cable Fault Location
Following recent developments, SPEN has used the T-P22 transient fault location devices to identify some problematic cables before they completely fault. Left in a substation, the faultfinder is connected to a known troublesome cable, on which there may have been flickering lights or voltage problems. The T-P22 then monitors the cable and waits for an event to trigger, which should then give the location of an up-coming fault. The T-P2x can then be remotely or manually interrogated and the information examined to give an accurate fault location.

It has been found that by using this developed technology with either the Kelman REZAP or cable fault sniffer, a fault can be accurately pinpointed with minimum disruption. The fact that the locators can be accessed remotely through GSM modems has already delivered strong benefits to ScottishPower, with the location of on fault at a substation in Anglesey, being detected first time from an engineer in Scotland.

SottishPower are working with collaborative partners and manufacturers to develop and automate the interrogation system, speeding up the process from triggering to identification with potential net supply quality benefits to the customer.

8 Looking Ahead - Focus for 07/08

Our focus for 2007/08 will continue to build on the foundations laid in the two years of IFI from 2005 with a focus on: engagement; trials; adoption and extension.

Improving engagement and activity: With over 35 live projects, SP is strengthening outreach into the business, however during 2007/08 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 2007/08 include:

- Data gathering for Dynamic Ratings / Thermal State Estimation (IFI 0513)
- Initial deployment of data gathering for AuRA-NMS (IFI 0532)
- Further development and testing of fault current limiting technology (IFI 0509 / IFI 0540)

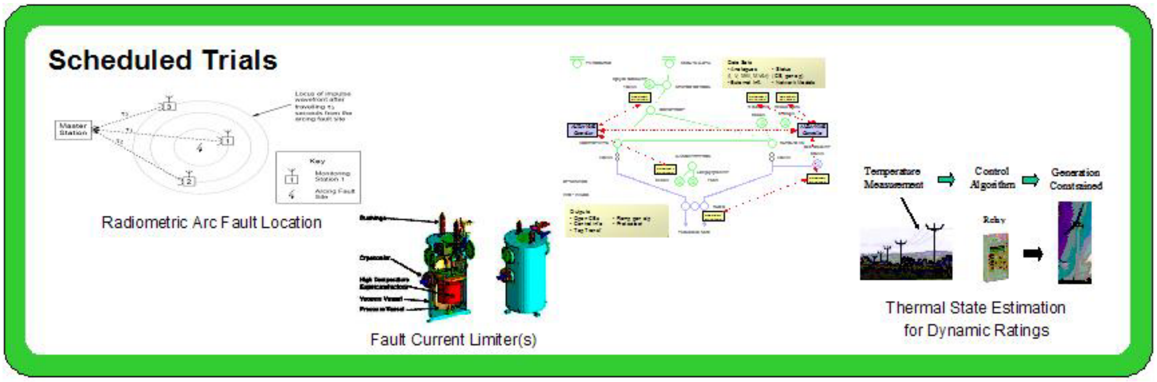


Figure 4: A sample of projects expected to move towards trial in 2007/08

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.

Develop an IFI programme for SP-Transmission: At time of writing, we are proactively working with the industry in the development of a revised Good Practice Guide for IFI. In addition to this, we are in discussion with National Grid and Scottish & Southern Energy to develop collaborative IFI projects for our SP-Transmission Licence.

9 Project Reports

Summary sheets for each of the individual projects 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).

Table 5: Project Report Locations

Project No.	**Project Title**	**Page**
IFI 0401-2	STP - Module 2 - Overhead Networks	D1
IFI 0401-3	STP - Module 3 - Cable Networks	D4
IFI 0401-4	STP - Module 4 – Substations	D7
IFI 0401-5	STP - Module 5 - Distributed Generation	D10
IFI 0402	LV Single Phase Voltage Regulator	D13
IFI 0403	Reference Network Development	D14
IFI 0404	Alternative Oils	D15
IFI 0405-2	Test Construction of Alt. Trident 132kV Overhead Line	D17
IFI 0406	Overhead Line Fault Passage Indicators	D18
IFI 0409	LV Fault Location Kehui T-P21	D19
IFI 0502	Fault Level Monitor Project	D20
IFI 0503	L36 33kv Overhead Line Spec. inc. OPPC	D22
IFI 0504	Fault Infeed Calculation verifications	D24
IFI 0505	Supergen V - AMPerES	D25
IFI 0506	Portable Smart Link (ASL) tester	D27
IFI 0507	SmartDust	D28
IFI 0508	Development of REDOX flow battery for energy storage	D30
IFI 0509	Superconducting Fault Current Limiter	D31
IFI 0510	Innovative Protection Solutions	D33
IFI 0511	Voltage Control - ACTIV (EATL)	D34
IFI 0513	Thermal Modelling and Active Network Management	D35
IFI 0514	Remote Line Temperature Monitor	D36

IFI 0515	Demonstration Network	D37
IFI 0517	GridSense LineTracker FPI (Conductor Temperature)	D39
IFI 0518	Offline corrosion monitoring (towers)	D40
IFI 0520	Energy Storage Devices for Distribution Networks	D41
IFI 0522	Supergen III	D42
IFI 0526	PD monitoring of cables	D44
IFI 0529	ESR Network (ESR 21)	D45
IFI 0532	AuRA-NMS (Automated Regional Active Network Management System)	D47
IFI 0535	Radiometric Arc Fault Location	D49
IFI 0538	Overhead line uprating project - Compact transmission lines	D50
IFI 0540	MANtIS (Managing Active Networks through Intelligent Systems)	D51
IFI 0606	Substation Acoustic Monitoring	D52
IFI 0607	LV Network Automation	D53
IFI 0613	4Energy Battery Aircon Device	D54
IFI 0615	University of Strathclyde UTC	D55
IFI 0618	Supergen 1 - FlexNet	D56
IFI 0619-1	Advanced Cable Technologies: Module 1 C Splice	D58
IFI 0620	Tower foundation radar	D59
IFI 0527, IFI 0536 & IFI 0537	ENA Projects: Earthing project (OSG SG14), Lightning Protection (develop ETR 134, Testing Procedure for ROCOF relays	D60

Appendix A – IFI Highlights for 06/07 submitted to ENA R&D Brochure

Low Voltage Regulator

Since March 2005 ScottishPower Energy Networks have been collaborating with US manufacturers MicroPlanet to develop their power electronic low voltage regulator (LVR) to make it suitable for use on the UK distribution network.

Initially developed as an energy efficiency device for single-phase domestic customers in the US, ScottishPower identified opportunities to use the regulators for over and under-voltage control to customers on the rural low voltage overhead networks. In doing so the device could be installed as either a temporary or permanent measure, subject to ease or cost of reinforcement, ensuring compliance to Statutory Voltage limits to our customers.

Following an extensive redesign and the successful completion of type tests in 2005/06, ScottishPower have joined forces with United Utilities to conduct network trials of the units.
In the first month (Dec 06), several units were installed to solve single phase, and a 3-phase, voltage complaints across the SP Distribution and SP Manweb network. The field trials have prompted the proving of two other new products: monitoring equipment produced by manufactures Hoiki and hydraulic lifting equipment to safely install the units on poletops, produced by manufacturers Lineman.

Over the course of a 12month trial ScottishPower intend to monitor the performance of a sample of units with the aid of an external contractor, GMC instruments. Upon completion of the trial, performance will be assessed to determine their suitability as an initial solution for any voltage complaint.

With the cost of LV network reinforcement sometimes being significant, the units may be utilised to postpone the need for reinforcement in some cases or be utilised on a permanent basis in instances where the voltage complaint is due to disturbing loads or unidentified causes. Aside from the financial benefits to the project there are less tangible yet important outcomes such as customer service and satisfaction.

LVR - Key Points

- Series connected single phase unit
- It has a rating of 80A / 18kVA
- The device utilises a series iron toroid and a shunt connected power electronics converter to buck and boost the input voltage waveform
- A series fuse protects the device from high fault current

ScottishPower first identified potential in the Low Voltage Regulator in 2003. Aside from the installation of two prototype units, no further development took place until the introduction of the Innovation Funding Incentive (IFI). The IFI has allowed the development of the technology for use in the UK, significantly accelerating deployment and adoption for the DNO market.

New 132kV Wood Pole Line Trial Build

Over the last couple of years, Scottish Power Energy Networks has been collaborating with LSTC (LS Transmission Consultancy Ltd) in the design and delivery a new type of wood pole electricity line for operation at 132kV.

There has been a rapid increase in renewable generation over recent years spurred on by market forces and the Government's energy targets. To date, wind energy has been the dominant renewable generation technology connected to the ScottishPower networks with output capacities increasing year-on-year. The disparity between the geographical position of the energy resource and the load customers often necessitates the build of electricity infrastructure to isolated, inaccessible or scenic areas, factors which raise construction and environmental issues with traditional tower lines. A new alternative was needed.

The following requirements were outlined during the design phase:

- The provision of a high capacity, earthed line construction of minimal visual impact
- Conformance to the new resilience specification, EN 50431.
- A trial build would prove the design and consolidate construction and maintenance techniques.

Meticulous designing ensured these targets were met; the challenge now was to turn the blueprints into reality. Following a competitive tender, Alfred McAlpine Infrastructure Services (AMIS) carried out implementation of the design, involving the construction of five spans of overhead line, utilising a number of different pole structures, in addition to a failure containment structure. The line, just south of Wrexham, North Wales, was standalone and could not be energised at any stage of the build. It took just over a month to construct, under some extremely harsh weather conditions within a forest at high altitude.

Advantages:

- Structures carry three phases of UPAS conductor (300mm^2)
- Under slung earth wire (100mm^2) with embedded optical fibre for communication (OPGW).
- New specification will enhance suite of lines available to SP
- Line has a summer rating of up to 174MVA - almost twice that of the standard Trident Line (89MVA)
- Opportunity for the design to be rolled out to other companies
- Opportunity for other parties to visit site to see line construction.

Without the IFI, this level of design and the quality of the trial build would not have been possible. The speed of the build and the robustness of the structures proven in the trial will allow progression to a live implementation in the very near future. It is anticipated that this will result in a new option for 132kV power transmission, not just for Scottish Power but for all national DNOs.

Appendix B – Expenditure Breakdown of Projects between Licences

As of 31st March 07 of the 41 projects reported:

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

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

Table B1: Overview of 06/07 projects showing application between distribution licences

Project Number	Project Title	Project Split		SP-M		SP-D	
		SP-M	SP-D	Internal £	External £	Internal £	External £
IFI 0401-2	STP - Module 2 - Overhead Networks	40%	60%	£2,600	£15,246	£3,900	£22,870
IFI 0401-3	STP - Module 3 - Cable Networks	40%	60%	£2,379	£15,246	£3,569	£22,870
IFI 0401-4	STP - Module 4 - Substations	40%	60%	£2,564	£15,246	£3,846	£22,870
IFI 0401-5	STP - Module 5 - Distributed Generation	40%	60%	£1,430	£15,246	£2,145	£22,870
IFI 0402	LV Single Phase Voltage Regulator	40%	60%	£2,819	£39,982	£4,228	£59,973
IFI 0403	Reference Network Development	40%	60%	£844	£458	£1,266	£686
IFI 0404	Alternative Oils	40%	60%	£1,015	£7,554	£1,523	£11,330
IFI 0405-2	Test Construction of Alternative Trident 132kV Overhead Line	100%	0%	£11,534	£186,823	£0	£0
IFI 0406	Overhead Line Fault Passage Indicators	40%	60%	£857	£13,798	£1,285	£20,696
IFI 0409	LV Fault Location Kehui T-P21	40%	60%	£3,034	£15,118	£4,551	£22,677
IFI 0502	Fault Level Monitor Project	40%	60%	£1,544	£3,658	£2,316	£5,486
IFI 0503	L36 33kv Overhead Line Spec. inc. OPPC	40%	60%	£8,633	£2,197	£12,949	£3,296
IFI 0504	Fault Infeed Calculation verifications	40%	60%	£1,191	£458	£1,787	£686
IFI 0505	Supergen V - AMPerES	40%	60%	£1,540	£10,458	£2,310	£15,686
IFI 0506	Portable Smart Link (ASL) tester	40%	60%	£953	£3,258	£1,429	£4,886
IFI 0507	SmartDust	40%	60%	£1,096	£5,088	£1,644	£7,631
IFI 0508	Development of REDOX flow battery for energy storage	40%	60%	£2,999	£458	£4,499	£686
IFI 0509	Superconducting Fault Current Limiter	40%	60%	£2,319	£13,458	£3,478	£20,186
IFI 0510	Innovative Protection Solutions	100%	0%	£3,939	£1,144	£0	£0
IFI 0511	Voltage Control - ACTIV (EATL)	40%	60%	£627	£458	£940	£686
IFI 0513	Thermal Modelling and Active Network Management	40%	60%	£2,523	£684	£3,785	£1,025
IFI 0514	Remote Line Temperature Monitor	40%	60%	£1,099	£11,937	£1,648	£17,905
IFI 0515	ScottishPower / RollsRoyce Prototype Network	40%	60%	£3,233	£8,677	£4,849	£13,015
IFI 0517	GridSense LineTracker FPI (Conductor Temperature)	40%	60%	£1,048	£21,608	£1,572	£32,412
IFI 0518	Offline corrosion monitoring (towers)	90%	10%	£2,157	£25,150	£240	£2,794
IFI 0520	Energy Storage Devices for Distribution Networks	40%	60%	£1,490	£10,210	£2,235	£15,315
IFI 0522	Supergen III	40%	60%	£735	£458	£1,103	£686
IFI 0526	PD monitoring of cables	40%	60%	£1,153	£458	£1,729	£686
IFI 0529	ESR Network (ESR 21)	40%	60%	£695	£458	£1,042	£686
IFI 0532	AURA-NMS (Automated Regional Active Network Management System)	40%	60%	£1,940	£62,177	£2,910	£93,265
IFI 0535	Radiometric Arc Fault Location	40%	60%	£654	£458	£981	£686
IFI 0527, IFI 0536 & IFI 0537	ENA Projects: Earthing project (OSG SG14), Lightning Protection (develop ETR 134, Testing Procedure for ROCOF relays	40%	60%	£681	£493	£1,021	£740
IFI 0538	Overhead line uprating project - Compact transmission lines	100%	0%	£1,566	£1,144	£0	£0
IFI 0540	MANtIS (Managing Active Networks through Intelligent Systems)	40%	60%	£708	£458	£1,062	£686
IFI 0606	Substation Acoustic Monitoring	40%	60%	£627	£458	£940	£686
IFI 0607	LV Network Automation	40%	60%	£1,053	£7,479	£1,579	£11,219
IFI 0613	4Energy Battery Aircon Device	40%	60%	£2,579	£16,222	£3,868	£24,333
IFI 0615	University of Strathclyde UTC	40%	60%	£964	£30,464	£1,446	£45,697
IFI 0618	Supergen 1 - FlexNet	40%	60%	£627	£458	£940	£686
IFI 0619-1	Advanced Cable Technologies: Module 1 C Splice	40%	60%	£627	£458	£940	£686
IFI 0620	Tower foundation radar	100%	0%	£2,000	£1,144	£0	£0

	SP-M		**SP-D**	
Totals	Internal £	External £	Internal £	External £
	£82,074	£566,397	£91,555	£529,284
Ratios	12.7%	87%	14.7%	85%

Table B2: Project NPVs, split between distribution licences

Project Number	Project Title	Project Split		NPV		
		SP-M	SP-D	Project NPV	NPV SP-M	NPV SP-D
IFI 0401-2	STP - Module 2 - Overhead Networks	40%	60%	£26,592	£10,637	£15,955
IFI 0401-3	STP - Module 3 - Cable Networks	40%	60%	£16,518	£6,607	£9,911
IFI 0401-4	STP - Module 4 - Substations	40%	60%	£22,587	£9,035	£13,552
IFI 0401-5	STP - Module 5 - Distributed Generation	40%	60%	£32,855	£13,142	£19,713
IFI 0402	LV Single Phase Voltage Regulator	40%	60%	£45,198	£18,079	£27,119
IFI 0403	Reference Network Development	40%	60%	£191,951	£76,780	£115,171
IFI 0404	Alternative Oils	40%	60%	£98,922	£39,569	£59,353
IFI 0405-2	Test Construction of Alternative Trident 132kV Overhead Line	100%	0%	£457,598	£457,598	£0
IFI 0406	Overhead Line Fault Passage Indicators	40%	60%	£297,916	£119,166	£178,750
IFI 0409	LV Fault Location Kehui T-P21	40%	60%	£349,240	£139,696	£209,544
IFI 0502	Fault Level Monitor Project	40%	60%	£92,045	£36,818	£55,227
IFI 0503	L36 33kv Overhead Line Spec. inc. OPPC	40%	60%	£3,320,668	£1,328,267	£1,992,401
IFI 0504	Fault Infeed Calculation verifications	40%	60%	-£12,603	-£5,041	-£7,562
IFI 0505	Supergen V - AMPerES	40%	60%	£46,609	£18,644	£27,965
IFI 0506	Portable Smart Link (ASL) tester	40%	60%	£63,970	£25,588	£38,382
IFI 0507	SmartDust	40%	60%	£25,653	£10,261	£15,392
IFI 0508	Development of REDOX flow battery for energy storage	40%	60%	£243,753	£97,501	£146,252
IFI 0509	Superconducting Fault Current Limiter	40%	60%	-£267,191	-£106,876	-£160,315
IFI 0510	Innovative Protection Solutions	100%	0%	£50,919	£50,919	£0
IFI 0511	Voltage Control - ACTIV (EATL)	40%	60%	£67,445	£26,978	£40,467
IFI 0513	Thermal Modelling and Active Network Management	40%	60%	£301,867	£120,747	£181,120
IFI 0514	Remote Line Temperature Monitor	40%	60%	£110,911	£44,364	£66,547
IFI 0515	ScottishPower / RollsRoyce Prototype Network	40%	60%	£709,171	£283,668	£425,503
IFI 0517	GridSense LineTracker FPI (Conductor Temperature)	40%	60%	£243,458	£97,383	£146,075
IFI 0518	Offline corrosion monitoring (towers)	90%	10%	£22,560	£20,304	£2,256
IFI 0520	Energy Storage Devices for Distribution Networks	40%	60%	-£33,905	-£13,562	-£20,343
IFI 0522	Supergen III	40%	60%	£20,000	£8,000	£12,000
IFI 0526	PD monitoring of cables	40%	60%	£0	£0	£0
IFI 0529	ESR Network (ESR 21)	40%	60%	-£16,445	-£6,578	-£9,867
IFI 0532	AURA-NMS (Automated Regional Active Network Management System)	40%	60%	-£364,068	-£145,627	-£218,441
IFI 0535	Radiometric Arc Fault Location	40%	60%	£45,787	£18,315	£27,472
IFI 0527, IFI 0536 & IFI 0537	ENA Projects: Earthing project (OSG SG14), Lightning Protection (develop ETR 134, Testing Procedure for ROCOF relays	40%	60%	£255,876	£102,350	£153,526
IFI 0538	Overhead line uprating project - Compact transmission lines	100%	0%	TBC	£0	£0
IFI 0540	MANtIS (Managing Active Networks through Intelligent Systems)	40%	60%	TBC	£0	£0
IFI 0606	Substation Acoustic Monitoring	40%	60%	TBC	£0	£0
IFI 0607	LV Network Automation	40%	60%	-£31,000	-£12,400	-£18,600
IFI 0613	4Energy Battery Aircon Device	40%	60%	£42,304	£16,922	£25,382
IFI 0615	University of Strathclyde UTC	40%	60%	TBC	£0	£0
IFI 0606	Substation Acoustic Monitoring	40%	60%	TBC	£0	£0
IFI 0618	Supergen 1 - FlexNet	40%	60%	TBC	£0	£0
IFI 0619-1	Advanced Cable Technologies: Module 1 C Splice	40%	60%	£90,726	£36,290	£54,436
IFI 0620	Tower foundation radar	100%	0%	£14,220	£14,220	£0

	Overall	SP-M	SP-D
Overall NPV	£6,582,107	£2,957,765	£3,624,342

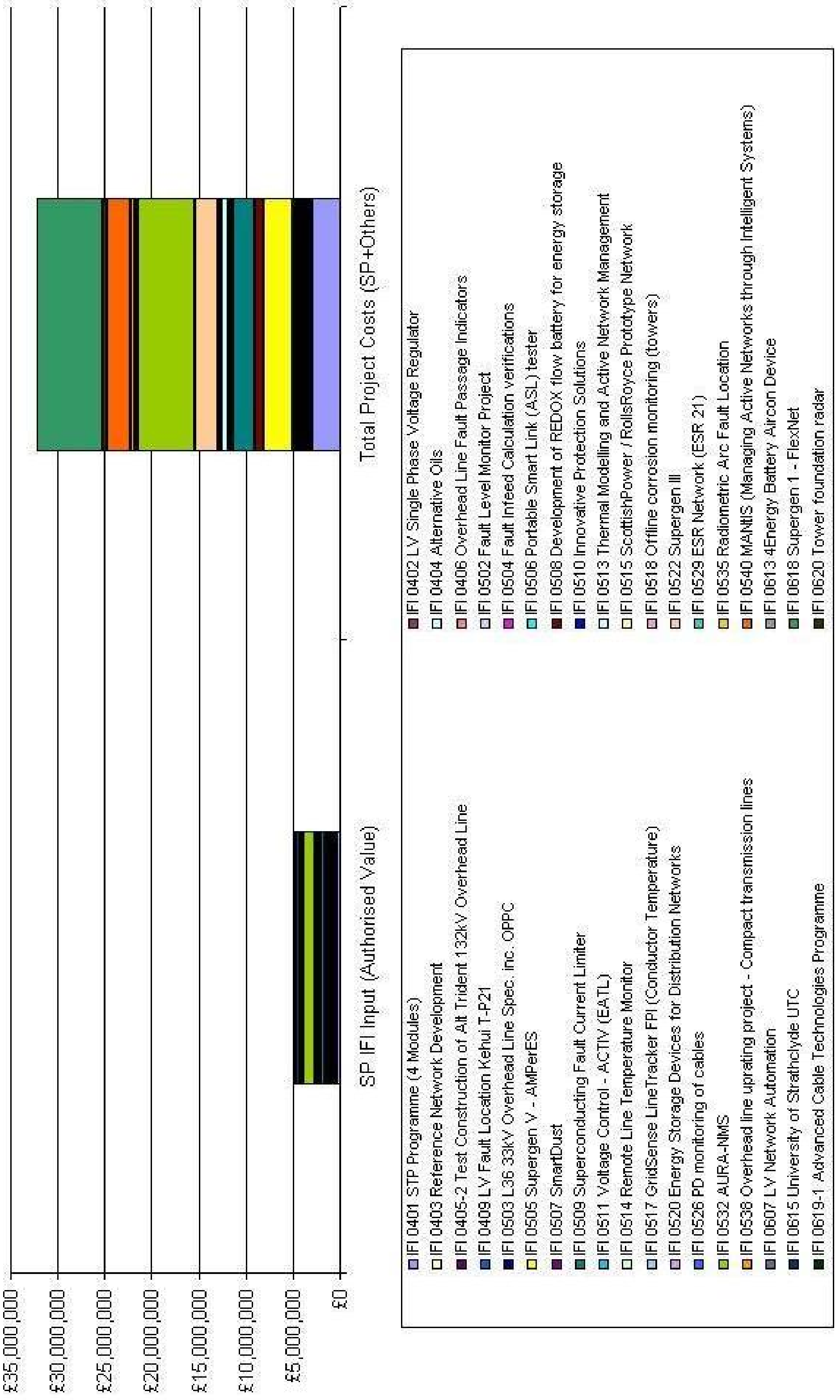


Figure B1: Measuring the Impact of Leverage across SP's Authorised IFI Projects

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 B2 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** – ScottishPower EnergyNetworks' 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 Power Systems 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. Whilst these costs will feature in following years, it does affect the balance of internal to external expenditure in the short term.

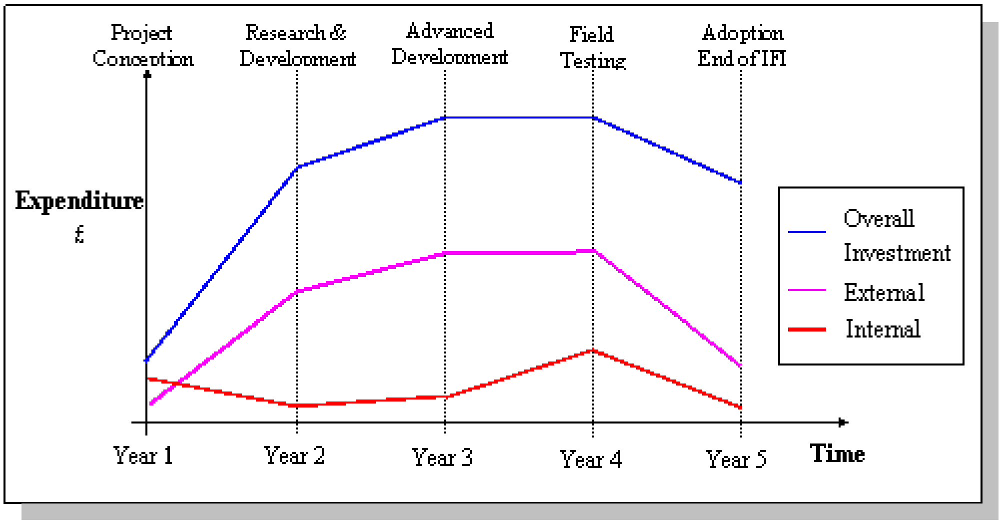


Figure B2: Example Expenditure Profile for an IFI Project

Appendix C – Methodology for NPV calculations in IFI projects

Introduction

Engineering Recommendation G85 the innovation "Good Practice Guide" clearly states that the expected benefits for IFI projects must be defined at the outset of the project. For 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. 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

<u>Aside:</u>

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

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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 B1, where, even by showing the development phase split into two: feasibility and pilot, the magnitude of roll-out 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.

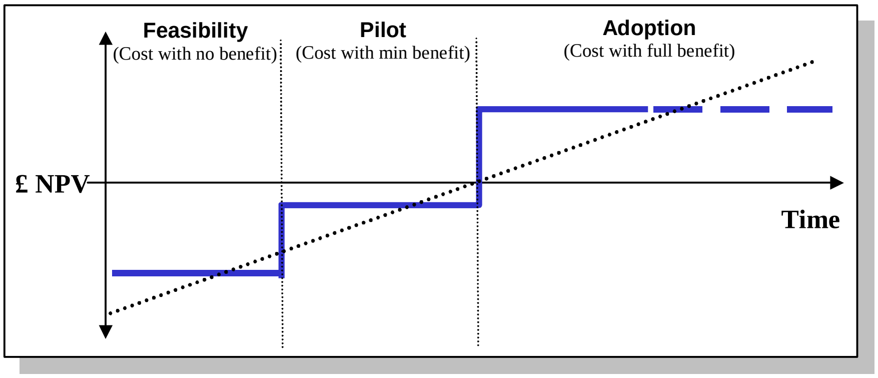

Figure B1: How project NPV changes over the course of its development

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 roll-out 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 have linked our project Probabilities of Success to the concept of Technology Readiness Levels (TRLs). 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.

Table C1: Technology Readiness Level / Probability of Success Definition

TRL	Definition	SP-EN Assessment of Probability of Success
1	Basic principles observed and reported.	Not IFI Eligible
2	Technology concept and/or application formulated.	25%
3	Analytical and experimental critical function and/or characteristic proof of concept.	
4	Technology component and/or basic technology sub-system validation in laboratory environment.	50%
5	Technology component and/or basic sub-system validation in relevant environment.	
6	Technology system/subsystem model or prototype demonstration in a relevant environment.	75%
7	Technology system prototype demonstration in an operational environment.	
8	Actual technology system completed and qualified through test and demonstration.	Case Specific
9	Technology System “qualified” through successful mission operations.	Not IFI Eligible (business case stage)

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.

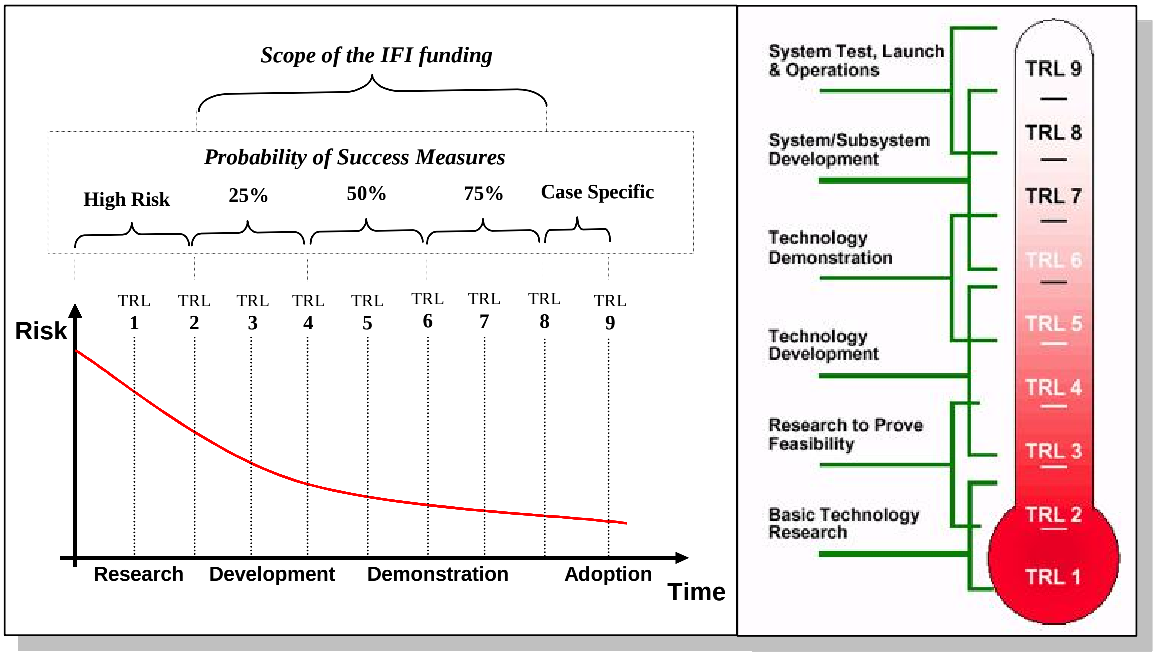

Figure C2: Relationship between Technology Readiness Level and Probability of Success

[Source (in part): NASA]

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.

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 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 06 – March 07

Table D1: IFI 0401-1: STP Module 2 – Overhead Lines

<table>
<tr><td>Project Title</td><td colspan="4">Strategic Technology Programme (STP): Module 2 - Overhead Networks</td></tr>
<tr><td>Project Description</td><td colspan="4">This describes a collection of Overhead Line projects under development at EA Technology SP-EN has invested in these projects as part as a collective of DNOs</td></tr>
<tr><td>Expenditure for (IFI) financial year</td><td colspan="2">Internal £6,500
External £41,407
Total £47,908</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £5,850
External £53,487
Total £59,337</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2">c. £296k p.a.</td><td>Projected 07/08 costs for SP-EN</td><td>Internal c. £8k p.a.
External c. £46k p.a.
Total c. £54k p.a.</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The STP overhead network programme for budget year 2006/7 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 projects within the programme aimed to:
• S2126_3 - Undertake long-term monitoring of conductor temperature by obtaining and analysing 12 months trial data.
• S2132_2 - Validate current and proposed new ice accretion models
• S2136_2 - Participation in European Project COST 727: Measuring and forecasting atmospheric icing on structures.
• S2138_2 - Investigate live-line jumper-cutting limitations Stage 2 is to undertake a controlled test programme.
• S2143_1 – To detect in-situ degradation of aluminium overhead line conductors
• S2144_1 – Determine the residual strength of tower fittings through experimental means
• S2145_1 Explore the use of novel conductors for uprating tower line circuits.
• S2146_1 Undertake torsion testing to evaluate possible limits for composite tension insulators
• S2147_1 Investigate the effect of multiple Spiral Vibration Dampers (SVD’s) on the performance of overhead line conductors
• S2149_1 – Explore high durability overhead line fittings. Initial stage to identify the range of fittings and materials.</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>Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Due to the age profile of system equipment 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.

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

	• 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; • reduce levels of premature failure of assets; • provide more cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults; • confidently extend the service life of towers and reduce potential levels of tower failures; • reduce lifetime costs by the appropriate use of alternative materials.		
Expected Timescale to adoption	Range 1-5 years Dependent on project	Duration of benefit once achieved	Range 3-10 years Dependent on project
Probability of Success	Range 1-10% Dependent on project	Project NPV (Present Benefits – Present Costs) x Probability of Success	£26,592 NPV developed by EATL on behalf of DNOs – not using SP methodology
Project Status **March 07**	Some projects within the programme are at an early stage, whilst others are complete. Issues have been identified relating to both operational and capital expenditure which, if successfully addressed, would enable the expected benefits to be achieved. • *S2126_3 - Undertake long-term monitoring of conductor temperature by obtaining and analysing 12 months trial data.* First year form initial test site data suggests that uprating may be possible in specific circumstances. A further site has been established and is being monitored. • *S2132_2 - Validate current and proposed new ice accretion models*. Data has been gathered from the test site and is being analysed prior to presentation to members. • *S2136_2 - Participation in European Project COST 727: Measuring and forecasting atmospheric icing on structures.* This is part of a much larger European collaborative project aiming to provide more accurate mapping of ice prone areas. Involvement is continuing with data exchange with other participants. This in turn will allow the most appropriate structure to be constructed. • *S2138_2 - Investigate live-line jumper-cutting limitations Stage 2 is to undertake a controlled testing programme.* The aim is to establish practical and safe limits for operational jumper cutting. • *S2143_1 – To detect in-situ degradation of aluminium overhead line conductors.* The preliminary work to explore available techniques has been completed. • *S2144_1 – Determine the residual strength of tower fittings.* A possible technique is being investigated which has clear financial benefits compared with traditional methods. • *S2145_1 Explore the use of novel conductors for uprating tower-line circuits.* This project is determining the applicability at the distribution level of novel conductor designs used at transmission voltages to allow increased ratings using existing structures. • *S2146_1 Undertake torsion testing to evaluate possible limits for composite tension insulators*. Laboratory testing has indicated torsion limits for a range of such insulators, which can be used to inform field staff.		

Project Status **March 07**	• *S2147_1 Investigate the effect of multiple Spiral Vibration Dampers (SVD's) on the performance of overhead line conductors.* The application of either multiple SVD's or heavy duty SVD's could allow increased overhead line tension • *S2149_1 – Explore high durability overhead line fittings. Initial stage to identify the range of fittings and materials.* This project is at an early stage and possible materials and treatments to improve corrosion resistance have been identified.
Potential for achieving expected benefits	Valuable projects extracted by SPEN during 0607 from this module includes: • *Which? Surge Arrester Guide*: Surge arresters were tested from a number of different manufacturers (all of which passed all of the relevant IEC tests) and found a wide variation is results. From this SP was able to put a contract in place for one of the top arresters, which will be least prone to failure. • *Icing of conductors at Deadwater Fell*: This report compared different conductors during winter conditions showing a variation in suitability to withstand winter weather. This information was used to create a new suite of overhead line design specifications that will supersede our existing suite. • *Life Expectancy of Copper Conductors*: As there is no in-situ test that can be performed on copper conductors, knowledge of their life expectancy will assist in planning replacement lines.
Collaborative Partners	CE Electric, Central Networks, United Utilities, Western Power Distribution, Scottish & Southern Energy, EDF Energy, NIE
R&D Providers	EA Technology Ltd

Table D2: 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 colspan="2">Internal £5,948
External £41,407
Total **£47,356**</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £7577
External £80987
Total **£88,564**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2">c. £259k p.a.</td><td>Projected 07/08 costs for SP-EN</td><td>Internal c. £8k p.a.
External c. £46k p.a.
Total c. **£54k p.a.**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The STP cable network programme for budget year 2006/7 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 2006-07 aimed to:
• S3132_6 - Addition of single core MV paper cable modeling functionality within CRATER cable rating software.
• S3132_7 - Addition of cable crossing modelling functionality within CRATER cable rating software.
• S3132_8 - Addition of load curve modelling functionality within CRATER cable rating software.
• S3132_9 - Addition of fluid filled cable modelling functionality within CRATER cable rating software.
• S3132_11 - Addition of EHV polymeric cable modelling functionality within CRATER cable rating software.
• S3140_2 – Towards Best engineering practice for ducted cable systems.
• S3145_1 – Investigate shrink back performance of PE sheath and insulation – Establish reliable test method.
• S3146_1 – Testing of fire retardant coatings and tapes.
• S3148_1 and S3148_2 - Requirements for earthing and bonding of single core MV power cables
• S3149_1 Assessment of different HV polymeric cable designs
• S4158_1 – Investigate user requirements for ducts
• S3159_1 - Series resonant testing of short lengths of HV cable</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>Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain the following benefits, including:
• Offset future increases in CAPEX and OPEX;
• CI/CML savings per connected customer;
• Increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
</table>

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 1-20% - dependent on project	Project NPV (Present Benefits – Present Costs) x Probability of Success	£16,518 NPV developed by EATL on behalf of DNOs – not using SP methodology
Project Progress **March 07**	Some projects within the programme are at an early stage, whilst others are complete. Issues have been identified relating to both operational and capital expenditure, which, if successfully addressed, would enable the expected benefits to be achieved. • S3132_6 - Addition of single core MV paper cable modeling functionality within CRATER cable rating software. The functionality to model and analyse this cable type is now available within the CRATER software tool, allowing member companies to evaluate a wider range of circuits. • S3132_7 - Addition of cable crossing modelling functionality within CRATER cable rating software. Comprehensive cable crossing functionality is now available in CRATER, allowing member companies to determine their own cable ratings and the interaction with NGC cables. • S3132_8 - Addition of load curve modelling functionality within CRATER cable rating software. The load curve modeling functionality in CRATER now allows a more accurate representation of the loads when determining ratings. • S3132_9 - Addition of fluid filled cable modelling functionality within CRATER cable rating software. A user-friendly spreadsheet tool for the cable engineer was created to determine sustained, cyclic and distribution current ratings for fluid filled cable ratings, using approved methods of calculation. • S3132_11 - Addition of EHV polymeric cable modelling functionality within CRATER cable rating software. The functionality to model and analyse this cable type is now available within the CRATER software tool, allowing member companies to evaluate a wider range of circuits. • S3140_2 – Towards best engineering practice for ducted cable systems. The report will form a sound basis for the creation of engineering recommendations and guidance documents for ducted cable systems. • S3145_1 – Investigate shrink back performance of PE sheath and insulation – Establish reliable test method. The project has demonstrated that shrink back can occur at lower temperatures and proposed a test to predict in service shrink back. • S3146_1 – Testing of fire retardant coatings and tapes. The project has, through testing, demonstrated an effective means of fire protection for triplex cables. • S3148_1 and S3148_2 - Requirements for earthing and bonding of single core MV power cables. Cable engineers can now determine the size of circulating currents and losses for their cable networks and use this information to determine, if appropriate, a cable size based on whole life costs. • S3149_1 Assessment of different HV polymeric cable designs. The initial stage of this project has not identified a suitable replacement design to lead sheaths for use as an effective moisture barrier in HV XLPE insulated cables rated at 66kV and higher.		
Project Progress **March 07**	• S4158_1 – Investigate user requirements for ducts. This project will allow DNOs to better tender for all types of plastic cable ducts since the requirements have been agreed between all users and all the major manufacturers • S3159_1 - Series resonant testing of short lengths of HV cable. This project will determine whether the use of variable frequency test sets is too onerous for the commissioning of short lengths of HV cable.		

Potential for achieving expected benefits	Valuable projects extracted by SPEN during 0607 from this module includes: • *Further developments of CRATER (cable rating software)*: SPEN bought into this project during 2005/06, since that time it has been further developed to incorporate a range of most commonly used cables in the UK. CRATER is currently in use by System Design and Project Engineering staff, it will be used during 07/08 to generate standard ratings for a document giving guidance across SPEN for cable ratings to be applied to our standard cables. • *Cable Duct Pulling Planner*: This is an excel based programme which is used to calculate the maximum bending radius for ducting, allowing cables to be pulled without causing undue stress and potential premature failure. During 2007/08 the Cable Duct Pulling Planner will continue to be used as a tool for assessment of pulling programmes submitted as part of major project tenders. • *User Specification for Cable Ducts*: The User Spec for Cable Ducts has updated the UK basis for specification of cable ducts and will be used to assist in preparation of ITT documents for the forthcoming renewal SPEN's bulk supply contract for cable ducts and provide a nationally accepted benchmark for acceptance of ducts installed by others.
Collaborative Partners	Central Networks, CE Electric, United Utilities, Western Power Distribution, Scottish & Southern Energy, EDF Energy
R&D Provider	EA Technology Ltd

Table D3: IFI 0401-3: STP Module 4 – Substations

Project Title	STP Module 4 –Substations			
Description of project	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			
Expenditure for financial year	Internal £6,409 External £41,407 Total **£47,817**	Expenditure in previous (IFI) financial years	Internal £7,007 External £53,487 Total **£60,494**	
Project Cost (Collaborative + external + SP-EN)	c. £280k p.a.	Projected 07/08 costs for SP-EN	Internal c. £8k p.a. External c. £46k p.a. Total c. **£54k p.a.**	
Technological area and / or issue addressed by project	Issues with the age profile of substation assets within the UK electricity distribution system are well known. Also, both regulatory and shareholder pressures preclude substantial investments of the large scale that was seen in the 1950's to 1970's. The challenge is to constantly review and innovate new solutions to monitor and define asset condition thereby allowing risks to be clearly defined and sound investment decisions to be taken The programme of projects which were approved for funding from the STP substations module budget and were undertaken in 2006/07 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: • S4164_3 – On load tap changer monitor – Stage 3. • S4176_2 – Comparison of available earth testing instruments • S4185_2 – AM Forum membership. • S4191_1 – Update and populate CBMVAL database. • S4193_2 – Enable effective quantification of risk and reliability. • S4194 – Regenerative transformer breathers. • S4197_1 – Concrete structure assessment. • S4200_1 – Methods to assess oil bunds and intelligent pump technology • S4201_1 – Corrosive sulphur in transformers • S4202_1 – Out of phase switching • S4203_1 – Review of INSUCON • S4205_1 – Assessment of contact greases for outdoor applications. • S4206_1– Substation security • S4207_1 – ERS33 switchgear rating at reduced temperature • S4208_1– Investigate the re-assessment of switchgear ratings • S4209_1 – Post maintenance testing • S4211_1 – Management and use of actuators • S4215_1 – Internal arc considerations in substations			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	Yes	Yes	No

<table>
<tr><td>Expected Benefits of Project</td><td colspan="3">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.
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:
• Offset future increases in CAPEX and OPEX
• Increased safety of staff and public by reducing the number of accidents/incidents;
• Both preventing disruptive failures of oil-filled equipment to reduce land contamination and avoiding unnecessary scrapping of serviceable components will alleviate environmental impact.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1-3 years - dependent on project</td><td>Duration of benefit once achieved</td><td>2-7 years - dependent on project</td></tr>
<tr><td>Probability of Success</td><td>5-40% - dependent on project</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td>£22,587
NPV developed by EATL on behalf of DNOs – not using SP methodology</td></tr>
<tr><td>Project Progress March 07</td><td colspan="3">Some projects within the programme are at an early stage, whilst others are complete. Issues have been identified relating to both operational and capital expenditure, which, if successfully addressed, would enable the expected benefits to be achieved.
• <i>S4164_3 – On load tap changer monitor – Stage 3</i>. The results from extending the laboratory system into a live substation have been very encouraging and a subsequent stage will allow an extended trial on a wider range of tap changers.
• <i>S4176_2 – Comparison of available earth testing instruments</i>. The project permitted cost effective comparison of four different types of electrode system to evaluate each instrument in relation to accuracy, cost, usability and robustness.
• <i>S4185_2 – AM Forum membership</i>. This project allowed members to be updated on substation asset management policies and practices adopted by other European Transmission System Operators (TSOs) and Distribution Network Operators in a cost effective manner.
• <i>S4191_1 – Update and populate CBMVAL database</i>. This project has delivered an up-to-date and easy-to-use software tool that enables members to make a valid assessment of the net financial benefits that might accrue from the implementation of CBM.
• <i>S4193_2 – Enable effective quantification of risk and reliability</i>. The project collated and analysed the consequences of recent events (over the past 10 years) in order to establish ‘benchmarks’ to quantify risk.
• <i>S4194 – Regenerative transformer breathers</i>. The project undertook an independent evaluation and cost benefit analysis of “maintenance-free” desiccant breathers.
• <i>S4197_1 – Concrete structure assessment</i>. The project highlighted the more common types of concrete degradation and the testing that is available to assess the extent of this degradation
• <i>S4200_1 – Methods to assess oil bunds and intelligent pump technology</i>. The project will enable members to compare the different policies, practices and bund pump technologies that have been adopted and to identify best practice.</td></tr>
</table>

Project Progress **March 07**	• *S4201_1 – Corrosive sulphur in transformers.* The project informed members regarding the issues and consequences of the failures in transformers due to corrosive sulphur. • *S4202_1 – Out of phase switching.* The project facilitated expert debate of out of phase switching issues. It was necessary for DNOs to fully understand the underlying system conditions and agree a common approach in this matter. • *S4203_1 – Review of INSUCON.* This project provided a cost effective summary commentary of INSUCON content and its relevance to members. • *S4205_1 – Assessment of contact greases for outdoor applications.* The project will recommend suitable products for the lubrication of outdoor contacts and identify best practice for their application. • *S4206_1– Substation security.* This project will undertake a wide review of the concept of, and approach to, the physical security of substations in order to deter theft. • *S4207_1 – ERS33 switchgear rating at reduced temperature.* The project will provide guidance that may allow utilities to run switchgear above maximum normal rated current values under specific conditions. • *S4208_1– Investigate the re-assessment of switchgear ratings.* The project will consider the provision of a methodology for understanding the risk of re-assigning switchgear fault level ratings without type testing. • *S4209_1 – Post maintenance testing.* The project will enable members to carry out the most appropriate testing regimes both from a financial and technical perspective and to establish pass/fail criteria. • *S4211_1 – Management and use of actuators.* This project should assist the members in ensuring that the risk of actuator failure is reduced, their reliability is increased and maintenance and testing is optimised. • *S4215_1 – Internal arc considerations in substations.* The project will enable members to better select HV/LV switchgear with respect to internal arc and ultimately lead to enhanced safety within the substation environment.
Potential for achieving expected benefits	Valuable projects extracted by SPEN during 0607 from this module include: • Onload Tap Change Monitor: This is being developed to warn of impending mechanical failure, which almost always leads to total loss of the entire transformer at £70k-120k. The development started in 06/07 and will continue into 07/08. • Risk Management Model: This was a lengthy theoretical study which sets out to quantity the financial risks of plant asset management. It proposes a method for applying judgement factors on when to replace such that the available budget is spent in the most cost effective manner. • A recent success has been the trial work on live tank oil sampling, which SP has begun this financial year. • Out of Phase Switching: This project considers the issue of switchgear rating when used in a network with embedded generation. The issue is that all DNOs are using "standard" distribution switchgear to connect local DG. The gear is fundamentally designed to BSI/IEC standards, which have performance set to meet the requirements of traditional distribution networks without generation. Traditional "generator" circuit breakers were made for very large generators, and were designed and tested to a different specification. The project is ongoing, and will continue into 07/08.
Collaborative Partners	Central Networks, CE Electric, United Utilities, Western Power Distribution, Scottish & Southern Energy, EDF Energy
R&D Provider	EA Technology Ltd

Table D4: IFI 0401-4: STP Module 5 – Distributed Generation

Project Title	Strategic Technology Programme (STP): Module 5 - Distributed Generation			
Description of project	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			
Expenditure for financial year	Internal £3,575 External £41,407 Total **£44,983**	Expenditure in previous (IFI) financial years	Internal £7,965 External £53,487 Total **£61,452**	
Project Cost (Collaborative + external + SP-EN)	c. £240k p.a.	Projected 07/08 costs for SP-EN	Internal c. £8k p.a. External c. £46k p.a. Total c. **£54k p.a.**	
Technological area and / or issue addressed by project	The projects undertaken through budget year 2006/7 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 been 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. These projects aimed to: • S5147_3 – Monitor Microgenerator Clusters • S5149_4 – Explore Active Voltage Control • S5142_2/3 – Generator Data and Structure for DG Connection Applications Stages 2 and 3 • S5152_2 – Latest developments in the connection of distributed generation • S5154 –Voltage Control Policy Assessment Tool on the IPSA Platform • S5157_1 – Evaluate the Performance of Small Scale Reactive Power Compensators Stage 1 • S5157_2 – Evaluate the Performance of Small Scale Reactive Power Compensators Stage 2 • S5160_1 – ACTIV Active Voltage Control • S5161 – Standard risk assessment approach to DNO protection • S5162 – Risk assessment analysis of voltage step changes • S5164 – Managing network risks associated with the application of ER P”/6 • S5167 – Assessment of enhanced ratings for overhead lines connecting wind turbines • S5168 – Design and operation implications for Grid Code compliance • S5180 – DNMS functions to support active network management			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	Yes	Yes	No
Expected Benefits of Project	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. 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: • Reducing the probability of voltage supply limit excursions resulting from increased distributed generation (eaVCAT interface to IPSA software tool); • Improving quality of supply and reducing risk of component failure (by understanding the effect and optimising use of impedance in the system);			

	• A better understanding of the risk presented by the distribution assets when considered as a network rather than discrete components; • 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); • 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 (Present Benefits – Present Costs) x Probability of Success	£32,855 NPV developed by EATL on behalf of DNOs – not using SP methodology
Project Status **March 07**	Some projects within the programme are at an early stage, whilst others are complete. Issues have been identified relating to both operational and capital expenditure which, if successfully addressed, would enable the expected benefits to be achieved. • *S5147_3 – Microgenerator Clusters.* Installation of monitoring points is complete at both the substation and LV network level. A twelve month monitoring programme has commenced. • *S5149_4 – Explore Active Voltage Control.* Modelling of typical radial and interconnected networks in preparation for flexing key parameters to examine limits of active voltage control. • *S5142_2/3 – Generator Data and Structure for DG Connection Applications.* A rationalised data structure has been agreed and implemented with all terms defined. • *S5152_2 – Latest Developments in the Connection of Distributed Generation.* Regular updates on new developments have been provided to members to help inform and influence the research programme. *S5154_1 – Develop a voltage Control Policy Assessment Tool on the IPSA Platform.* An interface between the existing eaVCAT software and the widely used IPSA power system analysis software has been established with eaVCAT making use of an embedded IPSA analysis routine. • *S5157_1 – Performance of Small Scale Reactive Power Compensators.* Five devices were identified, detailed information gathered and comparisons made using key criteria measures from members. • *S5157_2 – Performance of Small Scale Reactive Power Compensators.* This project examined the usage of DStatcoms with large windfarms and explored the implications for DNOs. • *S5160_1 – ACTIV Active Voltage Control.* An initial scoping study was completed and further work will be undertaken outside of the STP programme. • *S5161 – Standard risk assessment approach to DNO protection.* This stage of the project identified possible standard risk assessment approaches that could be developed for the selection of protection systems at the DNO / User interface • *S5162 – Risk assessment analysis of voltage step changes.* The project investigated voltage step changes in order to define possible limits used when planning network developments and generator connections. • *S5164 – Managing network risks associated with the application of ER P2/6.* The project examined the application of P2/6 across members and developed a baseline view of the network required to deliver minimum-security standards.		

Project Status **March 07**	- *S5167 – Assessment of enhanced ratings for overhead lines connecting wind turbines.* The project will determine if enhanced ratings can be safely applied to lines connected to wind-farm generators without the risk of infringing statutory line-to-ground clearances, and if so to recommend appropriate correction factors. - *S5168 – Design and operation implications for Grid Code compliance*. The project explores the network design and operational implications of the Grid Code target volts and slope concept. It will develop a testing procedure for DNOs to check the necessary voltage control with recommendations for 'standard' settings. - *S5180 – DNMS functions to support active network management*. To inform members of the additional active network management functionalities available in DNMS systems that are not typically being used in the control rooms at present.
Potential for achieving expected benefits	Valuable projects extracted by SPEN during 0607 from this module includes: - *Generation Data and Structure for DG connections*: This project was initiated due to complexities in obtaining data in generation connection applications in a consistent manner. A standard document has been produced, which is being developed further through the STP into a simplified electronic spreadsheet, which is automatically adapted to suit different forms of generation (e.g. wind, biomass, hydro, etc) for issue directly to generators. - *Risk assessment analysis of voltage step changes*: A short study defining a degree of commonality across DNOs in the application of voltage step-changes for generation connection studies. The outputs of this work have been presented as a recommendation to be added to the Distribution Code. - *Managing risks associated with P2/6*: Another short study, the outputs of which are currently being incorporated into the SP Design Manual.
Collaborative Partners	Central Networks, CE Electric, United Utilities, Scottish & Southern Energy, EDF Energy, ESB and Manx Electricity Authority
R&D provider	EA Technology Ltd

Table D5: IFI 0402: Single Phase LV Voltage Regulators

<table>
<tr><td>Project Title</td><td colspan="12">Single Phase LV Regulator</td></tr>
<tr><td>Description of project</td><td colspan="12">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 £7,046
External £99,956
Total **£107,002**</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £11,095
External £15,278
Total **£26,373**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">**c£250,000**</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £10,000
External £85,600
Total **£95,600**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">It is envisaged that this device will primarily used as a means of rapidly resolving voltage complaints in rural areas.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="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">• The device may be capable of resolving both temporary and permanent voltage complaints dependent on the type of complaint and the economics of the situation.
• Where there is a clear case for network reinforcement, which would require time to engineer the most cost effective solution, the voltage regulator could be used to resolve the complaint whilst a reinforcement scheme is designed, way-leaves negotiated and construction undertaken.
• Where the voltage complaint is due to disturbing loads or unidentified causes it could provide a permanent solution due to the fast response of the device to voltage dips and sags.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3"><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 colspan="3" rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>✦</td><td></td><td></td><td>✦</td><td></td><td></td></tr>
<tr><td colspan="8">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="5">£45,198</td></tr>
<tr><td>Project Progress **March 07**</td><td colspan="12">• Units tested at SP-EN with destructive tests carried out at NaREC
• Procedure and usage guide created for the units installation
• 10 LVRs installed in SP-M; 3 LVRs installed in SP-D (Ganged to resolve 3 Phase Voltage complaint)
• Monitoring equipment installed on 2 units (voltage recorders installed at customers premises at a number of other installations)
• See Appendix A for further information on this project</td></tr>
<tr><td colspan="3">Potential for achieving expected benefits</td><td colspan="10">• Project delayed by 6 months due to difficulties in creating a safe working procedure and usage guide for the units installation.
• Resourcing issues have delayed the trial rollout in SP-D.</td></tr>
<tr><td colspan="3">Collaborative Partners</td><td colspan="10">United Utilities (for trial phase)</td></tr>
<tr><td colspan="3">R&D Provider</td><td colspan="10">MicroPlanet USA</td></tr>
</table>

Table D6: IFI 0403: Reference Networks Phase 2

<table>
<tr><td>Project Title</td><td colspan="12">Reference Networks - Phase 2</td></tr>
<tr><td>Description of project</td><td colspan="12">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 colspan="3">Internal £2,110
External £1,144
Total £3,254</td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £6,614
External £60,000
Total £66,614</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">£341,200</td><td colspan="5">Projected 07/08 costs for SP-EN</td><td colspan="4">Internal £2,400
External £5,000
Total £7,400</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">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">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">• 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.
• 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 colspan="3">1 years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">5 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="3" rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>✦</td><td>—</td><td>✦</td><td></td><td></td><td></td></tr>
<tr><td colspan="9">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="4">£191,951</td></tr>
<tr><td>Project Status
March 07</td><td colspan="12">• Collaboration Agreement amended to include CE Electric
• CI and CML modelling completed
• Analysis of real network performance ongoing with data from: CN / UU / CE
• Investment scenario simulation tool:
o Completion of basic scenario modelling
o Validation studies to be completed
• Reliability performance explained and compared with CI/CML methodology completed</td></tr>
<tr><td colspan="4">Potential for achieving expected benefits</td><td colspan="9">The project remains on-track to achieve the expected deliverables, with a final report planned for Sept 07.</td></tr>
<tr><td colspan="4">Collaborative Partners</td><td colspan="9">United Utilities, Central Networks, PB Power, CE Electric</td></tr>
<tr><td colspan="4">R&D Providers</td><td colspan="9">Imperial College London</td></tr>
</table>

Table D7: IFI 0404: Alternative Insulating Oils

<table>
<tr><td>Project Title</td><td colspan="10">Alternative Insulating Oils Project</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 £2,538
External £18,884
Total **£21,422**</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £2,650
External £0
Total **£2,650**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£142,290</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £2,000
External £9,000
Total **£11,000**</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="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="4">Radical</td></tr>
<tr><td>No</td><td colspan="2">No</td><td colspan="3">Yes</td><td colspan="4">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Reduced environmental risk associated with oil spills.
• Potential to up-rate transformers at strategic sites.
• Opportunity to improve Energy Networks credibility with SEPA and other governing bodies.
• Opportunity to improve Energy Networks 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 colspan="6">Project NPV: (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£98,922</td></tr>
<tr><td>Project Progress **March 07**</td><td colspan="10">The following summarises what has been achieved in terms of technical understandings:
• Have quantified dielectric performance of ester oils as insulation materials through experiments and tests, dielectric performance is represented as electrical strength (kV/mm) under AC and Lightning voltages, with the effects of temperature, moisture contents and ageing conditions
• Have performed statistical analysis onto the experimental results to ensure that electric strength (kV/mm) could be linked with reliability index or probability of failure in an engineering environment
• Have identified electrical strength (kV/mm) of ester impregnated paper and pressboard under AC and Lightning voltages, along this line a reliable laboratory based solid insulation drying and impregnation procedure has been developed
• Impregnation procedures with ester oil have been studied through laboratory experiments, with theoretical study on capillary effect and viscosity as the backup
• Have identified/identifying DGA fingerprints, DP and Furfuran analysis of transformer insulation system when using ester oils (***expected to be completed within the present term of research***)</td></tr>
</table>

Potential for achieving expected benefits	The project is on target, with **on-going** research identifying dielectric capability of transformer insulation systems using ester oils, including: • Oil performance under realistic large oil gaps, a test cell up to 300kV (this limit is due to the external corona on the connecting pipe) has been designed and fabricated, tests for oils under the distance of 5, 10 and 15 mm have been carried out. Withstand voltage test for 100mm under 250kV for a half hour has been carried out for ester oils. Identified the need to monitor pre-breakdown using optical and discharge measurements. • Six month paper ageing to study the relationship between DGA, DP and Furfuran results. Quantify the AC and impulse breakdown strength of aged paper, in kV/mm. Identify the possible differences between esters and mineral oil in terms of paper ageing mechanism and by-products
Collaborative Partners	United Utilities, Central Networks
R&D Provider	University of Manchester

Table D8: IFI 0405: Alternative Design for 132kV Overhead Lines

<table>
<tr><td>Project Title</td><td colspan="10">Alternative Design for 132kV Overhead Lines</td></tr>
<tr><td>Description of project</td><td colspan="10">The design of a new heavy Trident 132kV wood pole overhead line specification, incorporating an underslung OPGW earth-wire for counteracting the rise of earth potential issues and for communications purposes.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £11,534
External £186,823
Total £198,357</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £49,109
External £79,471
Total £128,580</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£966,321</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £5,000
External £55,000
Total £60,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">• This is a project initiated to combat issues raised for the connection of renewable generation in Wales (SP-Manweb network).
• 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>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">There are multiple benefits to this project, including:
• Safety: Lower Rise of Earth Potential at substations through the addition of an earth-wire
• 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.
• 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>6 months</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 colspan="6">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£457,598</td></tr>
<tr><td>Project Progress March 07</td><td colspan="10">• Project trial build tendered and won by Alfred McAlpine Infrastructure Service (AMIS)
• An off-circuit trial consisting of 7 –8 spans of overhead line was successfully constructed on Forestry Commission land, south of Wrexham, North Wales
• Problems identified in trial phase once erected regarding conductor stringing arrangements – overcome and specification modified
• Site meeting planned April 07 with representatives from ENA member companies and invited guests to discuss and review design
• Trial planned for decommissioning May 07
• See Appendix A for further information on this project</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="9">This project is due to complete and be adopted during 07/08</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="9">N/A</td></tr>
<tr><td colspan="2">R&D Provider</td><td colspan="9">LSTC and construction contractor Alfred McAlpine</td></tr>
</table>

Table D9: 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>Internal £2,141
External £34,494
Total £36,635</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £13,267
External £0
Total £13,267</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£329,794</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £20,000
External £120,000
Total £140,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Implementing a reliable fault passage indicator with wireless communications for use on 33kV and 11kV overhead network will aid the location and isolation of faults.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>Yes</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">• Fault indicators will identify a more targeted search area for fault finding thereby improving response time and subsequent restoration of supplies to customers.
• This project focuses on reducing restoration time to rural customers.
• Reduced damage to land through unnecessary access. This also has customer service benefits, with a potential improved perception from landowners.</td></tr>
<tr><td>Expected Timescale to adoption</td><td><1year</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</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="6">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£297,916</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="10">• The budget is under development for the trial phase of the project
• The next step is to order units, install them on the network and analyse how effective they are
• Should benefits be realised during the trial phase a business case will subsequently be presented to show how their installation would benefit the company</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">• This project started as an investigation into the possible benefits of the installation of one type of FPI on one circuit on the SPD network
• The scope has since expanded to two primary substations, one in SPM and one in SPD with a more comprehensive test of four different types of device using both GSM and GPRS communications
• Solutions to bring data into the control room have been investigated</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">N/A</td></tr>
<tr><td>R&D Provider</td><td colspan="10">A range of manufactures are currently being identified</td></tr>
</table>

Table D10: 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 £7,584
External £37,796
Total £45,380</td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £12,835
External £7,638
Total £20,473</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£184,800</td><td colspan="5">Projected 07/08 costs for SP-EN</td><td colspan="4">Internal £7,100
External £20,000
Total £27,100</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="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">Preliminary use of the device for fault location on persistent LV faults is expected to:
Reduce the number of repeated fuse replacements
Minimise the number of joint holes
Remove the fault from the system in a shorter timescale than traditional ‘cut-and-test’ methods</td></tr>
<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 colspan="7">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£349,240</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="10">System still requires some development on the software. DNOs are working with a software company to develop an automated interface.
Development of reliable auto-poling is an urgent requirement for central system, operated from within a control room. Limited trial of iHost platform successful.
Business requirement for GPRS communications necessitates physical changes to existing modems and major changes to communications software.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Phase 1 successfully completed and has been taken outside development into adoption (30+ units purchased by business). Phase 2 to automate remote polling of devices has been undertaken.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Phase 1: N/A; Phase 2: EDF-Energy; United Utilities</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Kehui (UK) Ltd, Nortech</td></tr>
</table>

Table D11: IFI 0502: Fault Level Monitor Project

<table>
<tr><td>Project Title</td><td colspan="11">Electricity Supply Fault Level Instrument</td></tr>
<tr><td>Description of project</td><td colspan="11">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 colspan="2">Internal £3,859
External £9,144
Total £13,003</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £1,043
External £0
Total £1,043</td></tr>
<tr><td>Project Cost (Collaborative + external + [DNO])</td><td colspan="2">£190,000</td><td colspan="4">Projected 07/08 costs for SPEN</td><td colspan="5">Internal £5,000
External £20,000
Total £25,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">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="2">Significant</td><td colspan="5">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>No</td><td colspan="2">Yes</td><td colspan="5">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">The developed unit will allow the DNOs to accurately assess fault infeed levels and design distribution networks appropriately. The particular benefits of this project are seen to be:
• Provide a realtime and consistent estimation of fault level
• Accurately take into account all connected network elements (e.g. Motors);
• Facilitate the connection of distributed generation by providing a standardised methodology for the assessment of network fault levels
• Enable an ongoing assessment of the effects of connected distributed generation to be made;
• 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 colspan="2">3 years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">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="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£92,045
NPV for ENA projects calculated on a per Licence basis</td></tr>
</table>

Project Progress to **March 07**	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: • **Candidate monitoring sites and Deployment of loggers**– Network distrurbance data from 6 member have now been obtained using the Dranetz PX5 Power Quality instruments. • **Algorithm Evaluation and assessment –** The Fault Level Algorithm has been coded within the Matlab environment. A network model with known parameters was created in Matlab/Simulink and the fault level estimated for a range of scenarios. Results from the applied scenarios (voltage and current waveforms) are passed into the Fault Level algorithm and results compared. • **Dranview disturbance record analysis –** Dranview data at the 6 sites is being processed for integration into the coded Fault Level algorithm. The results from the 'real' data and the result from the Fault Level algorithm are then to be compared to the relevant power network models supplied by the site hosts (studied in PSS/E). • **Experimentation and Laboratory investigations –** A fault level monitor instrument is been tested on the University of Strathclyde Micro-grid system. This laboratory work will enable scenario results from a very well known and modelled network to be compared against the performance of an existing Fault Level instrument. Tests with static and active loads are being carried out.
Potential for achieving expected benefits	The work within this project is structured in such a manner so as to maximise the potential for achieving the expected benefits. There are three principle areas which are currently underway to assist in this: 1. Laboratory work (indicating a level of accuracy and agreement between measurement and model) 2. Theoretical work (a re-synthesis of the coding for the algorithm providing a positive view as the performance and accuracy of the underlying theory) 3. Site measurements (alignment with 'models' to predicted fault levels) Work in all these areas is currently underway, with the laboratory testing providing encouraging results of the theoretical and measured estimates of system fault level from the instrument. Further work is currently underway to establish a final conclusion in the level of fault level estimate accuracy which can be provided by the fault level monitor. The application and testing of the fault level monitor within a very well defined third party test network is also being pursued. The conclusion of these activities will be reviewed in September 2007 (the end of stage 1 of this project), and the results will be revised against a check list of acceptability criteria. From this, an informed decision to proceed to stage 2 can be made.
Collaborative Partners	ENA Member companies
R&D Providers	University of Strathclyde, EA Technology

Table D12: 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>Internal £21,581
External £5,493
Total **£27,074**</td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £1,043
External £0
Total **£1,043**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£50,000</td><td colspan="5">Projected 07/08 costs for SP-EN</td><td colspan="4">Internal £10,300
External £35,000
Total **£45,300**</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.

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>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">• Safety: Potential avoidance of unnecessary construction work associated with traditional methods of providing communications and hence reduction in the number of accidents.
• 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 are becoming increasingly important, this installation has the potential to reduce O+M costs associated with third party
• 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.
• 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 colspan="8">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£3,320,668</td></tr>
</table>

Project Progress **March 07**	• An off-circuit trial consisting of five L36 structures and four spans of conductor was successfully constructed at the training school at Dealain House. • The initial physical element of the trial is now complete and all components intended for use have been proven up to the design loadings. • The difficulties associated with the installation of the optical splice enclosures have been resolved and a review of the required access method for fibre optic splicing has been undertaken. • Some new components have been modified as a result of the trial to meet the requirements of the specification due to the high design loadings. • 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 circuit type scheduled complete April 2008, consents permitting.
Potential for achieving expected benefits	The specification has now been released to the business and is currently being utilised for proposed wind farm connections.
Collaborative Partners	N/A
R&D Providers	Design Phase: Lumpi Conductors (Austria)

Table D13: IFI 0504: Fault Infeed Calculations

<table>
<tr><td>Project Title</td><td colspan="3">Fault Infeed Calculations</td></tr>
<tr><td>Description of project</td><td colspan="3">A part funded project through the DTI (K/EL/00352/00/00) Technology Programme this aims to improve the quality of fault current calculations in commercial loadflow software packages.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,978
External £1,144
Total **£4,122**</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £1,043
External £0
Total **£1,043**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£116,500</td><td>Projected 07/08 costs for SP-EN</td><td>Internal £2,500
External £2,500
Total **£5,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The methods for calculating fault current contribution in commercial loadflow 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>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">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.

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>Duration of benefit once achieved</td><td>10 years</td></tr>
<tr><td>Probability of Success</td><td>25%</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 colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">-£12,603
The NPV of this project is negative, as it is at a too early stage to assess</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="3">• Carried out survey of different fault current calculation methods
• Undertook numerical comparison of calculation methods on simplified networks</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="2">Project is currently on target to deliver expected benefits.</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="2">United Utilities, Central Networks, DTI (via Technology Programme)</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="2">TNEI Ltd</td></tr>
</table>

Table D14: IFI 0505 Supergen V Amperes

<table>
<tr><td>Project Title</td><td colspan="4">Supergen V (AMPerES)</td></tr>
<tr><td>Description of project</td><td colspan="4">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>Internal £3,850
External £26,144
Total **£29,994**</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £1,610
External £0
Total **£1,610**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£3,140,000</td><td>Projected 07/08 costs for SP-EN</td><td colspan="2">Internal £10,000
External £50,000
Total **£60,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">SUPERGEN V proposal is aimed at:
• Improving knowledge of plant ageing
• Developing condition monitoring techniques
• Developing plant with reduced environmental impact
• Developing new protection and control techniques
• Enhanced network performance and planning tools</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">• Creation of intelligent diagnostic tools for plant and integrated network planning / asset management
• Reduction in the environmental impact of plant</td></tr>
<tr><td>Expected Timescale to adoption</td><td>10 Years</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</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 colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£46,609
Calculated figure based on assessment of planned trial with Liverpool University</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="4">The following are formal outputs from the consortium.
Reports:
• Report on 'Evaluation of G59 Protection relays
• Discussion Document on Vision and Priorities for Industrial demonstration
• Condition Monitoring Specification
• Lessons learnt from writing consortium agreement
• A review of voltage control
• Condition monitoring -State of the art report from Activity 5.2
Technology:
• A low cost RF unit has been produced based on the chromatic methodology of deploying the RF sensors.
• A fibre optic based acoustic sensor for detecting abnormal signatures from plant is near completion.
• Prototype knowledge based partial discharge analysis software. This is generic and can be applied to all partial discharge phase resolved signatures. It can categorise the discharge.</td></tr>
</table>

Project Progress **March 07**	• Equipment to control power quality of a voltage supply is nearing completion.
Potential for achieving expected benefits	As a result of a number of issues, the Consortium Agreement was not signed until November 2006. The agreement has led to the establishment of a Steering Group and an Executive Management group to provide full engagement, and effective participation, of all parties. Dependant on their internal regulations, some universities were able to start work in February 06 (when the offer letter was received), and others had to wait until November 06. The project is being brought on track, after the delayed start and is expected to meet original objectives. In particular there have been some delays in Work Package 3, as a result of delays in recruitment, and these are being managed in the context of the whole project. It is likely however that, although the majority of the project will be complete at the end of the four years, some students will still be active for a short period thereafter. Overall the management processes are strong and have been effective. Key links to industrial partners are now being formed, and in particular through Work Package 6, the first demonstrators on networks are being discussed. The first technical meeting was a major success with excellent attendance and participation. A number of papers have been written on work from within the project. For further details see www.supergen-amperes.org
Collaborative Partners	National Grid, United Utilities, Scottish & Southern Energy, EDF-Energy, Western Power Distribution, Central Networks, CE Electric UK, Northern Ireland Electric, EPSRC
R&D Providers	EPSRC selected universities – Manchester, Strathclyde, Liverpool, Southampton, Edinburgh, Queens University Belfast

Table D15: IFI 0506: Portable Smart Link (ASL) tester

<table>
<tr><td>Project Title</td><td colspan="10">Portable Automatic Sectionalising Link (ASL) tester</td></tr>
<tr><td>Description of project</td><td colspan="10">The development of a portable ASL (‘smart’ link) tester for use in the field to confirm performance prior to installation.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £2,382
External £8,144
Total £10,526</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £1,727
External £7,000
Total £8,727</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">£15,000</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="3">Internal £5,200
External £7,000
Total £12,200</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">Auto-Sectionalising Links (ASLs) are extensively used on SP’s overhead line networks in conjunction with pole mounted auto-reclosing circuit breaker to minimise the numbers of Customer Interruptions following a network fault.
SP has experienced some problems with mal-operations of an earlier vintage of units. The ASL testers that can be distributed to maintenance and fault operations overhead line staff that will allow them to test ASLs in the field allowing healthy units to be reused immediately on the network.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">Yes</td><td colspan="3">No</td><td colspan="2">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">Testing of ASLs in the field should enable healthy ASLs to be reused immediately on the network following operation, this should save money and operational time.</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">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 colspan="6">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£63,970</td></tr>
<tr><td>Project Progress March 07</td><td colspan="10">• Final prototype built, general functionality accepted by SP
• Product developed into commercial product
• Final units delivered July 06 and currently undergoing tests with field staff.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">This project successfully completed, and is planned for adoption in 2007/08.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Nortech, Cooper Bussmann, Access Hire Services LTD</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Nortech</td></tr>
</table>

Table D16: IFI 0507: Smart Dust

<table>
<tr><td>Project Title</td><td colspan="12">Smart Dust (sensor networks) – Phase 1</td></tr>
<tr><td>Description of project</td><td colspan="12">Smart ‘dust’ is 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 “motes” for detecting the passage of fault currents on 11kV overhead line networks.

Following on from this work, a collaborative project has been scoped between EDF-Energy, Central Networks and SPEN to develop higher power motes, overcoming some of the inherent problems associated with low powered units.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="4">Internal £2,740
External £12,719
Total **£15,459**</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £4,182
External £2,231
Total **£6,413**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="4">Phase 1 = £16k
Phase 2 = TBC</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="4">Internal £7,500
External £50,000
Total **£57,500**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The feasibility of the use of higher power motes as a medium for fault passage indication is being investigated in this project, the aim being to increase the efficiency of fault finding on the 11kV overhead network, ultimately reducing CML penalties.</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">No</td><td colspan="3">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">SmartDust 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 colspan="3">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" colspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>✧</td><td>✧</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£25,653 (Phase 1)</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="12">Feasibility study completed 0607 - key outcomes:
o Comms worked over longer than predicted distances
o Battery life is poor for high sample rate
o FPI sensors not developed – would need to buy into existing developments
o Future developments would need to be self powered
o Cost estimates for low powered devices do not show to be favourable for FPI application</td></tr>
</table>

Potential for achieving expected benefits	There are numerous FPIs in existence, however if the cost of the smart-mote units were sufficiently low, this technology could be a viable alternative. Significant analysis has been undertaken on the deployment characteristics of GSM/GPRS Fault Passage Indicators Vs motes, 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, high power mote: - allows a much higher percentage of locations of be monitored economically than any other option, across all price points and time savings - offers a much higher NPV than any other option Owing to these factors, a significantly higher percentage of network can be monitored (from 10% for GSM devices to above 70% coverage for motes), increasing the likelihood that they will be targeting faults (rather than solely focussing on worst performing circuits).
Collaborative Partners	EDF-Energy and Central Networks
R&D Providers	TBC (Phase 2 currently proposal in progress)

Table D17: IFI 0508: Development of Redox flow battery for energy storage

<table>
<tr><td>Project Title</td><td colspan="4">Development of Redox flow battery for energy storage</td></tr>
<tr><td>Description of project</td><td colspan="4">A part funded project through the DTI Technology Programme TP/3/ERG/6/1/16587(D05/726039) that aims to develop (design, build, test and install) an 11kV 250kW Redox flow battery unit for energy storage.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £7,498
External £1,144
Total £8,642</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £2,995
External £0
Total £2,995</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£965,567</td><td>Projected 07/08 costs for SP-EN</td><td colspan="2">Internal £3,500
External £30,000
Total £33,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Uses include, voltage support of long lines, overcoming reverse power effects through transformers and potential improvements to network performance. Development of a device which can be connected the our 11kV network and provide power by charging from the AC supply</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• 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, thereby providing potential savings.
• By placing these devices in the network, voltage problems could be reduced. Furthermore, a device could be employed where providing a supply is difficult of costly. A unit could run in conjunction with a small wind turbine to provide an islanded network.
• As a replacement for current lead-acid batteries, this technology has a low environmental impact.
• One of the most significant outcomes expected of this project is the understanding for how storage systems could be connected to the network, and their likely applications.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</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 colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">£243,753</td></tr>
<tr><td>Project Progress March 07</td><td colspan="4">• Site identified for the installation of the Redox unit
• Point of electrical connection to the SP-D 11kV network agreed
• Prototype design of Redox cell complete
• Construction programme in place</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="3">Project is currently behind schedule (between 6/9 months)</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="3">DTI (via Technology Programme), ESD Ltd, Univ. of Southampton, Econnect, Swanbarton Ltd</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="3">ESD Ltd (project managers)</td></tr>
</table>

Table D18: 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="2">Internal £5,796
External £33,644
Total **£39,440**</td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £7,468
External £5,000
Total **£12,468**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2">£2,345,967</td><td colspan="5">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £20,000
External £150,000
Total **£170,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">The development of a non-linear ‘high-temperature’ superconducting ceramic in series with a circuit breaker for the clamping and clearance of fault energy.

When the material is operated at below its critical temperature it loses all electrical resistance, thereby allowing load current to flow with negligible losses. Either the increased current density caused by fault current, or the loss of cooling medium (liquid nitrogen) causes the temperature of the superconducting material to rise and it reverts to a normal resistive state.

Being a solid state device, the SFCL has been proven to operate in a few milliseconds, after which the impedance remains high until the fault is cleared by conventional means (protection operated circuit breakers, fuses, etc.). The SFCL’s operation is sufficiently fast to ensure that the first peak of the fault current is limited. The subsequent limited current can be set to suit a specific application.

Three devices (one per DNO) will be constructed and installed covering a range of applications: transformer tails; bus section; interconnected network connection. The successful completion of this project is likely to pave the way for higher voltage devices.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="3">Significant</td><td colspan="5">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>No</td><td colspan="3">Yes</td><td colspan="5">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">To develop, understand and address the issues associated with the connection of an 11kV fault current limiting device to the network.

Successful trials will result in the development of commercially available devices that are capable of clamping fault levels to within network design limits. Once proven, this will open up another option for tackling network fault level, potentially providing an alternative to network reinforcement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="5">20 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">25%</td><td colspan="10">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td colspan="2">5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>✦</td><td>✦</td><td colspan="2"></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="10">£-267,191
Project NPV is negative due to the low TRL / high costs upon commencement</td></tr>
</table>

Project Progress **March 07**	• Bamber Bridge, Preston has been identified as the first trial site and a full specification of the SFCL has been prepared based on a detailed study of the local network impedances. • Modelling of the SFCL's interaction with the network has been undertaken and no particular problems are apparent. • Superconducting elements have been designed and tested and shown to provide the necessary performance. Design of the of the SFCL, its enclosure and associated equipment is in progress.
Potential for achieving expected benefits	• Applied Superconductor Ltd. experienced a setback in mid 2006 when a major offer of finance from a private investor was withdrawn. • The company has since secured the financial support required to ensure that the three planned pilots can be completed and the project is due to continue from the beginning of June 2007.
Collaborative Partners	United Utilities, CE Electric UK, Applied Superconductors Ltd
R&D Providers	Applied Superconductors Ltd

Table D19: IFI 0510: Innovative Protection Solutions

<table>
<tr><td>Project Title</td><td colspan="3">Innovative Protection Solutions</td></tr>
<tr><td>Description of project</td><td colspan="3">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 Manweb region.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,939
External £1,144
Total £5,083</td><td>Expenditure in previous (IFI) financial years</td><td>Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£150,000</td><td>Projected 07/08 costs for SP-EN</td><td>Internal £25k
External £125k
Total £150k</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">At present these interconnected 11kV and 6.6kV networks are protected through the use traditional unit based schemes. However a subset of these networks utilise bi-directional overcurrent and earth fault relays at remote primary substations.

Protection theory shows that it is impossible to achieve true time-based discrimination in a solidly interconnected ring network. In practice, experience shows that suitable 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>Type(s) of innovation involved</td><td colspan="3"><table><tr><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr><tr><td>No</td><td>Yes</td><td>Yes</td><td>No</td></tr></table></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Reducing the size protection zones CI and CML figures
Reducing time multiplier, protection clearance times should be improved
Resolving sympathetic tripping of adjacent breakers</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 year (assuming successful trial)</td><td>Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</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 colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td>£50,000</td></tr>
<tr><td>Project Progress March 07</td><td colspan="3">Functional specification developed and project tendered to a number of relay manufacturers from across globe
Technical selection of protection scheme completed</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="2">The project is planned for a network trial in 07/08</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="2">N/A</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="2">Schweitzer Engineering Laboratories and FreeWave Radio</td></tr>
</table>

Table D20: 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">A new voltage control relay using measurements from generation feeder CTs in addition to the LDC CT in the transformer has been developed by AVC manufacturers Fundamentals. This scheme claims to give full four-quadrant (real/reactive power) control of transformer voltages by discriminating the power flow influence of a connected generator from the load current and then refining the overall AVC response to optimise for both load and generation.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1,566
External £1,144
Total £2,710</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£254,206</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £2,400
External £32,676
Total £35,076</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 SPM / SPD in areas where the ratios of generation to load is high.</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">• A method of voltage control for high voltage power transformers that provides for the discrimination between load current delivered to customers from a node and current injected into the node by downstream generation. This would enable the application of a voltage boost to compensate for load-related voltage drops along connected feeders and a voltage attenuation to compensate for generation-related voltage rises at the point(s) of connection.
• A method wherein accurate voltage control is provided regardless of how much power is injected into the system by downstream generation.</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 colspan="8">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£67,445</td></tr>
<tr><td>Project Progress March 07</td><td colspan="10">• Preliminary work commenced and completed
• Collaborating parties agreement in principle
• Awaiting agreement of formal terms and conditions</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="9">This project is due to commence 2007/08.</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="9">Central Networks, Scottish & Southern Energy, United Utilities</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="9">EATL, Fundamentals</td></tr>
</table>

Table D21: IFI 0513: Thermal modelling and Active Network Management

<table>
<tr><td>Project Title</td><td colspan="4">Thermal modelling and Active Network Management</td></tr>
<tr><td>Description of project</td><td colspan="4">A part funded project through the DTI Technology Programme (TP/4/EET/6/I/22088) that aims to optimise network design, operation and control by exploitation of circuit thermal ratings.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £6,308
External £1,709
Total £8,017</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £3,226
External £0
Total £3,226</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£903,000</td><td colspan="2">Projected 07/08 costs for SP-EN</td><td>Internal £15,000
External £100,000
Total £115,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">• The ratings given to circuits are a function of the temperature by which they operate. The thermal status of a power system component is determined by factors such as: current flow, meteorological conditions and component heat transfer characteristics.
• This project seeks to explore the potential benefits arising from: (a) the improved utilisation of power system assets through the use of real time knowledge of the thermal status of the power system and (b) 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.</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">• Active network management and exploitation of equipment latent thermal ratings may be a way of accommodating increased levels of renewable generation in distribution networks cost effectively.
• Improved utilisation of distribution assets resulting in deferral and/or avoidance of reinforcement investments in distribution systems.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</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 colspan="4">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td>£301,867</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="4">• Collaboration agreement signed off and project commenced Sept 06
• 3x PhD appointments made Project at Durham University and preliminary research undertaken: data collection / standards review / network modelling
• Target software development platform identified
• Trial site identified and site visits undertaken</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="3">This project is progressing on target, with network trials / data gathering scheduled for 2007/08.</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="3">DTI (via Technology Programme), Durham University, Imass, Areva, PB</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="3">PB (project manager), as above</td></tr>
</table>

Table D22: 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 £2,747
External £29,842
Total £32,589</td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £2,925
External £10,000
Total £12,925</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£57,991</td><td colspan="5">Projected 07/08 costs for SP-EN</td><td colspan="4">Internal £3,000
External £19,292
Total £22,292</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">Yes</td><td colspan="3">No</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 at 11kV. This could have a significant effect on targeting capital spent reduce environmental impact.
• 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="5">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td>✧—</td><td>—</td><td>—</td><td>✧</td><td></td><td></td></tr>
<tr><td colspan="8">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£110,911</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="10">FMC-Tech have modified, integrated and tested the prototype equipment to SP specification including:
• Temperature monitoring embedded into fault passage indicator
• Integration of weather station
• Live tests conducted and trailed on ESB network</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="9">Equipment is scheduled for network trials in 07/08</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="9">Discussions underway with NIE</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="9">FMC Tech</td></tr>
</table>

Table D23: IFI 0515: ScottishPower / Rolls-Royce Prototype Network

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. 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 £8,082 External £21,692 Total **£29,774**	Expenditure in previous (IFI) financial years	Internal £15,566 External £0 Total **£15,566**	
Project Cost (Collaborative + external + SP-EN)	£7,200,000	Projected 07/08 costs for SP-EN	Internal £10,000 External £TBC Total **£TBC**	
Technological area and / or issue addressed by project	In partnership with collaborators, this project aims to: • Provide a demonstration network to allow the testing of new technologies on a 'real' network • Offer a real network that will incorporate 11kV and low voltage equipment, containing real loads, real generation and test real technologies • Create a facility which will be open to Academia, R&D Establishments, Manufacturers, and Network Operators The vision is to create a physical scale model that can represent the very different land and marine based networks for both ScottishPower and Rolls-Royce. The proposed system will incorporate real network components: cables, overhead lines, switchgear, transformers, protection and control equipment, in order to ensure it is both representative and credible to the real thing. Real Time Digital Simulators (RTDSs) will be used in parallel to model an underlying, more comprehensive network, effectively expanding the scale of the system. Technologies coming more prominently into play over the next 15 years, e.g. micro-generation, storage, fault current limiters, etc., will be included on the test network so as to test their effect, and vice-versa, on both marine and distribution systems.			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	Yes	Yes	Yes
Expected Benefits of Project	Benefits to DNOs from such a facility include: • **Safety** – A test network with dedicated staff will offer a facility to train staff in the operation of a more complicated network. Specific what-if scenario courses can be run through repeatable simulation, in the same manner as flight simulators are used to train pilots. • **Risk mitigation** – A real time simulator, with likely penetrations of high volume DG and microGen will indicate the technologies that will need to be developed in order to manage the increased risk this might pose to the network and/or our customers. • **Acceleration of trials / increased adoption rate** – The ability to operate the whole network through a vast range of loading conditions in a short period of time, will lead to the end of long duration (12-24mth) network trials of new technologies.			

<table>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>✧</td><td>✧</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£709,171</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="10">Development of proposal: A detailed proposal has been developed between SP and project partners consisting of:
Detailed design – a realistic and reconfigurable network design to simulate real 11kV and LV networks
Costing estimates – costing analysis of network components and connection to the local primary substation
Impact assessment – The completion of a network impact assessment into the challenges posed by connecting medium / high penetrations of 11kV and LV connected generation to the existing network
Exploration of funding opportunities: The consortium has been working extensively with funding bodies to develop a comprehensive project plan to comply with the needs of the project partners and State Aids rules.
Working with Ofgem: Dialogue has been established and maintained with Ofgem to develop the project and confirm its eligibility under IFI rules.
Use of the facility for product development / testing related to IFI projects thereafter will be funded separately. This facility will be available to any other network operator interested in using the centre.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Throughout 2006/07 ScottishPower has been working with partners to develop this proposal with a coherently designed network and appropriate funding / operation structure.

Whilst significant challenges have been overcome, delays have been encountered. Formal proposals will be put before both Ofgem and Scottish Enterprise in 2007/08.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">Scottish Enterprise (under consideration), Rolls Royce, University of Strathclyde</td></tr>
<tr><td>R&D Providers</td><td colspan="10">See Collaborative Partners</td></tr>
</table>

Table D24: IFI 0517: GridSense LineTracker FPI (Conductor Temperature)

<table>
<tr><td>Project Title</td><td colspan="4">GridSense LineTracker FPI (Conductor Temperature)</td></tr>
<tr><td>Description of project</td><td colspan="4">The LineTracker is a fault and load monitor device from which data is downloaded wirelessly to a control centre at 33kV.
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 colspan="2">Internal £2,620
External £54,019
Total £56,640</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £1,043
External £0
Total £1,043</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2">£140,000</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £7,000
External £70,000
Total £77,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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>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">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>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>
<tr><td colspan="4">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td>£243,458</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="4">The development stage of the project completed in Sept 06 with a number of prototype units available for trial.
Units purchased and delivered to UK.
Trial locations identified but not yet installed.</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="3">Equipment is scheduled for network trials in 07/08</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="3">United Utilities</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="3">GridSense CHK</td></tr>
</table>

Table D25: IFI 0518: Offline Corrosion Monitoring (towers)

<table>
<tr><td>Project Title</td><td colspan="10">Offline Corrosion Monitoring (towers)</td></tr>
<tr><td>Description of project</td><td colspan="10">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.
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 £2,396
External £27,944
Total **£30,340**</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">£31,300</td><td colspan="3">Projected 07/08 costs for SP-EN</td><td colspan="4">Internal £2,500
External £5,000
Total **£7,500**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">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="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="10">• Ability to quantify the threats on a geographical basis through a robust and auditable process.
• 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.
• Comparison between different replacement / refurbishment strategies.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">2 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="4">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 colspan="6">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">£62,000</td></tr>
<tr><td>Project Progress **March 07**</td><td colspan="10">• 2x 132kV circuits have been successfully modelled
• Specific areas of vulnerability associated with proportionally higher levels of corrosion on specific towers have been identified.
• Further work is planned to assess the residual strength of towers.</td></tr>
<tr><td colspan="3">Potential for achieving expected benefits</td><td colspan="8">SP intends to conduct further work with CAPCIS to assess tower strength in 07/08.</td></tr>
<tr><td colspan="3">Collaborative Partners</td><td colspan="8">N/A</td></tr>
<tr><td colspan="3">R&D Providers</td><td colspan="8">Capcis</td></tr>
</table>

Table D26: 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.

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 £3,725
External £25,525
Total £29,250</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal £4,375
External £1,000
Total £5,375</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">£30,000</td><td colspan="3">Projected 07/08 costs for SP-EN</td><td colspan="3">Internal £2,500
External £10,000
Total £12,500</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.
• 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>3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>✦</td><td>✦</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="8">-£33,905
Unable to detail the benefits case for storage without this work, hence –ve NPV.</td></tr>
<tr><td>Project Progress March 07</td><td colspan="9">• A study on 2 networks has been completed, concluding that use of a storage unit would be useful in enabling further connections of distributed generation in that network.
• Initial presentations have been given to the local Government on the outcomes of the study, and plans are in progress to cost out storage options in greater detail.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="9">• This project has completed its first stage report.
• A second stage is being planned for 07/08 to accurately cost different storage options technologies and identify any Regulatory barriers associated with a DNO operating energy storage.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="9">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="9">PB</td></tr>
</table>

Table D27: IFI 0522: Supergen III

<table>
<tr><td>Project Title</td><td colspan="4">Supergen 3 – Highly Distributed Power Systems</td></tr>
<tr><td>Description of project</td><td colspan="4">The SUPERGEN Highly Distributed Power Systems Consortium will address the research challenges associated with a systems approach to the design, operation and control of highly distributed power systems (HDPS).

It is the systems approach, the development of modular solutions and methods to support the realisation of highly distributed power systems (microgeneration, storage, etc), and importantly the focus on rigorous analysis methods for integrated technical, economic and environmental appraisal of such systems that both sets it apart from and complements other research initiatives.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1,838
External £1,144
Total **£2,982**</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £1,043
External £0
Total **£1,043**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£2,371,634</td><td>Projected 07/08 costs for SP-EN</td><td colspan="2">Internal £2,000
External £0
Total **£2,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The key objectives of the consortium’s programme of work are:
• Identify the most effective conceptual design for the realisation of a highly distributed power system (HDPS)
• Creation of an integrated appraisal framework for the economic, environmental and technical assessment of HDPS
• Assessment of market transformation and network access approaches in support of HDPS development.
• Realise a simulation facility capable of characterising, modelling and appropriately analysing the behaviour of a HDPS
• Engineering of management and control system for effective coordination of Distributed Energy Resources (DERs) in HDPS
• Realisation of DER inverter interface and control modes compatible with HDPS control, protection and power quality requirements
• Demonstration of modular DER integration and interfacing</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">• New demand and generation profiles
• Cumulative and interactive behaviour of many small DERs, in particular <5MVA units.
• Network integration of many small DERs, and mechanisms for “plug and play” integration.
• Impact on operational management.
• Device performance, in particular the incorporation of network added-value features.
• Operational planning with DERs, to support network investment against hard constraints.
• Market mechanisms, including charging mechanisms and the effectiveness of long term and short term market signals to influence DER behaviour.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
</table>

<table>
<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 colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£20k
Although this project has no direct SP cost input at this point, the benefits come from early access to reports</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="10">• Revision of initial Highly Distributed Power Systems (HDPS) concept
• Microgeneration models and building models developed for the derivation of expected running profiles
• An analysis conducted of the impact of a high penetration of DERs on a real LV suburban network protected by conventional protection
• Device model library extended to include dynamic models of DERs and grid interfaces
• The requirements and techniques for a HDPS planning tool have been identified and described in detail. The development and testing of a Multi Objective Planning tool for HDPS continues
• Developed a modular open-source (http://code.google.com/p/wxpylon/) software application, wxPylon, for the modelling of electric energy markets and networks with very large numbers of active loads and generators.
• Development and laboratory testing of suitable inverter control schemes
• Laboratory experimental testing and simulation of the parallel operation of multiple inverters with the grid.</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="9">Programme is currently on target.</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="9">EPSRC, Rolls Royce, plus letters of support from other industrial partners</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="9">University of Strathclyde (lead), Loughborough University, University of Manchester, University of Oxford, University of Bath, Imperial College</td></tr>
</table>

Table D28: IFI 0526: PD Monitoring of Cables

<table>
<tr><td>Project Title</td><td colspan="9">PD Monitoring of Cables</td></tr>
<tr><td>Description of project</td><td colspan="9">A portable partial discharge (PD) monitoring solution is to be developed and testing carried out on the SP 11kV network. The testing will involve a number of stages: pre-screening, PD monitoring for a period of time (up to 1 month), PD mapping and investigation into the state of cables/joints following cable replacement.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £2,882
External £1,144
Total £4,026</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">TBC</td><td colspan="3">Projected 07/08 costs for SP-EN</td><td colspan="3">Internal £ TBC
External £ TBC
Total £ TBC</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">Development of portable partial discharge monitor. Existing PD monitors are designed for permanent installation or spot testing (test period of a few minutes). The portable monitor can be installed in a substation and left for a period of many weeks. The monitor will be compact, rugged and easily transportable. It will also be enabled for remote access via a PC (eg from DNO control room).</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="2">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">• The PD monitoring technology under development will aid predictions of future faults occurrence, allowing improvements in the area of customer interruptions (CI).
• The increase in the rate of PD on a cable section is believed to be a more accurate indication of a cable reaching end-of-life (other than the age of the cable and past performance), hence the use of PD monitoring equipment can be used to help assess the need for cable replacement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">1 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>
<tr><td colspan="7">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">TBC</td></tr>
<tr><td>Project Progress March 07</td><td colspan="9">• Possible service providers identified and contacted regarding project requirements.
• Discussions held with other DNOs to establish progress in the area of PD monitoring UK-wide.</td></tr>
<tr><td colspan="3">Potential for achieving expected benefits</td><td colspan="7">The project relies on significant knowledge of the relationship between PD identified on cables and remaining cable life span to be established to fully maximise the benefits of PD testing.</td></tr>
<tr><td colspan="3">Collaborative Partners</td><td colspan="7">TBC</td></tr>
<tr><td colspan="3">R&D Providers</td><td colspan="7">TBC</td></tr>
</table>

Table D29: IFI 0529: ESR network (ESR 21)

<table>
<tr><td>Project Title</td><td colspan="12">ESR network (ESR 21)</td></tr>
<tr><td>Description of project</td><td colspan="12">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 colspan="3">Internal £1,736
External £1,144
Total £2,880</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £2,211
External £6,000
Total £8,211</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">£126,000</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £1,800
External £3,000
Total £4,800</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">• 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, DTI (Technology Programme), etc.</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">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">• Monitoring of selected publicly-funded research grants of specific interest to the industrial membership
• Maintaining an awareness of progress in major R&D initiatives such as SUPERGEN and other R&D initiatives such as UKERC, the Energy Research Partnership and APGTF
• Preparing R&D strategy papers on areas determined by the Network Panel
• Network of academic contacts
• Network of industrial contacts</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">Ongoing linkage to academia</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">3 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="8">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">-£16,445</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="12">• At the end of the year 43 academics were in membership of the Network (an increase of 5) and 14 industrial companies (no change).
• During the year 5 new grants were brought into the Network's monitoring and overview process. These covered the areas of electrical plant condition monitoring, combustion, structural integrity and materials for fusion.
• Mid-term presentations on 6 grants were received at Panel meetings. A total of 22 detailed review meetings were held involving the grant holders and the interested industrial members.
• The Network Panel received presentations during the year from four SUPERGEN consortia (Wind Power Technologies, Biomass Energy, Plant Life Extension and Future Network Technologies), and from UKERC and the Energy Research Partnership.
• The final version of the Network's R&D strategy paper on condition monitoring of electrical transmission and distribution plant (COMET) was posted on the Network web site</td></tr>
</table>

Potential for achieving expected benefits	This project encompasses a number of small projects each at differing stages of development
Collaborative Partners	**Industrial:** Scottish Power Generation, QinetiQ, National Grid, BNFL, Magnox Generation, SERCO Assurance, VATECH Reyrolle, ABB Switzerland Ltd, RWE Innogy Plc, ALSTOM Power, SP Power Systems Ltd, AREVA T&D (Technology Centre), E-ON UK (Power Technology Centre) **Academic:** 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 **Government:** DTI, EPSRC
R&D Providers	See above academics

Table D30: IFI 0532: AURA-NMS

<table>
<tr><td>Project Title</td><td colspan="12">AURA-NMS (Automated Regional Active Network Management System)</td></tr>
<tr><td>Description of project</td><td colspan="12">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 colspan="3">Internal £4,849
External £155,442
Total **£160,291**</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal £3,232
External £0
Total **£3,232**</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">£5,962,636</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £20,000
External £300,000
Total **£320,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="12">In general the scoping and development will consider the following major areas.
• Distributed Generation and demand side management to facilitate the connection of DG to the network;
• Develop a controller that will monitor electricity networks, isolate faults quickly and allow distributed generation to remain connected and operating.

The SP portion of this work is to focus on constraint management techniques for use on new / existing generation connections, focussing on the 33kV and 132kV networks. Although relevant to both SP-D and SP-M networks, the principle focus in case studies will be to overcome existing limitations in SP-M, with a focus on:
▪ Overcoming complexity of existing hard-wired intertripping schemes
▪ Determining a solution for managing multiple generation connections in a given locality
▪ Developing and implementing a system that can work in harmony with existing SCADA infrastructure
▪ Overcoming communications / equipment limitations of existing systems</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td 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">No</td><td colspan="3">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="12">Benefits are expected to include:
• Development of a constraint management solution with relevant experts
• Implement solution and prove concept
• Potential to create Registered Power Zone for additional revenue on the DG incentive
• Maximisation of the contribution of DG to the electricity network;
• Reduction in carbon emissions and help towards the UK governments climate change targets;
• Reduction in network losses by having the source of generation close to the load;
• Improvement in quality and security of supply;
• Improvement in network resilience; and
• Reducing the current market failures to increase network capacity for DG.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">7 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td 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>
</table>

Project NPV (Present Benefits x Probability of Success) – Present Costs	£-364,068 The figure is negative as this is a costly project starting from a low TRL
Project Progress **March 07**	• Most of the work in 06/07 has been taken up with academic research assistants understanding the problems of network operation, determining the existing communication limitations and considering what can be performed differently • Demonstration networks have been selected and information to describe the networks has been gathered. Information gaps are being identified. • The functional and specification requirements are being assessed
Potential for achieving expected benefits	Delays were encountered in the initiation of this project (contract signed Oct 06), however since that time, the project has run according to schedule.
Collaborative Partners	EDF-Energy, EPSRC Strategic Partnership
R&D Providers	ABB, Universities: Imperial College London (lead), Strathclyde, Durham, Edinburgh, Loughborough, Bath, Manchester

Table D31: IFI 0535: Radiometric Arc Fault Location

<table>
<tr><td>Project Title</td><td colspan="3">Radiometric Arc Fault Location</td></tr>
<tr><td>Description of project</td><td colspan="3">Applied research, and follow up installation of a system to triangulate fault locations on overhead lines from the high frequency radio wave signatures produced from an arcing fault.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1,634
External £1,144
Total £2,778</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £1,043
External £0
Total £1,043</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£292,000</td><td>Projected 07/08 costs for SP-EN</td><td>Internal £3,000
External £50,000
Total £53,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The principle of the technology is:
There is a correlation between RF discharges and network faults on overhead lines
The RF signal can be picked up by a radio antenna up to around 70km away
If antennae are spread across the network, a mesh is formed – in a similar manner to the GSM network
If a fault can be accurately clocked, triangulation can be used from a number of base stations to give an approximate geographic location (accuracy ~300m)
If this information is linked to GIS / SCADA data a more accurate fault location can be obtained</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="3"><table><tr><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr><tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr></table></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">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>3 Years</td><td>Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</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 colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">£45,787</td></tr>
<tr><td>Project Progress March 07</td><td colspan="3">Project tabled with ENA R&D working group
Full Approval from all DNOs
Collaboration Agreement in development
Project expected to commence September 07</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">Delays in negotiating the commercial terms and conditions have resulted in significant deadline slippage for the commencement of this project. At time of writing it is planned to start September 07.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="3">All UK DNOs</td></tr>
<tr><td>R&D Providers</td><td colspan="3">University of Strathclyde</td></tr>
</table>

Table D32: IFI 0538: Overhead Line Uprating Project – Compact Transmission Lines

<table>
<tr><td>Project Title</td><td colspan="11">Overhead Line Uprating Project – Compact Transmission Lines</td></tr>
<tr><td>Description of project</td><td colspan="11">An EPSRC funded project to investigate options for increasing the capacity of overhead lines through using the same tower / wood pole infrastructure, but modified insulator / cross-arm arrangement to increase the voltage at which a circuit operates.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £1,566
External £1,144
Total **£2,710**</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2">c.£500,000</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £1,500
External £2,000 (TBC)
Total **£3,500**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">The project intends to work through several key stages in order to move the development from applied research to development:
• Control of electrical stress
• Control of electrical strength
• Tests and full scale trials
• Environmental consequence impact assessment
• Development of design
• Pilot studies (industrially funded)</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="2">Significant</td><td colspan="4">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">Yes</td><td colspan="4">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">By working with industrial partners they aim to feed into tower designs that will allow either:
• Tower height to be reduced for a given voltage, thereby reducing the visual impact, or
• Uprating of existing towers, thereby increasing the power density for a given power corridor to maximise the use of existing circuit infrastructure.
This development is relevant to a range of network uprating projects including 33kV to 132kV; 132kV to 275kV and potentially 400kV to 500kV.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">6 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">30 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>✦✦</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">TBC</td></tr>
<tr><td>Project Progress **March 06**</td><td colspan="11">The project has achieved EPSRC funding and is planned to commence 07/08.</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="10">The project is on target.</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="10">National Grid, Central Networks, EDF Energy, Balfour Beatty, AMEC, Babcock Networks</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="10">Cardiff University</td></tr>
</table>

Table D33: 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 DTI (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 £1,770
External £1,144
Total £2,914</td><td colspan="5">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td>£2,453,030</td><td colspan="5">Projected 07/08 costs for SP-EN</td><td colspan="4">Internal £12,000
External £0
Total £12,000</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="2">Significant</td><td colspan="5">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>Yes</td><td colspan="2">Yes</td><td colspan="5">No</td><td colspan="2">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
• Provision of fault ride-through capabilities by control of fault current limiting devices.
• Availability of proven enabling technologies should anticipated levels of DG be realised.
• The ability to accommodate greater penetration of DG without the need for costly network reinforcement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="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)
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 colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">TBC
To be determined once a suitable enabling technology has been aligned to a specific network application.</td></tr>
<tr><td>Project Progress March 07</td><td colspan="10">• Project successfully accepted at outline and full application stages on DTI technology program
• Work packages, delivery timescales plus associated rolls and responsibilities defined for project.</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="9">The project is on target.</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="9">Rolls-Royce, Manchester and Strathclyde University, DTI (via Technology Programme)</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="9">Rolls-Royce, Manchester and Strathclyde University</td></tr>
</table>

Table D34: IFI 0606 Substation Acoustic Monitoring

<table>
<tr><td>Project Title</td><td colspan="11">Substation Acoustic Monitoring</td></tr>
<tr><td>Description of project</td><td colspan="11">An optical fibre acoustic monitoring technique has been used with some success on monitoring electrical switchgear at transmission voltages. When coupled to a unique processing method known as chromaticity, a number of features are emergent from the complex signal which are indicative of equipment condition.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £1,566
External £1,144
Total **£2,710**</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="6">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2">£TBC</td><td colspan="3">Projected 07/08 costs for SP-EN</td><td colspan="6">Internal £TBC
External £TBC
Total **£TBC**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">The acoustic sensor has also been used to detect partial discharges on gas-insulated system. The processing method for the extraction of information has also been extended and refined through a non-power application on acoustic data gathered by a test train running at 100mph. Defects in the track of the order of 1 cm could be detected. This project sims:
• To establish a cost effective prototype systems for monitoring acoustic emissions from equipment in substations using readily available components
• To use hardware and chromatic software algorithms to provide a means of detecting and classifying emergent signals from the detected complex acoustic signals detected at substations
• To assess the performance of such optical fibre based systems with conventional acoustic detectors in an EMI hostile environment
• To establish guidelines for the use of optical fibre based acoustic detection systems directly on HV equipment</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="4">Radical</td></tr>
<tr><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="3">No</td><td colspan="4">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">Development of a cost-effective in-situ monitoring and alarm system for the detection of substation changes, e.g. Partial Discharge, substation security, etc.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">5 Years</td><td colspan="3">Duration of benefit once achieved</td><td colspan="6">20 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>✧</td><td>—</td><td>—</td><td>✧</td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">TBC</td></tr>
<tr><td colspan="3">Project Progress **March 07**</td><td colspan="9">Outline proposal stage only.</td></tr>
<tr><td colspan="3">Potential for achieving expected benefits</td><td colspan="9">An initial feasibility study is planned to be taken forward under the Supergen 5 programme in 07/08.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="11">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="11">Liverpool University</td></tr>
</table>

Table D35: IFI 0607: LV Network Automation

<table>
<tr><td>Project Title</td><td colspan="9">LV Network Automation</td></tr>
<tr><td>Description of project</td><td colspan="9">This project focuses on the adaptation of the “SignalSure” technology, recently implemented by Network Rail for their 660V signalling systems, for use on LV networks as a method of automation to reduce both CI and CML.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £2,631
External £18,698
Total **£21,329**</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="3">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="3">£32,550</td><td colspan="3">Projected 07/08 costs for SP-EN</td><td colspan="3">Internal £5,000
External £15,000
Total **£20,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">The project aims to assess the technical and commercial opportunities presented by the SignalSure product. To ascertain the technical feasibility with a network trial, to define applications / deployment and to reassess the financial costs-benefit analysis for potential roll-out.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="2">Incremental</td><td colspan="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td colspan="2">No</td><td colspan="2">Yes</td><td colspan="2">No</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">Application of the technology should provide the following benefits:
• Reduction of CMLs on the LV network,
• Increased asset life of circuit elements by the reduction of both fault currents and stresses during fault location,
• Reduced cost and time of fault location through rapid identification of faults location
• Elimination of repeated intermittent faults</td></tr>
<tr><td>Expected Timescale to adoption</td><td 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>
<tr><td>Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">-£31,000
Only the initial stage costs have been presented above (with zero benefit) as Phase 1 of the project is detailing the costs-benefits.</td></tr>
<tr><td>Project Progress **March 07**</td><td colspan="9">• Benefits of system deployment report underway.
• Cost issues and constraints report underway.
• Preliminary safety / operation impact report completed.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="9">There are likely to be niche applications to highly populated circuits where this technology would assist. Network trials are being scheduled for 2007/08.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="9">Potential for Phase 2: EDF-Energy, Scottish & Southern Energy, United Utilities</td></tr>
<tr><td>R&D Providers</td><td colspan="9">EA Technology</td></tr>
</table>

Table D36: IFI 0613: 4Energy Battery Aircon Device

<table>
<tr><td>Project Title</td><td colspan="11">4Energy Battery Air-conditioning Device</td></tr>
<tr><td>Description of project</td><td colspan="11">Remote Terminal Units (RTU's) are required for secondary substation automation and telecontrol, powered by two integral valve regulated lead acid batteries. The batteries have been subjected to high ambient temperature due to the heat emitted from electronic components within the RTU and radiated heat from the secondary power transformer, when located within the substation building. Such temperature excursions can have a detrimental effect on battery life. This project seeks to address this issue to ensure that battery longevity is realised.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £6,446
External £40,555
Total £47,001</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="6">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2">£57,855</td><td colspan="3">Projected 07/08 costs for SP-EN</td><td colspan="6">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">The project aims to develop a battery air conditioning solution to smooth out the temperature variation and keep the battery ambient temperature within 20°C.</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="5">Radical</td></tr>
<tr><td>No</td><td colspan="2">Yes</td><td colspan="3">No</td><td colspan="5">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">• Integrity of network automation is realised through battery availability
• Battery life will be extended and consequent replacement costs reduced
• Reduced disposal of lead acid batteries and consequent reduction in environmental impact</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Adopted</td><td colspan="3">Duration of benefit once achieved</td><td colspan="6">5 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>✧</td><td>─</td><td>─</td><td>─</td><td>─</td><td>─</td><td>✧</td><td></td></tr>
<tr><td colspan="5">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="7">£42.304</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="11">• Battery air condition unit developed, and proved to meet the functional design specification.
• Contract negotiated/purchase of 500units
• Due diligence of their new manufacturing facility undertaken, and safety and quality culture discussed
• Further applications of this technology discussed to investigate additional benefits of applying the developed product principle</td></tr>
<tr><td colspan="3">Potential for achieving expected benefits</td><td colspan="9">The project was successfully completed in February 2006.</td></tr>
<tr><td colspan="3">Collaborative Partners</td><td colspan="9">N/A</td></tr>
<tr><td colspan="3">R&D Providers</td><td colspan="9">4Energy</td></tr>
</table>

Table D37: IFI 0615: ScottishPower Advanced Research Centre (SPARC)

<table>
<tr><td>Project Title</td><td colspan="11">ScottishPower Advanced Research Centre (SPARC) – University of Strathclyde</td></tr>
<tr><td>Description of project</td><td colspan="11">Three workstreams have been proposed:
• <i>Asset Engineering</i>: Field based activities, concentrating on the technologies used to gather and interpret data then control and manage individual assets.
• <i>Asset Strategy</i>: Office, desktop, PC based analytical activities including the analysis of data, concentrating on underlying trends of asset populations (from asset ageing to network performance).
• <i>System Development</i>: Forward looking network design activities considering the connectivity between the assets. It should consider both the medium term (5 years) and longer-term trends (>10 years), which will affect the design of the network (e.g. load, generation, standards, regulations, Ofgem incentives/penalties).
A number of related projects will be developed within each workstream.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £2,409
External £76,161
Total £78,570</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="5">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2">£460,083</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="5">Internal £15,000
External £103,000
Total £118,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">• Asset Engineering research stream focuses on methods and technologies that enable better use of individual assets.
• Asset Strategy research stream focuses on methods and tools that enable better management of populations of assets.
• System Development research stream focuses on analytical techniques that provide SP with better capability to plan and design the power system.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td colspan="4">Technological substitution</td><td colspan="5">Radical</td></tr>
<tr><td>Yes</td><td>Yes</td><td colspan="4">Yes</td><td colspan="5">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">Research activities will seek to realise business benefits across a range of areas including system performance, opex and capex. Key areas have been identified in the SPARC proposal, which are being used to form the basis of a more comprehensive programme of deliverable projects.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="5">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">Varies per project</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td>✦✦</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">TBC</td></tr>
<tr><td>Project Progress March 07</td><td colspan="11">• Roles and responsibilities for SP and SU defined
• Work streams defined and associated outline projects developed
• Collaboration Agreement produced and Terms and Conditions agreed</td></tr>
<tr><td colspan="3">Potential for achieving expected benefits</td><td colspan="9">Given the potential number of projects within each research stream in order maximise benefits the number of projects will require to limited and prioritised.</td></tr>
<tr><td colspan="3">Collaborative Partners</td><td colspan="9">N/A</td></tr>
<tr><td colspan="3">R&D Providers</td><td colspan="9">University of Strathclyde</td></tr>
</table>

Table D38: IFI 0618: Supergen 1 - FlexNet

<table>
<tr><td>Project Title</td><td colspan="11">Supergen 1 - FlexNet</td></tr>
<tr><td>Description of project</td><td colspan="11">FlexNet is a four-year EPSRC funded programme that takes forward the process of preparing electricity networks for a low carbon future and builds on an initial programme of works, **FutureNet** that is nearing completion.

The programme recognises the interdependance of many factors in achieving change through its integration of the work of internationally recognised researchers from disciplines such as social pyschology, economics, power systems analysis, power systems technology and public policy and the long-term, radical nature of the changes needed and is not dependant on any particular form of generation</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="4">Internal £1,566
External £1,144
Total **£2,710**</td><td colspan="3">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="4">£6,974,970</td><td colspan="3">Projected 07/08 costs for SP-EN</td><td colspan="4">Internal £5,000
External £20,000
Total **£25,000**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="11">**FlexNet's** intention is to put in place a substantial body of work that will build on the achievements of **FutureNet** and lay out the major steps, technical, economic, market design, public acceptance and others, that will lead to flexible networks, including starting to showcase these so that they can be taken up by the commercial sector, Government and Regulators for practical implementation.

Some of the key issues to be addressed by the programme include:
• How can we judge the degree of flexibility needed?
• How can flexibility be achieved?
• How much flexibility should come from primary plant giving margin and how much from secondary plant giving enhanced controllability?
• What constrains or encourages flexibility, what technologies are acceptable and what economic frameworks and public policies provide flexibility at the least overall long-term cost?</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td colspan="3">Incremental</td><td colspan="3">Significant</td><td colspan="3">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td colspan="3">No</td><td colspan="3">No</td><td colspan="3">No</td><td colspan="2">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="11">• Understanding of flexible network requirements able to cost-effectively deal with a wide range of possible futures
• Develop networks that can 'think' for themselves
• Engagement with stakeholders in progressing the research ideas toward deployment
• Research that forms the basis of policy advice
• Inputs to the UK government's Energy Review, the UKERC assessment of Intermittency, evidence to select committees of parliament and submissions to OFGEM consultations.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">5 Years</td><td colspan="5">Duration of benefit once achieved</td><td colspan="4">15 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td 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 colspan="8">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">TBC</td></tr>
</table>

Project Progress **March 07**	• Overview of work streams developed • Funding proposal accepted by EPSRC
Potential for achieving expected benefits	Project due to commence October 07
Collaborative Partners	Those involved in **FutureNet** where **Academic:** 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. **Industrial**: 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 Partership, The National Grid Company plc, New and Renewable Energy Centre, Regenesys Rolls-Royce plc, Scottish Power - Power Systems, Scottish Renewables Forum, Scottish and Southern Energy plc, Toshiba International (Europe) Ltd and United Utilities plc
R&D Providers	As academic institutions above

Table D39: IFI 0619: Advanced Cable Technologies

<table>
<tr><td>Project Title</td><td colspan="10">Advanced Cable Technologies</td></tr>
<tr><td>Description of project</td><td colspan="10">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="2">Internal £1,566
External £1,144
Total **£2,710**</td><td colspan="4">Expenditure in previous (IFI) financial years</td><td colspan="4">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Cost (Collaborative + external + SP-EN)</td><td colspan="2">c£30,000</td><td colspan="4">Projected 07/08 costs for SP-EN</td><td colspan="4">Internal £2,000
External £1,200
Total **£3,200**</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="10">The programme addresses cabling technologies and associated issues. The example project considers the following.
• Given the extensive annual cable jointing activity this project seeks to realise savings on ever-increasing excavation and reinstatement costs as well as improving the reliability of cable joints.
• 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>Incremental</td><td colspan="2">Significant</td><td colspan="4">Technological substitution</td><td colspan="3">Radical</td></tr>
<tr><td>No</td><td colspan="2">No</td><td colspan="4">Yes</td><td colspan="3">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="10">A range of project benefits are expected under this programme. For the example project benefits expected would include the following.
• Enhanced reliability of cable joints
• Reduced likelihood of jointing installation error
• Smaller cable joints
• Reduced excavation and reinstatement costs
• Quicker jointing times
• Joint holes being left open for less time and therefore reduced likelihood of 3rd party incidents.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 Years</td><td colspan="4">Duration of benefit once achieved</td><td colspan="4">3 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" 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 colspan="7">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£90,726</td></tr>
<tr><td>Project Progress **March 06**</td><td colspan="10">Further possible projects are under consideration for inclusion within the Advanced Cabling Technologies programme.</td></tr>
<tr><td colspan="2">Potential for achieving expected benefits</td><td colspan="9">The example project discussed is on target. Other related projects will be developed under this programme.</td></tr>
<tr><td colspan="2">Collaborative Partners</td><td colspan="9">N/A</td></tr>
<tr><td colspan="2">R&D Providers</td><td colspan="9">Bound under confidentiality</td></tr>
</table>

Table D40: IFI 0620: Tower Foundation Radar

Project Title	Tower Foundation Radar
Description of project	When tower line circuits have been identified for refurbishment or replacement it is necessary to make an assessment of the foundation condition. Traditional methods involve invasive excavation to expose the foundation blocks for visual inspection. This project will trial underground structure survey technologies already utilised in the civil and geotechnical engineering industries to assess the condition of tower foundations and compare with the findings of traditional techniques.

Expenditure for financial year	Internal £2,000 External £1,144 Total **£3,144**	Expenditure in previous (IFI) financial years	Internal N/A External N/A Total N/A
Project Cost (Collaborative + external + SP-EN)	£51,400	Projected 07/08 costs for SP-EN	Internal £2,500 External £48,900 Total **£51,400**

Technological area and / or issue addressed by project	Due to the intensive labour and time effort involved it is normal practice when excavating foundations to perform an assessment on a 10% sample of towers. The objective with this non - invasive technology is to enable all tower foundations to be examined.

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

Expected Benefits of Project	• Ability to survey all tower foundations along a route • Survey times are dramatically reduced and cheaper • Proven portable equipment, allowing easier access to sites with reduced environmental damage. • Ability to make a comparison between techniques.

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

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

Project NPV (Present Benefits x Probability of Success) – Present Costs	£14,220
Project Progress **March 07**	Proposal received. Tower circuits identified
Potential for achieving expected benefits	The project is on target.
Collaborative Partners	None
R&D Providers	Sterling Geophysical Surveys Ltd

Table D41: IFI 0701: ENA IFI Projects

Project Title	ENA IFI Projects			
Description of project	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 05/06 IFI Annual Report: 1. IFI 0527: Testing Procedure for ROCOF relays 2. IFI 0536: ENA Earthing Project 3. IFI 0537: ENA Lightning Protection			
Expenditure for financial year	Internal £1,702 External £1,233 Total **£2,935**	Expenditure in previous (IFI) financial years	Internal £4,249 External £2,688 Total **£6,937**	
Project Cost (Collaborative + external + SP-EN)	c£30,000	Projected 07/08 costs for SP-EN	Internal £1,500 External £5,000 Total **£6,500**	
Technological area and / or issue addressed by project	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. • **ROCOF Relay functional specification** – Produce an Engineering Report into the sensitivity of loss of mains relays to genuine loss of mains by determining the number of sample cycles required and the percentage change of load compared to generator ratings (of different construction and size).The test information will be used to develop a matrix of optimum settings and test procedures for relay specification. • **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. • **SG17 Lightning Protection** – Produce a new Engineering Technical Report on lightning protection to include: o Background information on lightning density across the UK, annual variations and effect of topography. o Catalogue and provide a view on current practices and procedures. o Determine and advise on equipment protection levels and arrangements.			
Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	Yes	No	No
Expected Benefits of Project	• **ROCOF Relay functional specification** – Improved understanding will allow more effective settings to be applied to these relays, which will reduce the number of spurious trips. This will improve power quality to other connected customers and the specification should reduce the cost associated with generation scheme quotes. • **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. • **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.			
Expected Timescale to adoption	1 - 10 Years	Duration of benefit once achieved	10 – 40 Years	

<table>
<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>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£255,876
Note – Project costs include implementation and have been calculated by the ENA assuming a typical distribution license area.</td></tr>
<tr><td>Project Progress
March 07</td><td colspan="10">**ROCOF Relay functional specification –** Final report published
SG14 Earthing Project – Part 1 (Investigation at Test Facility):
• Report and CIRED paper completed.
• Measurements are carried out at the S&S Ltd test facility to enable better understanding of transfer potential.
• The measurement results were compared to predictions using the CDEGS software. The initial results are encouraging and suggest that there would be benefit in proceeding with more detailed investigations at 11kV distribution substations where the HV and LV earths are known to be separate.
Part 2 (Investigation at 11kV substations - site tests):
• Identification of suitable sites has been underway.
• Two sites were identified in WPD area and the site work has commenced.
• Additional test sites in CN and CEE areas still to be proven and confirmed as suitable.
SG17 Lightning Protection – Draft document completed and sent to DNOs for comment.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">**ROCOF Relay functional specification** – The final report provides the basis for new settings guidelines which should enable the majority of perceived benefits to be achieved.
SG14 Earthing Project – Initial research and simulation work produced encouraging results and provided justification for further work – testing. It is not yet known whether savings will be achieved until the outcome of the testing work is known.
SG17 Lightning Protection – High</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">UK Distribution Network Operators (DNOs)</td></tr>
<tr><td>R&D Providers</td><td colspan="10">**ROCOF Relay functional specification** – University of Strathclyde
SG17 Lightning Protection – External Consultant (Brian Wareing)
SG14 Earthing Project – Strategy & Solutions</td></tr>
</table>