Innovation Funding Incentive and Registered Power Zone Report

for period 1 April 2008 to 31 March 2009

Scottish Hydro Electric Power Distribution

Southern Electric Power Distribution

Scottish Hydro Electric Transmission

Contents

1. Executive Summary

Over the last year, SSE Power Distribution (SSEPD) has continued our commitment to research and development (R&D) activities using the Innovation Funding Incentive (IFI).

During the year ended 31 March 2009, our distribution and transmission licence assets under three wholly owned subsidiaries, Scottish Hydro Electric Power Distribution plc (SHEPD), Southern Electric Power Distribution plc (SEPD) and Scottish Hydro Electric Transmission Limited (SHETL), have initiated new projects and continued IFI projects started in previous years.

As in previous years there are a wide range of activities ranging from national collaborations with multiple work packages to specific projects to address identified problem areas. In particular, we have projects aiming to improve the capability of the transmission network and facilitate the connection of renewable generation. Wherever possible we have sought to minimise the cost of R&D activities by seeking complementary funding and forming collaborations.

The total qualifying expenditure for the reporting period of 1st April 2008 to 31st March 2009 for SSEPD was £1,382,000. This total comprises expenditure of; £660,000 for our SEPD distribution business, £283,000 for our SHEPD business and £439,000 for our transmission business, SHETL.

In aggregate, this is a slight reduction across all three networks in the total qualifying expenditure from the previous year (which was £1,915,000) reflecting the difficult financial conditions experienced during 2008.

One RPZ scheme was registered in the Scottish Hydro Electric Power Distribution (SHEPD) area in 2005/06. Progress has been hampered by the slow uptake from generation developers and it is expected that the first generators will actually connect during 2009. Additional potential schemes have been considered and further work is continuing on developing these opportunities.

2. Introduction

As part of the recent Distribution Price Control Review (DPCR) effective from 1 April 2005, Ofgem (the regulatory body for the energy industry) introduced two new incentives: the Innovation Funding Incentive (IFI) and Registered Power Zones (RPZ). The primary aim of these two incentives is to encourage the distribution network operators to apply innovation in the way they pursue the technical development of their networks. A Good Practice Guide (Engineering Recommendation G85) has been produced by the DNOs that is available free of charge via the Energy Networks Association's website: www.energynetworks.org.

The IFI mechanism is intended to provide funding for projects primarily focused on the technical development of the networks to deliver value (i.e. financial, quality of supply, environmental, safety) to end consumers. IFI projects can embrace aspects of transmission and distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning. A network operator is allowed to spend up to 0.5% of its Combined Distribution Network Revenue or up to 0.5% of its Base Transmission Revenue (subject to a minimum of £500,000) on eligible IFI projects.

RPZs are focused specifically on the connection of generation to distribution systems. The estimates made by distribution network operators 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 all distribution voltage levels bringing new system design and operating challenges.

RPZs are therefore intended to encourage distribution network operators 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 RPZ incentive applies from April 2005 and, at present, this excludes DG applications processed prior to this date.

Open reporting (i.e. available in the public domain) of IFI & RPZ projects is required by Ofgem; this is intended to stimulate good management and promote sharing of innovation good practice.

In line with this, we will publish our IFI & RPZ report on the SSEPD website: www.ssepd.co.uk. To enhance accessibility, they will also be available on Ofgem's website: www.ofgem.gov.uk

3. Scope

This document contains the reports for SSEPD for our distribution and transmission licence assets under three wholly owned subsidiaries:

- Scottish Hydro Electric Power Distribution plc (SHEPD)
- Southern Electric Power Distribution plc (SEPD)
- Scottish Hydro Electric Transmission Limited (SHETL)

It details activities in the period from 1st April 2008 to 31st March 2009.

Separate IFI summary reports have been provided for each licence area with one set of detailed individual project reports. For the distribution businesses, projects are generally developed for the benefit of both licence areas, reflecting our strategy of running both companies using one common best practice. All reports have been produced in accordance with the Regulatory Instructions and Guidance (RIGs) issued by Ofgem and ENA Engineering Recommendation G85 and G85 Issue 2. SHETL's IFI reports have been produced in accordance with Special Licence Condition J5.

With regards to the RPZ incentive, the SHEPD area is seeing a higher level of distributed generation activity than SEPD, and it is consequently more active in developing innovative solutions in this field. As there is no completed or current RPZ development activity in the SEPD licence area, there is no report for the SEPD area in this reporting period.

In addition to reporting on activities in 2008/09 we have included information on current projects and intended developments.

4. IFI Report

Our programme of IFI projects in 2008/09 consists of a number of projects which have originated as a result of collaborative work with external organisations in academia, such as the University of Strathclyde, and service providers, such as EA Technology Ltd (EATL), and others which have originated internally. The latter have emerged from our own analysis of areas of work which could benefit from an innovative approach.

We continue to see considerable amounts of renewable generation development and connection to our network in the SHEPD and SHETL area, consisting mainly of wind farms. Given the international and national targets to increase the quantity of our electricity generated from renewable resources it is clear that the pressure on networks to facilitate this growth will increase. However, network issues and constraints have become apparent at both a distribution and transmission level, which, as a result, has provided one of the key themes for our R&D strategy.

At distribution voltages, we believe active network management systems, and other methodologies becoming accepted as elements in the vision of a Smart Grid, can be developed to allow more generation to be connected to the existing infrastructure. SSEPD are progressing research to reduce the impact of network constraints and maximise the value of Distributed Energy Resources. Earlier work has been developed as an ongoing IFI project to deliver an active network management system on Orkney and this work lead to the Orkney network becoming our first Registered Power Zone in 2006. This project continues to involve the University of Strathclyde, who are an acknowledged UK leader in the field of electrical and electronic engineering with particular involvement in active networks, and has lead to the creation of a spin out company to commercialise the results of this collaboration, Smarter Grid Solutions Ltd.

At transmission voltages, we believe innovative methodologies can be developed to allow more generation to be connected to the existing infrastructure. SHETL have been progressing research to reduce the effect of network constraints, including the evaluation of two dynamic line rating systems in order to develop our understanding of these techniques which could lead to determining the extent to which the capacity of the existing infrastructure can best be utilised.

4.1 IFI Highlights

The Evolution of Distribution Networks towards the Smart Grid Vision

SSE Power Distribution (SSEPD) is engaged in a number of projects and activities which we consider are relevant to the evolution of our Distribution and Transmission networks towards the Smart Grid vision.

This brief report summarises our current projects and activities.

Active Network Management

A substantial increase in renewable energy generation is an important part of the plan for the UK to meet national and international targets for reductions in emissions. Renewable resources are often located in remote areas where the connection to the national grid will be via relatively weak distribution networks. This can constrain the exploitation of the renewable resources in outlying areas.

An excellent example of this situation on the Scottish Hydro Electric Power Distribution (SHEPD) network is the Orkney Isles. The amount of Distribution Generation (DG) allowed to connect to the Orkney distribution network is currently limited by network constraints, however the Orkney Isles are an area of abundant renewable resource with several wind farms and the European Marine Energy Centre.

Our Orkney Active Network Management (ANM) project has developed an ANM scheme to realise additional generator connection capacity onto the Orkney network.

We believe that the principles of operation for the ANM scheme hold for other situations where the thermal capacity of radial distribution networks is under utilised or acts as a barrier to the connection of new DG units. The scheme is therefore expected to be applied to other parts of the UK network following corroboration of the operation of this first scheme on Orkney, establishing this project as an important step in developing intelligent networks.

No Interruptions

Electrical energy storage is a potential solution to the challenge of meeting a variable load from renewable generation sources which are variable in nature. For rural customers, brief power interruptions due to network re-closures are an accepted norm. This project aims to reduce the customer impact on the elderly and disabled by deploying small scale electrical energy storage units.

Stage 1 of the No Interruptions project was the Lights On trial. Initial customer surveys were conducted and combined with our research into available technologies to determine the best approach. This resulted in the Lights On trial which keeps customers' lights on using an Uninterruptible Power Supply.

The Lights On trial, involving 21 domestic customers, has been highly successful and well received. However, a low fault rate on the trial networks has resulted in the trial being extended for another year to permit a more thorough assessment of the devices used.

Preliminary work for Stage 2 of the No Interruptions project, "Power On" is now underway, which will aim to provide a solution to keep on several essential services during power outages.

Flow Battery Trial

Large scale electrical energy storage has been proven to operate effectively overseas but to date there has been no operational experience within the UK.

A review of the available options was completed by SSEPD during 2006 and modular flow battery technology was identified as one of the options sufficiently advanced to be considered for a trial installation. Our evaluation of flow battery technologies and manufacturers resulted in the installation of a 150kWhr Zinc Bromide flow battery at one of our transmission substation sites to determine key performance parameters.

At our transmission substation sites, the provision of standby power supplies has historically been provided by a combination of generators and lead acid batteries. This project will provide an insight into a new technology which may offer superior performance with reduced maintenance and installation costs.

Our experience during this project will also inform the project scope for a larger scale energy storage system trial on our distribution network

Distribution Automation

Improvements in quality of supply through reductions in customer interruptions and customer minutes lost can be achieved by using automatic network reconfiguration in the event of a fault on the network. This can be carried out using a number of methodologies and SSEPD is trialling the next generation of Distribution Automation (DA) technology using IntelliRupter devices embedded in the network with the IntelliTeam distributed artificial intelligence running software to undertake autonomous actions.

High specification peer to peer communications are necessary for the scheme to operate effectively and our pilot scheme is being run on the Isle of Wight to evaluate the performance of these devices to automatically reconfigure the network into isolatable sections in our IntelliTeam DA project.

The pilot scheme will evaluate both overhead and underground plant functionality and the interaction on mixed overhead and underground networks.

LV Network Automation

It is recognised that a cost effective means to better isolate faults on the low voltage electricity distribution network is likely to yield significant performance benefits. Current practice is reliant upon fuses, typically located at substation sites and arranged so as to protect individual phases of a low voltage feeder.

The LV Sure project aims to develop an automatic LV network reconfiguration system based upon the "SignalSure" system currently installed on the rail network. By embedding a number of autonomous points of isolation at strategic locations, which are co-coordinated by an intelligent device, the faulty section will be isolated and supply restored to healthy sections.

Partial Discharge Alarm

Networks of the future are anticipated to be self healing, with advanced monitoring systems for fault detection and condition assessment.

We are currently running several projects along this theme to improve the way we operate and manage our network assetts by providing trials and supporting development of monitoring technologies.

One these projects is the Ultra TEV Alarm system which aims to provide a cost effective way to provide an indication of the condition of medium and high voltage switchgear by monitoring partial discharge activity.

Partial discharge is an electrical discharge which occurs across a section of insulation without a complete breakdown in the insulation. This diagnostic technique can provide advance warning of pending insulation failure.

We are running trials to assess the effectiveness of this technology and initial results have shown the system to be working as expected in terms of providing visibility of partial discharge activity to staff entering the substation along with evidence of historic activity on site to help determine switchgear condition and reliability.

Partial Discharge Mini Monitor

Another device using partial discharge detection is the SSM Mini 4-Channel, On-line Partial Discharge Portable Monitor which is being trialled in our PD Mini Monitor project. In this project, the aim is to detect the partial discharge activity in medium voltage switchgear and associated 11kV cables.

The monitors will record the PD level in internal memory storage facilities, which can be accessed both locally and remotely to enhance condition assessment monitoring for improved asset management.

Dynamic Circuit Rating

There has been growing interest in the use of dynamic ratings for transmission and distribution circuits. This is the concept of varying the thermal rating of part or all of a circuit according to the ambient conditions. A number of systems have now been developed varying in complexity from using macro weather data to online dynamic measurements of circuit parameters.

The work under this project includes the assessment of currently available technologies and how these can be integrated within the network operator's display and functional tools. The implications of deploying these systems are being investigated with regards to load management and system planning.

To date, we have data from a trial installation which indicates that the system has performed within expected parameters. The system will be developed further to enhance the application of the devices on the network which should lead to the project delivering the expected benefits

SUPERGEN 1 - FLEXNET

With the publication of the LENS report in 2008 laying out future electricity network scenarios for the industry, the electricity industry now needs to decide the major steps in moving forward.

Through the Supergen 1 – Flexnet project, SSEPD, as a member of a large EPSRC supported consortium, involving seven universities, aims to contribute to the substantial body of work the project will put in place, building on the achievements of the FutureNet project, to 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.

The project aims to address some of the key questions in developing and managing flexible networks;

- 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?

5. RPZ Report

5.1 Current Activities

Earlier work with the University of Strathclyde resulted in Ofgem registering our application for the Orkney network in 2005/2006 as SHEPD's first Registered Power Zone.

The considerable renewable energy resource on the Orkney Isles has attracted significant levels of wind farm and marine development such that the connection of further renewable energy generation output is constrained by the capacity of the distribution network. The active network management scheme, developed in collaboration with the University of Strathclyde, will make better use of the existing infrastructure thereby providing a quicker and lower cost alternative to network upgrading and reinforcement works. The active management scheme is expected to realise a total of 72MW or more of generator connected capacity onto the Orkney network. Currently 47MW is already contracted on a firm or non-firm basis and a further 25MW of new non-firm generation output could be allowed onto the network by the active management scheme. Of this 25MW, it is estimated that at least 15MW will be economically viable.

This concept is being developed as an IFI project and closed loop trials were run on the Orkney distribution network during 2006. Significant information was gained from the trials and the results analysed. The key outcomes from this analysis were the verification of the control logic and an understanding of the response of the participating distributed generation. Additional analysis of wind farm behaviour on Orkney has been carried out by the University of Strathclyde to further develop the design of the scheme. Other key outcomes during 2006/07 were the development of logic design rules for the full active network management scheme and creation of a generator constraint analysis tool - Gen CAT – to calculate the expected curtailment of new non-firm generation connecting to the scheme. This tool has been used to analyse each potential new non-firm generation connection to provide an indication of the level of curtailment the applicant would experience if they were the first new non-firm generation to be connected under the scheme. Further studies will be carried out as willing generators commit to connect to the active network management system.

During 2007/08, contracts were placed for the development of the necessary software and hardware systems. These systems were developed and factory acceptance testing carried out.

In this reporting year we made further progress leading to the installation of the scheme in 2009/10 to match to the generation developers' construction programmes. The installation works have been completed of the core ANM system and the first two monitoring points on the 33kV network.

The communications links necessary to connect the next two monitoring points have been progressed as these are located at outlying points on the network.
Commercial arrangements have been developed to support the ongoing operation and optimisation of the ANM system with Smarter Grid Solutions Ltd.

Delays by generation developers in gaining planning consent and finance have delayed the progress of this project and are outwith our control.

The key outcomes of the work to date represent significant progress in this field. It is planned to apply active network management in other network locations where it can provide a cost effective alternative to conventional reinforcement.

5.2 Future RPZ

The current RPZ framework is only valid until the end of March 2010, and it is not clear if this will continue into the period of Distribution Price Control Review 5 (2010 -2015) or be substantially modified. SHEPD is keen to establish Ofgem's position on this as the uncertainty casts doubt on developing further schemes.

We remain optimistic about the development of an active network management system for Skye and the Western Isles and have been carrying out extensive network studies to determine its viability and potential. We would hope to develop proposals under RPZ or a similar incentive mechanism during the early part of DPCR5.

The recent "Interim Connect and Manage Proposals" from Ofgem proposes the introduction of ANM systems on some parts of our transmission network, allowing the earlier connection of DG by constraining existing or new generators, either as an alternative to conventional reinforcements, or as an interim arrangement pending completion of the network upgrades. SHEPD welcomes these innovative proposals as it will allow the best use of the existing system, while helping to meet renewable targets.

6. Benefits achieved from IFI projects

Now that the IFI programme has become established we are able to identify further benefits from the development of innovative methodologies and equipment.

Trenchless Excavation

The replacement of underground cables is usually carried out by open excavation which creates significant disruption, incurs significant cost and has a significant impact on the environment. The general public and business community are increasingly less tolerant of road closures and delays due to infrastructure works.

Recognising these factors has lead SEPD to develop and trial a new system to allow the in situ replacement of existing underground cables with new cables.

Benefits of this system are:

- Reduction in material sent to landfill
- Reduction in costs
- Less disruption to the public

Experience to date with use of washover techniques has shown that by selecting schemes for cable replacement where the washover system can be used, there is a significant reduction in costs usually associated with conventional cable replacement.

So far we have installed just over 19km of underground cable using this technique.

A price comparison with conventional open cut practices for the projects which comprise the 19km, has estimated the total cost saving to be in excess of £900k.

In addition to the reduction in the cost of carrying out the works, the amount of spoil sent to landfill is significantly reduced and we have estimated that we have avoided over 3,000 lorry loads of spoil. Along with the saving in landfill tax, we have also saved the fuel costs and avoided the associated exhaust emissions.

We have avoided the conventional open trench works and as the washover system also installs the cable faster, we have significantly reduced the public inconvenience and disruption often associated with extensive cable works.

Assessment of Tree clearance from GIS

SSEPD has a requirement to remove trees as a requirement of ESQCR (2006) Resilience Requirements from locations that could impact upon our overhead lines. This innovative project uses Ordnance Survey digital information imagery data within existing GIS applications to assess the tree cutting requirement.

A comparative method of gathering sufficiently detailed information to be able to accurately carry out an office based assessment of the tree cutting requirement would require data to be gathered by LiDAR survey from a helicopter at an estimated cost of £250 per km.

For SSEPD this would mean a cost of over £10M to gather data from all of our overhead lines.
Experience within this project to date indicates that we are likely to be able to avoid this level of expenditure and identify the tree cutting requirements for under £500,000.

LV Power Electronics Regulator

We now have experience of installing 17 of the MicroPlanet devices at various locations on our network.

15 installations are working satisfactorily; including 4 sites where the regulator facilitated the connection of wind turbines rated 5kW to 15kW on rural networks. Operational experience to date indicates that the circuitry of the regulator and turbine invertor did not cause any interaction problem. One successful voltage complaint remedy involved 3 regulators, one on each phase, demonstrating that there is no problem of the regulators adversely affecting each other.

Only 2 problems have been reported to date. One faulty unit is likely to have been due to damage in transit and at one site it was found that the minimum input voltage was too low for the regulator to operate. The cause was identified as unauthorised additional load on a long LV feeder. The regulator worked correctly within its operational parameters.

7. Financial Summary

As the SSE Power Distribution research and development activities on distribution voltage level projects are operated from a common perspective across both distribution licence areas; the costs and benefits for these have been taken as applying across both licence areas in proportion to the size of each area as determined by Combined Distribution Network Revenue. In round terms, this leads to 33% being allocated to SHEPD and 67% to SEPD.

Qualifying expenditure for the reporting period of 1st April 2008 to 31st March 2009 was £283,000 for SHEPD and £660,000 for SEPD, of which £62,000 and £144,000 relates respectively to internal costs.

For SHETL, the qualifying expenditure for the same period was £439,000 of which £48,000 relates to internal costs. The overhead costs associated with the employment of full time R&D Manager and Project Manager have been apportioned across the portfolio of projects.

Financial information on the IFI projects relevant to the reporting year 1st April 2008 to 31st March 2009 are contained in the individual reports for SHEPD, SEPD and SHETL set out in the following sections and listed in Appendix 1.

Adoption costs have not been included at this stage but will be evaluated and taken into consideration as individual projects progress and application to the business can be more accurately assessed.

8. Conclusion

SSEPD recognises the key role that research and development can play in enabling our industry to meet the challenges of an ageing infrastructure, a need for continuous improvement in customer service and the challenges of a changing generation mix with the growing importance of distributed energy resources.

We are committed to the successful exploitation of our current programme of projects and will develop our portfolio to address areas that will deliver further benefits and add value.

9. Regulatory Reports of IFI & RPZ Activities for April 2008 to March 2009

Scottish Hydro Electric Power Distribution IFI Report	
Combined Distribution Network Revenue	£166.9m
IFI Allowance	£834,000
Unused IFI Carry Forward to 2009/2010	£417,000
Number of Active IFI Projects	27
Summary of benefits anticipated from IFI Projects.	Total NPV of projects is £982,320 Various customer, safety, and environmental benefits will accrue along with more effective utilisation of existing assets
External Expenditure 2008/2009 on IFI Projects	£221,000
Internal Expenditure 2008/2009 on IFI Projects	£62,000
Total expenditure 2008/2009 on IFI projects.	**£283,000**
Benefits actually achieved from IFI projects to date.	Reduction in capital cost of installing underground cable Improvement in quality of supply and reduction in fault location costs Reduction in cost of rectifying voltage complaints Improved customer service to vulnerable customers in rural area
Regulatory Report for DG incentive, RPZs and IFI Reporting year 2008/09 Scottish Hydro Electric Power Distribution plc	**£m**
IFI carry forward to 2009/10 (£m)	**0.417**
Eligible IFI Expenditure (£m)	**0.283**
Eligible IFI Internal Expenditure (£m)	**0.062**
Combined Distribution Network Revenue (£m)	**166.9**

Southern Electric Power Distribution IFI Report	
Combined Distribution Network Revenue	£405.6m
IFI Allowance	£2,028,000
Unused IFI Carry Forward to 2009/2010	£1,014,000
Number of Active IFI Projects	27
Summary of benefits anticipated from IFI Projects.	Total NPV of projects is £ 2,292,079 Various customer, safety, and environmental benefits will accrue along with more effective utilisation of existing assets
External Expenditure 2008/2009 on IFI Projects	£516,000
Internal Expenditure 2008/2009 on IFI Projects	£144,000
Total expenditure 2008/2009 on IFI projects.	**£660,000**
Benefits actually achieved from IFI projects to date.	Reduction in capital cost of installing underground cable Improvement in quality of supply and reduction in fault location costs Reduction in cost of rectifying voltage complaints Improved customer service to vulnerable customers in rural area
Regulatory Report for DG incentive, RPZs and IFI Reporting year 2008/09 Scottish Hydro Electric Power Distribution plc	**£m**
IFI carry forward to 2009/10 (£m)	**1.014**
Eligible IFI Expenditure (£m)	**0.660**
Eligible IFI Internal Expenditure (£m)	**0.144**
Combined Distribution Network Revenue (£m)	**405.6**

Scottish Hydro Electric Transmission Ltd IFI Report	
Combined Distribution Network Revenue	£59.3m
IFI Allowance	£500,000
Unused IFI Carry Forward to 2009/2010	£61,000
Number of Active IFI Projects	8
Summary of benefits anticipated from IFI Projects.	Total NPV of projects is £ 3,768,764 Various customer, safety, and environmental benefits will accrue along with more effective utilisation of existing assets
External Expenditure 2008/2009 on IFI Projects	£391,000
Internal Expenditure 2008/2009 on IFI Projects	£48,000
Total expenditure 2008/2009 on IFI projects.	**£439,000**
Benefits actually achieved from IFI projects to date.	Nil as projects are at an early stage
Regulatory Report for DG incentive, RPZs and IFI Reporting year 2008/09 Scottish Hydro Electric Power Distribution plc	**£m**
IFI carry forward to 2009/10 (£m)	**0.061**
Eligible IFI Expenditure (£m)	**0.391**
Eligible IFI Internal Expenditure (£m)	**0.048**
Combined Distribution Network Revenue (£m)	**59.3**

Scottish Hydro Electric Power Distribution RPZ Report	
Name of RPZ	Orkney Active Distribution Network Management
DG Capacity	15 MW expected 0 MW connected in 2008/09
Starting Year	2005/06
Description of project and technical details.	New generators accepted under the RPZ scheme will be instructed to limit their output to match the available export capacity to the mainland grid. Available capacity will be derived from real time network measurements and will depend upon the level of Orkney demand and output of existing generation
Expenditure for financial year	£85,000
Type(s) of innovation involved	Radical
Status (planned, under construction, operational) and operational starting year	Under construction – expected to be operational in 2009/10 to meet construction programme of participating renewable generation developers
Connection cost	Average of £135,000
Expected benefit to customers when project was registered	Ability to connect an additional 15 MW of new renewable generation to the Orkney Distribution network

10. Individual IFI Project Reports

2004_01: STP2 Overhead Network Module

Project Title	Strategic Technology Programme Overhead Network Module 2		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £6,000 External £43,500 Total **£49,500**	Expenditure in previous (IFI) financial years	Internal £15,753 External £131,897 Total **£147,650**
Project Cost	**£316,102**	Projected 09/10 costs	Internal £6,000 External £45,629 Total **£51,629**
Technological area and / or issue addressed by project	The Module 2 programme for budget year 2008/9 aimed to reduce costs and improve performance of overhead networks by increasing understanding of issues that have a negative impact on costs and performance. The programme is expected to also have a positive impact on safety and environmental performance. The projects all address real problems that have been identified by the module steering group members as significant and which require technical investigation and development. **Completed Projects (March 09):-** o S2126_4 Monitoring conductor temperature at fixed current – at Cashlie and Queensferry; o S2132_2 Validation of ice accretion models using Deadwater Fell; o S2136_3 Continued involvement with European Project COST 727; o S2138_2 Investigation of live-line jumper-cutting limitations; o S2143_2 Develop in-situ degradation monitor for aluminium OHL conductors – Stage 2: Feasibility study; o S2146_2 Torsion tests on composite insulators - Stage 2: Effect of torsion on tension insulators; o S2149_2 High durability OHL fittings - Stage 2: Costing for testing prototype high durability fitting; o S2150_1 Evaluation of TDR for assessment of tower foundations; o S2152_1 Evaluate performance of Czech Icemeter at Deadwater Fell; o S2153_1 Suitability of hand-held PD detector for condition assessment of pole-top equipment; o S2154_1 Experimental investigation of novel conductors – Stage 1: Icing; o S2156_1 Build Three Prototype Field Pole Leakage Current Detectors; o S2159_1 LV shrouding - review of current practices and standards		

<table>
<tr><td></td><td colspan="4"><u>Projects Still In Progress (March 09):-</u>
o S2110_4 Extend OHRAT to include User Defined Covered Conductor
o S2136_4 & 4A European Project COST 727: Measuring and forecasting atmospheric icing on structures, including Czech ice meter trial;
o S2143_3 Develop in-situ degradation monitor for Al OHL conductors - Stage 3 Instrument Development;
o S2147_2 Increasing vibration limit of CCs to 20%UTS using multiple std or single Hi-mass SVDs
o S2151_2 Alternatives to wood poles - Stage 2: Erection and fitting trials on concrete poles
o S2154_2 Experimental investigation of novel conductors at Deadwater Fell – Stage 2: Vibration;
o S2157_1 Novel conductors for 132kV wood pole lines;

Updated information can be found at:- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>15</td><td>-9</td><td>24</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects in this module will significantly increase the safety and reliability of the network. In certain cases the asset life may also be extended.
If these projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain benefits including:
• Cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults;
• Reduce levels of premature failure of assets and so avoid of risk of injury or loss of life or damage to property as a result of falling overhead lines;
• Avoid redesign, reconstruction or refurbishment of overhead lines where this is driven by a perceived need to increase ratings or strengthen lines, and is required to conform with existing standards but which may be unnecessary;
• Co-operation between European countries in the development of forecasting methods of atmospheric icing and for the exchange of forecasting tools;
• Comparison of new covered conductor with known performance of older types
• Extend the service life of towers and reduce potential levels of tower failures;
• Review alternatives to wood poles;
• Reduce lifetime costs by the appropriate use of alternative materials;</td></tr>
</table>

	• Give Members a better understanding of novel conductors for new-build or re-conductoring 132kV wood pole lines that gives lower capital cost, minimum visual impact, environmental acceptance than other methods of improving power transfer.		
Expected Timescale to adoption	Range 2-5 years - dependent on project	Duration of benefit once achieved	Range 2-10 years - dependent on project
Probability of Success	Range 10-50% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£64,624
Potential for achieving expected benefits	A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it's' inception.		
Project Progress to **March 2009**	Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year.		
Collaborative Partners	Other DNOs		
R&D Providers	EA Technology		

2004_02: STP3 Cable Networks Module

Project Title	Strategic Technology Programme Cables Module 3		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £6,000 External £52,500 Total **£58,500**	Expenditure in previous (IFI) financial years	Internal £15,753 External £141,017 Total **£156,770**
Project Cost	**£381,767**	Projected 09/10 costs	Internal £6,000 External £55,291 Total **£61,291**
Technological area and / or issue addressed by project	The STP cable network programme for budget year 2008/9 aimed at identifying and developing opportunities to reduce the costs of owning cable networks. The reduction of whole life cost through greater reliability and improved performance of cables and associated accessories comes under the remit of Module 3. Where appropriate, Module 3 worked with other Modules to achieve common goals. **Completed Projects (March 09):-** o S3132_12 & 15: CRATER Near Real time Determination & functionality development; o S3148_4 Requirements for earthing and bonding of single core MV power cables: feasibility of earthing and bonding of single core MV cable systems; o S3151_1 Understanding and controlling thermo-mechanical forces in cables systems: Study to assess work carried out on thermo-mechanical forces in cable systems; o S3152_1 Separable connectors and cable compartments in 11 kV switchgear; o S3153_1 & 2: Economics and environmental impacts of distribution cable losses: Model development including CO_2 burden calculation ; o S3168_1 & 2: Comparing future designs of HV and EHV polymeric cables: Review of current specifications and designs and study to determine the interaction between resin and semi-conducting layers; o S3169_1: Further studies on the retraction of insulation and over-sheath of cables; o S3171_1: Jointing on to wet cables. **Projects Still In Progress (March 09):-** o S3132_16: CRATER annotation; o S3144_2: Comparison of processes for the treatment of redundant fluid filled cables: Comparative field trials; o S3151_2 & 3 Understanding and controlling thermo-mechanical forces in cables systems: Modelling of thermo-mechanical forces in cable systems;		

<table>
<tr><td></td><td colspan="4">o S3155_1 Trial testing of triplexed cable in plastic ducts;
o S3157_1 Partial discharge testing of MV cable systems to provide asset risk management data;
o S3164_1: Develop fluid filled cable design tool;
o S3165_1: Performance ageing tests on polymeric terminations
o S3166_1 & 2: Performance of cold- and heat-applied accessories under resin: Assessing interaction between resin and semi-conducting layer;

Updated information can be found at:- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>-8</td><td>21</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO Member of the programme to gain the following benefits, including:
• offset future increases in CAPEX and OPEX;
• CI/CML savings per connected customer;
• Reliable, safe and easy to use method of detecting excess moisture in paper insulation of cables;
• Reduce excavation required in locating leaks from fluid-filled cables, reduce the times and costs of leak location, and also reducing outage times;
• Reduce cable purchase costs;
• Reduce design costs.
• Increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-3 years - dependent on project</td><td>Duration of benefit once achieved</td><td colspan="2">Range 2-10 years - dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 15-50% - dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£87,318</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it’s’ inception.</td></tr>
</table>

Project Progress to **March 2009**	Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year.
Collaborative Partners	Other DNOs
R&D Providers	EA Technology

2004_03: STP4 Substation Module

Project Title	Strategic Technology Programme Substations Module 4		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £6,000 External £38,500 Total **£44,500**	Expenditure in previous (IFI) financial years	Internal £15,753 External £126,982 Total **£142,735**
Project Cost	**£319,784**	Projected 09/10 costs	Internal £6,000 External £40,400 Total **£46,400**
Technological area and / or issue addressed by project	The aim of the 08/09 Substation Programme was to develop already well established themes such as life extension of aged assets within legal and heath and safety constraints, examination of new technologies, developing an understanding of, and innovative solutions for, the impact on substation assets of increasing levels of distributed generation on networks and condition monitoring techniques. The majority of projects have not only resulted in essential knowledge transfer, they have enabled skills to be developed between STP 4 Members and European partners. Key examples of this were the participation in the AM Forum, (S4185_4), reviewing how transformers are connected within Europe (S4221 _2) Each of which has contributed significantly to developing better understanding of electrical plant, improving safety implications, utilisation, performance and life cycle. Some of these projects have resulted in the creation of further supplementary projects for 2009/2010. **Completed Projects (March 09):-** o S4164_5: Tap changer monitor stage 5; o S4178_2: Impedance Testing of Substation Batteries; o S4181_3: Ongoing Programme Of Transformer Post Mortems; o S4209_2: Post Maintenance Testing: Project Workshop Jan 09; o S4222_2: Alternatives to ENATS 35-1 Transformers: Extension 315KVA Ground Mounted Transformers; o S4233_1: 145kV Earthing switch Asset Management Manual; o S4235_1: Researching New Techniques for Optimising Plant Maintenance Policies; o S4237_1: Battery Cabinet Temperature Control; o S4238_1: Module 4 Information Dissemination; o S4239_1: Research and Testing of Electrical Contact Cleaning Products; o S4241_1: Study of Circuit Breaker Timing Measurements & Methods; o S4244_1: Review of methods to dissipate pressure in Substations during equipment failure; **Projects Still In Progress (March 09):-** o S4164_5: Tap changer monitor stage 5; o S4178_2: Impedance Testing of Substation Batteries;		

<table>
<tr><td></td><td colspan="4">o S4185_4: European AM Forum Membership 08/09;
o S4221_2: Out Of Phase Modelling Report;
o S4224_1: X/R Extrapolation of 12kV Vacuum circuit Breakers;
o S4226_1: Environmental Corrosion, Specification, Testing of Plant & Equipment;
o S4230_1: Optimisation of Operational Support and Response for Electrical Plant & Equipment;
o S4236_1: Aquagen recombination system;
o S4245_1: Switchgear – Effect of Low Power Factor Switching. (Joint Investigation with STP5: S5181_1).

Updated information can be found at:- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>14</td><td>-9</td><td>23</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;
• Preventing disruptive failures of oil-filled equipment, tapchangers, earth switches increasing safety and avoid unnecessary scrapping of serviceable components will alleviate environmental impact.
• Liaison with European Utilities to share new technology and failure modes;
Increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Range 1-5 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 2-8 years - dependent on project</td></tr>
<tr><td>Probability of Success</td><td colspan="2">Range 10-100% - dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£67,777</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it's' inception.</td></tr>
<tr><td>Project Progress to March 2009</td><td colspan="4">Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">Other DNOs</td></tr>
<tr><td>R&D Providers</td><td colspan="4">EA Technology</td></tr>
</table>

2004_04: STP5 Distributed Energy Resources Module

Project Title	Strategic Technology Programme Networks for Distributed Energy Resources Module 5		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £6,000 External £51,500 Total **£57,500**	Expenditure in previous (IFI) financial years	Internal £15,753 External £140,140 Total **£155,893**
Project Cost	**£441,001**	Projected 09/10 costs	Internal £6,000 External £54,358 Total **£60,358**
Technological area and / or issue addressed by project	During the budget year 08/09, Module 5 has consolidated the work programme by clustering much of the work around a number of key issues of relevance in the planning, design and operation of networks for distributed energy resources; namely, fault level management, network losses, load related investment, circuit ratings, power quality and microgrids. Most of the projects aim to increase network performance and reduce risk whilst having a positive impact on DNOs' environmental performance. **Completed Projects (March 09):-** o S5169_1 Route plan to transform networks from passive to active networks o S5161_2 Standard Risk Assessment Approach to DNO protection requirements o S5183_1 Communications for active network management o S5187_1 Module 5 participation in ENARD Annex II DG System Integration o S5188_1 & 2 Latest developments in issues associated with low carbon network designs o S5189_1 Techniques for assessing harmonic distortion from generation plant o S5193_1 Fault level management o S5194_1 Load related investment - Feasibility study o S5195_1 Network Losses - Feasibility study o S5197_1 & 2 Power Quality Issues - voltage dips and swells o S5198_1 Microgrids - Feasibility study o S5200_1 LV Fuse Reach o S5201_1 Distribution Network Losses – Loss Reduction Initiatives		

<table>
<tr><td></td><td colspan="4"><u>Projects Still In Progress (March 09):-</u>
o S5147_8 Microgenerator clusters - Stage 8 - extension of monitoring / analysis
o S5151_5 Network Risk Modelling - Stage 5
o S5181_1 Effect of low power factor switching
o S5190_1 Whispergen output characteristic monitoring
o S5204_1 Monitoring and impact of domestic heat pumps
o S5205_1 Fault level management - Feasibility Study.

Updated information can be found at:- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>9</td><td>-10</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects within this module have been cost effective and help improve reliability and safety of generation connection in distribution networks in line with government policy.

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

• Contributing to the achievement of Government white paper aims of introduction of significant numbers of micro-CHP units to the UK homes by 2010 and greater numbers beyond then;
• Paving the way for more actively controlled networks in support of a move to a lower carbon economy;
• Enhancing the knowledge and awareness of overseas best practice in DG system integration, which can be applied, as appropriate in the UK;
• Reduction in the cost of connections for developers seeking to connect load and distributed generation;
• Understanding of the potential to use the Senergy / IMASS connection modelling tool to simplify / reduce the cost of providing indicative connection costs;
• Developing a more consistent, knowledgeable and auditable application of LV fuse reach across the network, hence a more reliable network reducing CML/CI;
• Being better placed to assess the possibilities for real reductions in losses on DNO networks to reduce GB GHG emissions;
• Understanding how to accommodate energy saving technologies such as heat pumps into distribution network design.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Range 1-7 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 1-15 years - dependent on project</td></tr>
</table>

Probability of Success	Range 5-60% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£89,367
Potential for achieving expected benefits	A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. However, STP has delivered a number of notable innovations since it's inception.		
Project Progress to **March 2009**	Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year.		
Collaborative Partners	Other DNOs		
R&D Providers	EA Technology		

2004_05: PD User Group

Project Title	PD User Group		
Description of Project	The PD User group is a technical forum where information on partial discharge related failures can be discussed.		
Expenditure for financial year	Internal £3,000 External £6,000 Total **£9,000**	Expenditure in previous (IFI) financial years	Internal £13,753 External £17,908 Total **£31,661**
Total Project Costs	**£66,540**	Projected 2009/10 costs	Internal £3,000 External £6,000 Total **£9,000**
Technological area and / or issue addressed by project	Partial discharge is the primary cause of disruptive failure of HV switchgear. The PD User group is a technical forum where information on partial discharge related failures can be disseminated and the understanding of partial discharge on switchgear can be enhanced through targeted investigative, research and development work. This in turn will enhance the way in which HV assets are managed and maintained and make a positive impact on the safety of operators working within substations.		
Type(s) of innovation involved	Significant/ Incremental		
Expected Benefits of Project	Due to the ageing profile of switchgear and the introduction of air insulated switchgear designs using cast resin insulation, which is less tolerant to the effects of partial discharge activity, unless the condition of switchgear is actively assessed and managed there is a likelihood of increasing failure rates. The expected benefits of the projects undertaken during FY09 are: • Understanding of the potential partial discharge related failure points for all types of switchgear • Determine the mechanism of failure relating to surface discharge • Attempt to ascertain the end of life period of switchgear found to be experiencing surface related partial discharge • Understanding the typical sound signatures of surface related partial discharge by the use of analysis in the time and frequency domain • Enhanced interpretation of the results of routine partial discharge surveys • Better targeting of maintenance teams to switchgear in need of attention • Preservation or reduction of the low failure rate for HV distribution switchgear • Understanding the effect of the environment on the levels of PD activity and condition of switchgear.		
Expected Timescale to adoption	Range 2-5 years - dependent on project	Duration of benefit once achieved	Ongoing
Probability of Success	Range 50-100% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of success	£11,225

Potential for achieving expected benefits	**Enhanced data manager** During FY08 the PD user Group invested further in the formation of a database of results that enables significant and key information to be quickly drawn from the large population of historical results. The database now incorporate pictures, drawings, failure records, sound files (for the analysis of heterodyned ultrasonic activity). This greatly enhances the incident reporting facilities which helps engineers to better interpret the results of partial discharge surveys and make an assessment on whether switchgear is in need of immediate attention. The database is currently being web enabled to allow members direct access from their computers. **Profile of the long term degradation of switchgear** Following on from the investigation last year, different types of switchgear and components commonly used by the DNO's will be sited at EA Technology and investigated for discharge activity, in some cases creating a discharge source to be monitored. The aim of this work is to try and determine the mechanism of failure associated with surface discharge to try and determine the end of life period once a discharge source has been found. Work will also include the investigation into typical sound signatures for surface discharge activity.
Project Progress **March 2009**	o Findings showed correlation between discharge levels and humidity but highlighted that there is no correlation between the magnitude of ultrasonic sound generated by surface discharge and closeness to failure. o Developed a greater understanding of potential failure mechanisms of the new types of switchgear being introduced to the Networks. o Several new instruments were developed and tested by members.
Collaborative Partners	DNOs
R&D Provider	EA Technology

2004_06: Protective Coatings Forum

Project Title	Protective Coatings Forum		
Description of Project	Quality control and consultancy services related to protective coatings for overhead line towers and substation plant.		
Expenditure for financial year	Internal £3,000 External £6,000 Total **£9,000**	Expenditure in previous (IFI) financial years	Internal £13,753 External £17,000 Total **£30,753**
Total Project Costs	**£38,940**	Projected 2009/10 costs	Internal £3,000 External £6,490 Total **£9,490**
Technological area and / or issue addressed by project	EA Technology has been actively involved in work on surface coatings for overhead line towers and substation plant for a number of years, primarily sponsored by the DNOs and the National Grid. Specifications for tower and plant paint systems have been produced for use by the sponsoring companies. For overhead line towers, most companies currently use two-coat paint systems based on urethane alkyd or modified vinyl resins, manufactured to specifications produced by EA Technology and the National Grid. To ensure satisfactory quality control throughout the industry, a batch certification scheme has been set up and paint samples from manufacturers and painting contracts are checked on a regular basis. As a result, problems relating to paint application have been largely eliminated and the performance of the paint systems has been much improved. Other services provided include troubleshooting, evaluation of various new products and special purpose paint systems, surveys of coatings on new plant and general guidance on surface coatings. In recent years, European legislation has been introduced with the aim of reducing emissions of Volatile Organic Compounds (VOCs), such as the solvents in paint systems, to the atmosphere. The Process Guidance Note PG6/23 (97): Coating of Metal and Plastics, introduced the concept of EPA Compliant Coatings and proposed alternative approaches for surface coatings to reduce VOC emissions. In July 2003, a draft revised version of PG6/23 was issued for consultation, PG6/23A. The main change is the inclusion of requirements specified in EC Directive 1999/13/EC, known generally as the Solvent Emission Directive (SED). The aim of the SED is to reduce emissions of VOCs from specified industrial processes. Full implementation of SED is required by October 2007. This will not immediately affect the use of the solvent based paints currently used for painting towers and plant, because the directive is applicable only to factory applied coatings and does not include coatings applied to outside installations, such as bridges, refineries, towers etc. However, The European Commission and EU Member States have recognised that they need to do even more to improve air quality, and hence two new directives are being prepared. One refers to ozone. The other, the future National Emissions Ceiling Directive will require Member States to reduce their emissions of several air pollutants including VOCs to lower levels from 2010.		

	These directives may well lead Member States to require the Protective Coatings sector to further reduce emissions arising from the use of its products. This suggests that current tower paints may be acceptable until 2010. However, the availability of suitable low solvent paint systems as substitutes for the currently used solvent based systems must be seen as a priority for all users of large quantities of paints. In anticipation of the proposed legislation, EA Technology developed an environmentally friendly water based tower paint system as part of the NORUST project, part funded by the Commission of European Communities, in conjunction with a paint manufacturer, a resin manufacturer and an overseas (Spanish) utility company. Field trials were carried out on overhead line towers in six UK DNOs. These were completed in 1998, and one of the tasks of the project is to continue to monitor the field performance of the paint system, with a view to ensuring a smooth transmission to environmentally friendly paint systems as demanded by legislation. Other VOC compliant paint systems, which have been evaluated, through laboratory test programmes and field trials, have included water based and high solids two-pack epoxy coatings. A stated task within the project is to continue to assess VOC compliant paint systems which may be suitable for painting towers and substation plant.
Type(s) of innovation involved	Significant
Expected Benefits of Project	It is anticipated that the majority of overhead lines will be needed along existing routes for the foreseeable future. Present lines will remain in service as long as the structures can be maintained economically. Currently, the National Grid owns and operates some 7000 route-km of 400kV and 275kV transmission lines with approximately 28,000 towers. The DNOs operate and maintain the 132kV system which comprises approximately 48,000 towers in total. Current paint systems are expected to last for 10 to 12 years, provided the towers have been previously well maintained and the steelwork is in good condition. Life expectancy of the paint systems on rusty substrates will be lower, possibly 5 years. It is essential that any new VOC compliant paint systems proposed for use on overhead line towers should perform at least as well as the currently used solvent based systems, since they are likely to be more expensive, although material costs account for a relatively small proportion of total contract costs. For a typical DNO, a small improvement in performance would generate financial benefits in the region of £10,000 per annum, together with associated environmental benefits. Single coat paint systems, whether VOC compliant or not, have the added advantage of reducing painting costs by reducing the number of visits to each tower during painting contracts.

Expected Timescale to adoption	2 - 4years dependent on legislation	Duration of benefit once achieved	Ongoing benefit
Probability of Success	50% - 100%.	Project NPV = (PV Benefits – PV Costs) x Probability of success	£2,000
Potential for achieving expected benefits	The potential for achieving the expected benefits is considered to be fairly high (see Project Progress below)		
Project Progress **March 2009**	Major tasks within the project are the development of VOC compliant coatings (in conjunction with paint manufacturers) and testing and evaluation of new products. Additional work has been carried out to develop a specification for removal of algae growth from tower surfaces prior to painting. Some high solids two-pack materials, which are VOC compliant, have been identified which have the potential to replace the solvent based systems, and may be applied as a single coat. However, application of these products in the field can present difficulties with mixing, pot-life and H&S. Previously, water-based systems have performed well on galvanised and steel surfaces in good condition, but not as well as solvent based systems on rusty substrates. Laboratory tests and field trials over the past year have confirmed these results. Composite systems, comprising solvent based primers, with water based top coats, which may comply with SED requirements, offer an alternative solution. However, over the past year, paint manufacturers have been active in developing new water based paint systems, and other one-pack systems based on urethane alkyd and modified vinyl resins that may also be applied as a single coat. These will be tested in the laboratory over the next year, and may also be evaluated in field trials.		
Collaborative Partners	ENA Member companies		
R&D Provider	Paint manufacturers, EA Technology		

2004_11: ENA Projects

<table>
<tr><td>Project Title</td><td colspan="3">ENA Projects</td></tr>
<tr><td>Description of Project</td><td colspan="3">Fault Level Monitor Project
An ENA co-ordinated project the objective of which is the development of an on-line instrument that can successfully measure / estimate fault level on a distribution network with repeatability and reliability.

Earthing Transfer
To develop new techniques to assess the impact of lower voltage earth electrodes on higher voltage ‘hot zones’, and to measure the resistance of distribution substation earth systems.

Harmonic Impedance Modelling
To commission a study and develop guidance for long underground cable harmonic impedance modelling.

Loss of Mains
Testing on a range of LoM relays resulting in a matrix of optimum settings and test procedures for relay specification.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,000
External £9,000
Total £11,000</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £9,458
External £19,739
Total £29,197</td></tr>
<tr><td>Total Project Costs (Collaborative + external + [company])</td><td>£252,982</td><td>Projected 09/10 costs</td><td>Internal £2,000
External £10,000
Total £12,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">Fault Level Monitor Project
The device will connect to the network, and establish the network source impedance from small-scale disturbances / perturbations resulting from transformer tap changer operation, etc. This impedance can accurately be correlated to a true network fault level for that location, providing near real-time information to network control and planning engineers alike.

Earthing Transfer
All designs for earthing systems consider the effects of touch and step potentials under fault conditions. However the quantity of concern is actually the current flowing through a human body when in contact with metalwork subject to this potential and the time the current flows for. An electrode simply sited in soil which has a surface potential cannot be regarded as presenting the same hazard as metalwork with a direct metallic connection to the earth fault current return path. However there exists at this time no methodology for assessing the either the hazard posed by such an earth electrode or the possible effects of the earth when connected to a distributed system on the ROEP contours.
This project will if successful determine these effects and provide a means to provide cost effective safe earthing systems without the need for extensive separations between HV and LV electrodes which in a PME system may be impractical to achieve and maintain.</td></tr>
</table>

	Harmonic Impedance Modelling The report covers the detailed modelling of cable and overhead line components. Particular attention is paid to cable models appropriate for distribution networks, as this is was the initial objective of the project and literature on modelling of cables is not as widespread as that for other items of equipment Loss of Mains To carry out testing on a range of LoM relays in order to develop a clear understanding of the stability of these relays when confronted by a range of network disturbances applied at a range of relay settings. This information will be used to develop a matrix of optimum settings and test procedures for relay specification. More specifically, the aims are: • Produce recommendations for relay immunity, to a range of simulated disturbances, typically found on a distribution network. • Produce a matrix of recommended settings to give optimum sensitivity based on typical generator types and ratings for Vector Shift, ROCOF and perhaps changes of reactive power. • Identify the range of protection settings that would be needed to meet the above recommendations. • Identify from frequency records (held by NGT and ENA members) and previous work by EATL, a maximum system disturbance for which LOM relays should not operate: Frequency shift of X Hz over a period of Y cycles. Instantaneous single- and two-phase voltage angle shifts of Z degrees. • Produce recommendations for sampling period (ROCOF relays) and number of phases monitored (ROCOF & Vector Surge) • Produce a matrix of recommended settings for both ROCOF and Vector Surge relays based on generator type, generator rating and system fault level • Define a set of type tests to verify: (a) Relay immunity to the disturbances specified in (4) above (b) Relay operation for disturbances greater than those specified in (4) above. • Compliance with the relevant parts of ENA TS 48-5.
Type(s) of innovation involved	Incremental and Significant
Expected Benefits of Project	IFI0502: Fault Level Monitor Project The developed unit will allow the DNOs to accurately assess fault infeed levels and design distribution networks appropriately. The particular benefits of this project are seen to be: • Provide a real-time and consistent estimation of fault level • Accurately take into account all connected network elements (e.g. Motors); • Facilitate the connection of distributed generation by providing a standardised methodology for the assessment of network fault levels • Enable an ongoing assessment of the effects of connected distributed

<table>
<tr><td></td><td colspan="3">generation to be made;
Provide reassurance to generator developers that decisions to upgrade networks are not subjective but based on objective measurement.

<u>Earthing Transfer</u>
The project will determine the effects of LV earth systems on HV systems. The results of this should determine the means to provide cost effective, safe earthing systems without the need for extensive separations between HV and LV electrodes which in a PME system may be impractical and costly to achieve and maintain.

<u>Harmonic Impedance Modelling</u>
The study objective is the development of an ETR type guidance note to supplement G5/4 (2001) and help reduce and simplify modelling requirements for relatively small capacity 33kV and 11kV connections

<u>Loss of Mains</u>
• An improved understanding of LoM relays
• Use of more effective settings resulting in a reduced number of unwanted generator trips due to system disturbances
• More effective use of LoM relays (eg as interface protection) resulting in reduced installation costs</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td>Duration of benefit once achieved</td><td>10 – 40 Years</td></tr>
<tr><td>Probability of Success</td><td>25 - 50% dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of success</td><td>£92,045</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3"><u>Fault Level Monitor Project</u>
The confidence limits in the case of the induction motor infeed assessment were affected by the relatively low number of recorded disturbances and also appear to have been affected by the ‘two-stage’ nature of many of the disturbances. Further work should be undertaken to examine the effect of the load response of non-linear static loads on the estimate of fault level contribution from induction motors. A PhD studentship at the University of Strathclyde the PNRA to explore this issue is being advertised

<u>Earthing Transfer</u>
High. The results from tests and simulations can be used to propose a recommended procedure for measuring transfer potential between HV and LV systems, suitable for inclusion in a DNO policy document.

<u>Harmonic Impedance Modelling</u>
The frequency dependent behaviour of overhead lines and cables was assessed. A sensitivity analysis has shown that simplified models and power frequency models may be used to represent the harmonic behaviour of a single core conductor overhead line and cable with a reasonable degree of accuracy over the frequency range assessed.</td></tr>
</table>

	Loss of Mains Potential for achieving expected benefits is high. The final report provides the basis for new settings guidelines which should enable the majority of perceived benefits to be achieved.
Project Progress **March 2009**	Fault Level Monitor Project The results of the tests carried out at NaREC show that the EA Technology Fault Level Monitor is capable of delivering an assessment of both the source and motor infeed elements of fault level. The accuracy of the assessment can be delivered with the tolerance levels (+/- 5%) which were set down by ENA OSG sub-group. However, it should be noted that the instrument is based on a hardware platform which is obsolete and no longer supportable. Stage 2 of the previous work carried out in conjunction with the University of Strathclyde, was intended to develop a new Fault Level Monitor. Consideration should be given to the need to carry out further development of a new platform to collect and analyse the disturbance data. Earthing Transfer During the first four phases of the project (as per IFI 2007-2008) the project team were able to confirm by calculation and measurement (including analysis at two live substations) that the LV electrode system interacts with the external potentials created by a close, but electrically separated HV installation. The findings are completely new and help to explain why there is so little evidence of damage to LV equipment when there is an HV earth fault on equipment quite close by. It was possible to quite closely match the theoretical and measured results at the two live test substations but they were each considerably ore complicated that the vast majority of installations in terms of their earthing requirements. Because the finding are so new and unexpected there is a need to carry out the following: (1) Theoretical and practical measurements at a simple substation whose earthing arrangements match what is or should be done at the majority of sites throughout the UK. (2) Use computer models of similar and improved earthing arrangements for the same type of substation to develop several case study examples. These will consider changes to the electrode orientations, separation distances, electrode depths etc. Not only will these help explain the effects, but they will also be used to develop more appropriate earthing strategies rules and support equations.. The case studies will be documented in a manner that permits publication. (3) Make the findings known in the UK, Europe and Internationally. The main reason for this is to ensure that the new practices become established and for this they must be reflected in the standards that are presently being developed. (4) Prepare text describing a method for calculating the transfer potential for inclusion in ENA TS 41-24 The work set out above for phase 5 is anticipated to take 15 months to complete.

	Harmonic Impedance Modelling An interim report has been issued following the first section of work on the cable modelling which addresses the technical cable modelling issues on the original project brief. The extension to the brief to stage 2.5 as it is called is the focus of the final report which is taking the time and will not be available until the meeting of the working group on the 9th of July 2009. Loss of Mains The final report has been published and will be presented as an ENA Technical Report. The only outstanding item is for the ENA Protection Assessment Panel to produce a ENA TS for "Functional Test Requirements for Loss Of Mains Relays"
Collaborative Partners	National Grid, ScottishPower Energy Networks, CE Electric UK, Electricity North West, Central Networks, Western Power Distribution, EDF-Energy Networks
R&D Provider	IFI0502: Fault Level Monitor Project: University of Strathclyde, EA Technology Earthing Transfer: Strategy & Solutions Harmonic Impedance Modelling: TNEI Loss of Mains: University of Strathclyde

2005_14: Orkney ANM

Description of project	Development of Active Network Management (ANM) scheme for Orkney. This project is integral to establishing a Registered Power Zone on Orkney.				
Expenditure for financial year	Internal External Total	£10,000 £75,000 **£85,000**	Expenditure in previous financial years	Internal External Total	£41,753 £170,868 **£212,621**
Technological area and / or issue addressed by project	The amount of Distribution Generation allowed to connect to the Orkney distribution network is currently limited by network constraints. An increase in renewable energy generation is commonly accepted to be an important part of the plan to meet UK and international emissions reductions targets. Renewable resources are often located in remote areas where the connection to the national grid will be via weak distribution networks requiring substantial network infrastructure reinforcement. Theoretically, networks may be filled to capacity with contracted renewable generation but, due to diversity, the actual real time contribution can be significantly less than the contracted capacity. If renewable resources are to have their full potential realised then a combination of new network technologies and advances in system planning and operation are required. The Orkney Isles are an area of abundant renewable resource with several wind farms and the European Marine Energy Centre. Orkney is connected to the mainland network by two 33kV submarines cables and analysis shows that the active network management scheme may be capable of releasing capacity for DG connections by up to three times the firm capacity of the existing distribution network.				
Type(s) of innovation involved	Radical				
Expected Benefits of Project	Financial project benefits are derived from comparing the cost of the active network solution with the cost of extensive conventional reinforcement. This project will allow connection of further distributed generation on Orkney by use of novel techniques				
Expected Timescale to adoption	Short - within three years.		Duration of benefit once achieved		10 years
Estimated Success probability (at start of project)	Low - 10%				
PV of Project Costs	£280,000	PV of Project Benefits	£675,000	NPV of Project	£423,000

Potential for achieving expected benefits	The detailed design of the ANM system has progressed to a stage that confidence is high that the technical objectives of the project will be achieved. Contractual arrangements have been confirmed for the first two generators to participate in the scheme. If construction of these two generators progresses as planned then it is expected that the operation of the ANM system will be fully demonstrated in Autumn 2009 with multiple constraint points being monitored and the two generators being constrained as necessary to maintain the network within operational limits. The principles of operation for the ANM scheme hold for other situations where the thermal capacity of radial distribution networks is under utilised or acts as a barrier to the connection of new DG units. The scheme is therefore expected to be applied to other parts of the UK network - following corroboration of the operation of this first scheme on Orkney.
Project Progress **March 2009**	Following successful factory acceptance testing, installation works have been completed of the core ANM system and the first two monitoring points on the 33kV network. Commissioning of these components is progressing. The communications links necessary to connect the next two monitoring points has been progressed as these are located at outlying points on the network. Commercial arrangements have been developed to support the ongoing operation and optimisation of the ANM system. Delays by generation developers in gaining planning consent and finance have delayed the progress of this project and are outwith our control.

2006_01: Supergen V - AMPerES

Description of project	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).				
Expenditure for financial year	Internal External Total	£6,000 £25,000 **£31,000**	Expenditure in previous financial years	Internal External Total	£5,753 £75,000 **£80,753**
Technological area and / or issue addressed by project	• WP 1: Programme delivery, outreach and implementation • WP 2: Enhanced network performance and planning • WP 3: Adaptable protection and control techniques • WP 4: Infrastructure for reducing environmental impact • WP 5: Ageing mechanisms • WP 6: Condition monitoring techniques				
Type(s) of innovation involved	Radical				
Expected Benefits of Project	The expected aims of the project are: • To deliver a suite of intelligent diagnostic tools for plant • To provide platform technologies for integrated network planning and asset management • To progress plans to develop and implement improved and reduced environmental impact networks • To develop models and recommendations for network operation and management •				
Expected Timescale to adoption	Year 2013		Duration of benefit once achieved		20 years
Estimated Success probability (at start of project)	25%				
PV of Project Costs	£120,000	PV of Project Benefits	£192,000	NPV of Project	£72,000
Potential for achieving expected benefits	Asset management is core to the business. The appropriate use of the emerging opportunities for condition monitoring is key to optimising performance, both financially and in quality of supply. Some of the technologies being developed in this programme are likely to be utilised, however much more important is the broader window this work gives to the global research community. Through demonstration sites the true value of condition monitoring will be identified, enabling appropriate business decisions on adoption of technologies.				

Project Progress **June 2009**	Technology & trials: • The detection, control and protection synchronous islands have been demonstrated on a 50kVA diesel generator. The demonstration employs a real-time phasor measurement system. An AC optimal power flow method for assessing the maximum distributed generation (DG) penetration in distribution networks has been developed. A novel method of detection of loss of grid techniques is being developed. A low-cost system with internet broadcast capability has also been developed: four are currently in operation. An investigation into how regions of a distribution network can operate during emergency islanded mode conditions is also underway. • Optimized design of existing overhead lines of wood pole line, and a lattice tower line. The methodology has been employed to analyse the behaviour of low-sag composite conductors on a 33kV wood-pole structure. The model is now being utilised on a wood-pole line on Scottish Power and a lattice tower line on the National Grid, and may substantially improve the performance of sections of the network without major infrastructure changes. • A unique installation for transformer monitoring at National Grid comprising of two 275/132kV, 180MVA transformers, is implementing results of research on condition monitoring architectures, diagnostics and machine learning. • Development of condition monitoring architecture for power networks has progressed well and is being implemented on a National Grid transmission transformer. Diagnostic and support modules are included, and exploit a range of ageing models including those developed within this project. Work on ageing has shown that the rate of damage may not be affected by harmonic content, but resulting partial discharge signals change significantly. • PP-based alternatives to XLPE cable insulation have been characterised. Additional funding has been secured for the more applied work to develop routes to commercial exploitation. Vegetable oils have been shown to be a basis for replacement of mineral oils in HV equipment. • Strathclyde and Liverpool have been applying knowledge-based partial discharge analysis and chromatic analysis to data from EdF Energy cable monitoring systems. All publications and reports are available to all the partners from a secure web site: http://www.supergen-amperes.org/

2006_03: LV Sure

Description of project	To develop an automatic LV network reconfiguration system based upon the "SignalSure" system currently installed on the rail network. By embedding a number of autonomous points of isolation at strategic locations which are co-coordinated by an intelligent device the faulty section will be isolated and supply restored to healthy sections.				
Expenditure for financial year	Internal External Total	£4,000 £48,000 **£52,000**	Expenditure in previous financial years	Internal External Total	£12,753 £102,144 **£114,897**
Technological area and / or issue addressed by project	It is recognised that a cost effective means to better isolate faults occurring on the low voltage electricity distribution network will yield significant performance benefits. Current practice is reliant upon fuses, typically located at substation sites and arranged so as to protect individual phases of a low voltage feeder. Whilst providing a reliable and simple means of fault isolation the resultant scale of loss of supply may be large and may require the passage of high fault current to achieve fast operation. By embedding a number of autonomous points of isolation at strategic points within the low voltage network and having their operation co-ordinated with an “intelligent” device rather than a fuse at the substation, the loss of supply resulting from a fault can be reduced. Appropriate discrimination with downstream protective devices, such as service fuses, should allow a fault to be detected and isolated with smaller fault current passage, thereby reducing the stress on network components. EA Technology and Equipmake have developed a Patented automation system for Power Circuits called “SignalSure”. In the event of a fault on the circuit SignalSure isolates faulted sections of the circuits. Isolation of the faulted section and restoration of supply to unfaulted sections of the circuit is completely automatic and does not require communication between the devices which comprise the SignalSure system. Currently SignalSure is installed and operational on the rail network and is used to reconfigure signalling power circuits in the event of a fault. However, with minor modifications it can be adapted to provide an automatic network re-configuration function for low voltage electricity distribution networks, delivering an enhanced level of performance for customers.				
Type(s) of innovation involved	Significant innovation				
Expected Benefits of Project	Improvement in Quality of Supply is expected due to a reduction in CIs and CMLs. Financial benefits will be derived from a reduction in operating costs associated with LV underground cable faults				
Expected Timescale to adoption	3 years		Duration of benefit once achieved	10 years	

Estimated Success probability (at start of project)	50%				
PV of Project Costs	£188,000	PV of Project Benefits	£300,000	NPV of Project	£112,000
Potential for achieving expected benefits	The project at present is expected to deliver a suitable system for deployment on the network, however given some technical constraints at present the potential for achieving expected benefits remains in line with an expected probability of success of 50%				
Project Progress **March 2009**	Tasks completed to date are : o Review of typical LV network topologies. o Reviewed current regulations, operational practices and processes o Analysed low voltage fault incidence using data provided by Scottish & Southern Energy o Identified possible applications and deployment options o Estimate the benefits for a number of agreed alternate SignalSure deployment strategies and produce a benefit matrix o Identified the technical constraints and financial implications of adapting existing SignalSure components for use of LV networks o Production of an implementation strategy, based on the preferred configuration. o Phase 2 – Stage 1 has seen the completion of a review of engineering and performance specification. o Completion of a system specification for the system along with production of a detailed project plan and preliminary test plan which has now been agreed will allow the project to proceed.				

2006_05: Distribution Network Analysis

Description of project	Distribution Network Analysis using advanced statistical modelling techniques to better predict the effects of weather events on the network.				
Expenditure for financial year	Internal External Total	£6,000 £0 **£6,000**	Expenditure in previous financial years	Internal External Total	£10,754 £65,788 **£76,542**
Technological area and / or issue addressed by project	The aims of the project are; o to develop effective statistical models which will enable accurate advance warning to be provided of power line faults arising from climatic or weather conditions o to develop predictive models which can enable preventive measures to be taken which will reduce the incidence and duration of weather related power supply disruption. o to reduce costs by responding faster to weather induced circuit failures and by enabling pre-emptive actions to reduce the likelihood of failure caused by storm conditions. The activities of the project will include; o Manipulate data in SSEPD fault records database, clean data, and apply regression and trend analysis. Develop a model based on line fault data. o Obtain and manipulate historic weather and climatic data identify factors impacting on line faults e.g. wind, rain, snow etc. o Develop a model of line faults with respect to weather and climatic factors. Define confidence limits. o Carry out a cost benefit analysis based on the application of the model to engineer mobilisation in advance of line faults. o Carry out a cost benefit analysis based on the application of the model to power cut-off under severe storm conditions. o Carry out trials and tests as required and support implementation as appropriate. o Develop systems and train staff in statistical analysis of fault and climatic data, embed systems for use and development in the future. Application of the developed predictive model will lead to improved reliability of the power distribution network. Allocation of resource on the basis of the model will decrease the response time for repair of the network, increasing efficiency and minimising frequency and duration of interruption to supplies.				
Type(s) of innovation involved	Technological Substitution				
Expected Benefits of Project	Financial and Quality of Supply				
Expected Timescale to adoption	Short – 3 years		Duration of benefit once achieved	10 years	

Estimated Success probability (at start of project)	Medium 50%				
PV of Project Costs	£143,000	PV of Project Benefits	£144,000	NPV of Project	£1,000
Potential for achieving expected benefits	Although considerable progress has been made, the critical part of the project is the production of the statistical models,as this is the current phase of the project it will only be once sufficient progress has been made with these models will it be possible to determine the likelihood of success.				
Project Progress **March 2009**	o The project is currently running behind schedule. o The associate is employed under a Knowledge Transfer Partnership with the University of St Andrews. o Following successful completion of academic modules at the University, the associate developed his understanding of the business context and the operational drivers for this project. o Data sources were identified for collation of data and this data has been cleaned for use in the project.. o A preliminary statistical model has been produced and work undertaken to make predictions from this model, rebuild the data set and further develop this initial model. o Work was also completed on a mini project to derive a methodology for a more cost effective assessment of the management of overhead line refurbishment.				

2006_06: Crow Control

Description of project	Crows have continuously caused problems in areas where nesting sites are scarce. The project will evaluate overhead line construction design methods which may reduce the likelihood of nest building, along with deterrents on existing lines. Alternative nesting site provision will also be evaluated.				
Expenditure for financial year	Internal External Total	£12,000 £0 **£12,000**	Expenditure in previous financial years	Internal External Total	£20,754 £5,560 **£26,314**
Technological area and / or issue addressed by project	Prevention of flashovers and outages attributed to nesting crows. The objectives of this project are : suitable monitoring techniques for different types of trials; financial benefit derived as well an improvement in quality of supply.				
Type(s) of innovation involved	Technological substitution				
Expected Benefits of Project	Financial and Quality of Supply.				
Expected Timescale to adoption	Short - within three years.		Duration of benefit once achieved		Lifetime of asset.
Estimated Success probability (at start of project)	Low - 25%				
PV of Project Costs	£15,000	PV of Project Benefits	£17,000	NPV of Project	£2,000
Potential for achieving expected benefits	Although good progress is being made with the project and some success has been achieved it is clear that further work is necessary to determine an effective solution to this problem.				
Project Progress **March 2009**	Project currently on target. This season's field program will involve gathering observational data on the features of nest building by hooded crows with the intention of establishing why the location of crows nests in the network are not evenly distributed. From this it is hoped that it will be possible to establish which factors are effective at predicting the location of nests on the network. This will allow efficient management of the problem in subsequent years, when trials of deterrents and /or ways to allow safe nesting can be run. The Firefly diverter, will be fitted again this year in response to all cases of crow nesting in the hope crows will be deterred from rebuilding.				

2006_07: GIS Tree Clearance

Description of project	Geographic Information System (GIS) to support tree cutting activities				
Expenditure for financial year	Internal External Total	£34,000 £44,175 **£78,175**	Expenditure in previous financial years	Internal External Total	£26,254 £59,000 **£85,254**
Technological area and / or issue addressed by project	This project aims to develop trial and evaluate an innovative application using Ordnance Survey Imagery data within the existing GIS application to assess tree cutting requirements. This is in line with ESQCR regulation regarding Avoidance of Interference with or Interruption of Supply caused by trees. GIS operators are able to measure the length of affected o/h line requiring tree clearance by feeder.				
Type(s) of innovation involved	Significant				
Expected Benefits of Project	Quality of Supply and Financial				
Expected Timescale to adoption	Short within 3 years		Duration of benefit once achieved	10 Years	
Estimated Success probability (at start of project)	25%				
PV of Project Costs	£143,000	PV of Project Benefits	£412,000	NPV of Project	£288,000
Potential for achieving expected benefits	Development and testing using pilot data was completed last year. Data has been supplied to the field operatives with very positive results to date. The project is on target to complete by Autumn 09.				
Project Progress **June 2009**	95% south area complete and 80% north area complete. Data has been captured for 1000 networks in GIS from a total of 1200.				

2006_08: HV Sure

<table>
<tr><td>Description of project</td><td colspan="5">HV Network Automation without inter-device communication.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£5,000
£16,000
£21,000</td><td>Expenditure in previous financial years</td><td>Internal
External
Total</td><td>£6,754
£40,835
£47,589</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">This project is designed to develop a new design of HV ‘switch’ that has the capability to test whether or not a fault exists in the adjacent network section.

These devices can work autonomously to decide whether or not to supply to restore supply to that section following loss of supply resulting from a fault. Technology already exists for LV applications and the project seeks to transfer the concept to the HV distribution network in a series of stages:

1. Establish the technical feasibility and explore the issues which would arise in applying the system to the HV distribution network.
2. Analyse the safety and operational implications arising from use of the system.
3. Produce a prototype system suitable for deployment on open ring HV distribution network circuits.
4. Install and test the system on agreed HV circuits of the SSEPD network.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Significant, Technological Substitution, Radical</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">By embedding the new ‘switch’ devices at strategic points within the HV network, an automation scheme can be applied to the HV network that will operate autonomously without the need for inter-device communication or human intervention. The particular benefits of this project are seen to be:

• An alternative to existing HV Automation systems exist that rely on costly and sometimes unreliable communication circuits being available to transfer status or timing information.

• Extend the opportunities for automaton schemes to circuits without communications with the resultant improvement in CIs, CMLs and restoration times for those circuits.

• By avoiding closing onto a fault, the network is not exposed to multiple fault current pulses, thereby reducing the stress on network components.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Medium – 7 years</td><td>Duration of benefit once achieved</td><td colspan="2">20 years</td></tr>
<tr><td>Estimated Success probability (at start of project)</td><td colspan="5">Low 25%</td></tr>
</table>

PV of Project Costs	£170,000	PV of Project Benefits	£272,000	NPV of Project	£102,000
Potential for achieving expected benefits	The potential for achieving the expected benefits has been assessed as being low so progress on this project has been suspended.				
Project Progress **March 2009**	The first two stages of the project have been successfully completed: 1. Establish the technical feasibility and explore the issues which would arise in applying the system to the HV distribution network. 2. Analyse the safety and operational implications arising from use of the system. Project suspended.				

2007_01: DG and ARM Strathclyde

Description of project	Sponsored endowment with University of Strathclyde for applied research and development of Distributed Generation (DG) and Asset Risk Management (ARM)				
Expenditure for financial year	Internal External Total	£6,000 £41,000 **£47,000**	Expenditure in previous financial years	Internal External Total	£5,753 £80,874 **£86,627**
Technological area and / or issue addressed by project	Increased and more controlled output from Distributed Generation. Improved management of distribution assets.				
Type(s) of innovation involved	All innovation types involved (incremental, significant, technological substitution and radical)				
Expected Benefits of Project	Financial project benefits are expected. The benefits will be across a range of areas including construction, maintenance, refurbishment and operation. This funding provides close links with a noted academic organisation and will promote rapid transfer of new technology and ideas into existing business areas.				
Expected Timescale to adoption	3 years.		Duration of benefit once achieved	Lifetime of asset. – 40 years	
Estimated Success probability (at start of project)	Success probability is expected to be 20% overall on the whole programme of projects.				
PV of Project Costs	£80,000	PV of Project Benefits	£82,000	NPV of Project	£2,000
Potential for achieving expected benefits	Work to date has delivered benefits by informing the development and application of asset risk management within SSE Power Distribution				
Project Progress **March 2009**	Projects currently on target. Significant work completed on asset risk management during this year.				

2007_02: PD Mini Monitor

<table>
<tr><td>Description of project</td><td colspan="5">It is planned to install the SSM Mini 4-Channel, On-line Partial Discharge Portable Monitors onto ten 11kV feeders from both the North and Southern networks. The SSM Mini Monitor is designed to detect the Partial Discharge (PD) in MV switchgear and the associated 11kV cables. Therefore it will be used as a monitoring device which will record the PD level in its memory storage for viewing purposes where results can be monitored both remotely and locally.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£9,000
£31,250
£40,250</td><td>Expenditure in previous financial years</td><td>Internal
External
Total</td><td>£3,900
£31,250
£35,150</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">o By deploying ten of the SSM Mini Monitors on 11kV feeders, PD trend analysis will be possible as results are stored both locally and remotely.

o To prove that the SSM Mini Monitors are able to monitor for partial discharge activity in primary substations on both MV switchgear and 11kV cables.

o Understand the analysis obtained from the SSM units and distinguish between low levels of PD activity that would require regular monitoring and severe levels that will warrant replacement for the switchgear/cable.

o By integrating the PD test and monitoring technology within a condition-based asset management approach, electricity utilities can make huge savings to their OPEX and CAPEX expenditure.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Significant</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Financial
Assessing the health condition of certain assets i.e. MV switchgear and 11kV cables through online testing for Partial Discharge activity that will allow for more strategic decisions to be made about refurbishing and replacement programmes. Cost saving of cable and MV switchgear could reach to £105,000.

Knowledge Transfer
Working together with the directors of HVPD who collectively have over 50 years of experience in Partial Discharge testing (online and offline) will provide much opportunity for a further understanding on Partial Discharge monitoring. Collaborating with EDF energy is also a bonus as they have been extensively involved in Partial Discharge monitoring over the past few years.

Network Performance
Carrying out permanent online testing on suspected Partial Discharge activity sites will prevent disruption to supply which will help reduce customer minutes lost (CML) and customer interruptions. PD monitoring will also allow the replacement of only the cable accessories or small sections of cables where the insulation is defective, instead of the wholesale replacement of the entire cable (at huge expense). Also from analysing the data, deferring asset replacement to beyond the 'design life' of the cable/switchgear whilst still maintaining good network reliability and availability figures is made possible.</td></tr>
</table>

	External Risk Partial Discharge at critical levels can lead to catastrophic outcomes i.e. switchgear/cable damage and injury or fatality to any person in proximity . On-line PD testing of HV plant gives advance warning of pending insulation failure thus allowing time to take remedial action during planned outages.				
Expected Timescale to adoption	2/3 years		Duration of benefit once achieved		20 Years
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£68,103	PV of Project Benefits	£101,888	NPV of Project	£36,166
Potential for achieving expected benefits	It is expected that the project benefits listed above will be achieved once all 10 of the mini monitors are deployed and trialled on both SHEPD and SEPD 11kV networks.				
Project Progress **March 2009**	In the past year, HVPD have designed a PD mini monitor with a GPRS modem to allow users to view data remotely. To enable use of this facility, HVPD are producing an online database to provide real time substation PD data remotely, and will continue enhancing the monitor design. The first PD mini monitor trial has commenced at one site in SHEPD's area. By the end of July 2009, it is planned to have all 10 mini monitors installed across the SHEPD and SEPD 11kV networks.				

2007_03: Self Tuning Petersen

Description of project	Introduction of new technology solution using self tuning arc suppression coils as an alternative to traditional resistance earthing methodology.				
Expenditure for financial year	Internal External Total	£5,000 £26,000 **£31,000**	Expenditure in previous financial years	Internal External Total	£4,900 £28,456 **£33,356**
Technological area and / or issue addressed by project	Understanding of design installation and maintenance requirements of self tuning arc suppression technology along with improved fault location measurement.				
Type(s) of innovation involved	Incremental, significant and technological innovation solution.				
Expected Benefits of Project	o Reduction in Customer Interruptions and Customer Minutes Lost. o Improvement in safety performance of network. o Production of design, installation and maintenance specifications with required changes to operational practices may be required.				
Expected Timescale to adoption	3 years.		Duration of benefit once achieved		Lifetime of asset. – 40 years
Estimated Success probability (at start of project)	Success probability is expected to be 50% overall.				
PV of Project Costs	£352,968	PV of Project Benefits	£500,844	NPV of Project	£158,079
Potential for achieving expected benefits	Work to date is sufficient to justify replacement of existing Petersen coil systems with the self tuning technology when they are due for renewal. This will deliver cost and performance benefits in the short term. Further work is required to determine the case for the conversion of resistance earthed systems.				
Project Progress **March 2009**	System studies were completed on chosen circuits along with cost benefit analysis. A review of arc suppression technology and applications has been completed and further work is required to fully assess the safety implications.				

2007_07: IntelliTeam DA

Description of project	A pilot scheme to evaluate the performance of next generation network automation to automatically reconfigure the network into isolatable sections.				
Expenditure for financial year	Internal External Total	£10,000 £92,000 **£102,000**	Expenditure in previous financial years	Internal External Total	£5,900 £98,500 **£104,400**
Technological area and / or issue addressed by project	It is proposed to establish a pilot scheme to evaluate both the overhead and underground plant functionality and how they can interact on mixed networks. The pilot will be split into three phases – phase 1 is to understand the costing and technical requirements for interfacing onto our network and the design of an underground circuit breaker – phase 2 is to install the equipment on a section of overhead network with phase 3 on a section of underground network.				
Type(s) of innovation involved	Incremental Innovation, Technological Substitution, Significant Innovation.				
Expected Benefits of Project	Large improvements in CI/CMLs can be achieved using true automation - exploiting modern technology, and where the manual element is removed as much as possible. Using 'intelligent' auto-reclosers there is no restriction imposed by protection discrimination – this being achieved using a high speed radio link with banks of auto-reclosers having the same or graded protection settings. These auto-reclosers will detect the faulted section, reclose for transient faults, isolate permanent faults and reconfigure the network. The control engineer would only see permanent faults. Real time load management and network constraints will allow the load management to be automated. This scheme can equally well be applied to the underground network using bespoke circuit breakers.				
Expected Timescale to adoption	3 Years		Duration of benefit once achieved	20 Years	
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£188,325	PV of Project Benefits	£277,860	NPV of Project	£95,713
Potential for achieving expected benefits	Potential for achieving expected benefits is high but only achievable when applied economically, i.e. dependent on network layout and radio availability. The extent of effective rollout possible is still to be assessed.				
Project Progress **March 2009**	Approximately 75% of hardware is now in place (intellirupters and radios), however software issues slowed progress, resulting in the system not being fully functional at the present time. Although progress has not been made as expected, the unanticipated delays have been satisfactorily handled and the project is progressing well.				

2007_08: Live Line Tree Felling

Description of project	Carry out a desk top review of potential methods and techniques to carry out tree felling next to live lines. Methods and techniques will be assessed and ranked according to their potential for success. Proposals and costs for further detailed research including field works to develop a live line tree cutting method will be presented.				
Expenditure for financial year	Internal External Total	£5,000 £14,500 **£19,500**	Expenditure in previous financial years	Internal External Total	£5,400 £2,750 **£8,150**
Technological area and / or issue addressed by project	Several thousand trees are to be cut during the next ten years which will require the development of a procedure and process to enable felling of trees safely within traditional safety zones by contractors.				
Type(s) of innovation involved	Significant				
Expected Benefits of Project	The ability to fell trees without the need for an outage will save significant time and money. The initial scoping report will save time and resources by focusing further research work on the areas that are most likely to be successful.				
Expected Timescale to adoption	2 years		Duration of benefit once achieved	40 years	
Estimated Success probability (at start of project)	20%				
PV of Project Costs	£72,400	PV of Project Benefits	£115,840	NPV of Project	£43,440
Potential for achieving expected benefits	Initial work on this project has progressed well but it is too early to judge the potential for achieving the expected benefits.				
Project Progress **March 2009**	Work package 1 (GIS scoping analysis) completed March 2009. 3 more work packages to complete.				

2007_09: Ultra TEV Alarm

Description of project	The UltraTEV Alarm system is a cost effective way to provide permanent condition monitoring of switchgear, enhancing operator safety and providing confidence in the continuing reliability and safety of plant.				
Expenditure for financial year	Internal External Total	£3,000 £0 **£3,000**	Expenditure in previous financial years	Internal External Total	£4,900 £22,690 **£27,590**
Technological area and / or issue addressed by project	The UltraTEV Alarm can be used for a variety of applications: • Low cost permanent monitoring of critical assets • Workforce confidence following a switchgear incident • Enhancing substation staff confidence and safety • To automatically restrict substation access • Extending life of assets scheduled for replacement • Indicating problems with newly commissioned switchgear				
Type(s) of innovation involved	Significant				
Expected Benefits of Project	Quality of Supply, Financial and Safety				
Expected Timescale to adoption	3 Years		Duration of benefit once achieved		10 Years
Estimated Success probability (at start of project)	20%				
PV of Project Costs	£28,434	PV of Project Benefits	£33,394	NPV of Project	£5,943
Potential for achieving expected benefits	The project has to date progressed in line with initial project objectives.				
Project Progress **March 2009**	The two trial systems installed have been monitored remotely by EA Technology with monthly reports produced for both systems. Results to date have shown PD activity at one of the trial sites which on further detailed testing has been more specifically located within the switchgear concerned with remedial action taken to reduce the PD activity. Initial results have shown that the system is delivering the expected results in terms of providing visibility of PD activity to staff entering the substation along with collection of historic activity at site to determine switchgear condition and reliability. Further trials will be required involving re-deployment of a system to an alternative location. The project progress remains on target.				

2007_10: Integrated Vegetation Management

<table>
<tr><td>Description of project</td><td colspan="5">Integrated Vegetation Management (IVM) is a management system being developed for reducing the risks to supply due to vegetation. Lengthening clearance times (i.e., reducing the frequency of maintenance) and reducing maintenance costs.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£5,000
£0
£5,000</td><td>Expenditure in previous financial years</td><td>Internal
External
Total</td><td>£5,400
£52,000
£57,400</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The Integrated Vegetation Management project will consist of three work packages with the following content.

<u>WP1</u>
This will involve a review of IVM techniques & technologies in four key areas:
• Management process
• Machinery and mechanical issues
• Live line techniques
• Herbicides
The output of Work Package 1 will be a short report for each of the four areas, summarising the identified IVM approaches in each. An estimate of the cost and pay-back period associated with each identified technique will be provided.

<u>WP2</u>
Work Package 2 will involve assessing each of the techniques and technologies identified by Work Package 1 in the context of SSE’s network and current practices. This will be done through a critical review of each technique and technology accounting for cost, pay back period and compatibility with existing SSE management systems and processes.
The output of Work Package 2 will be to refine the list of techniques and technologies to identify those that have the greatest potential for SSE to consider implementing, accounting for efficiency, cost and pay back time.

<u>WP3</u>
The potentially useful techniques brought forward from Stage 2 will be worked up into a field guide that will enable SSE staff to identify in the field which techniques should be adopted at a particular site, accounting for:
• Cost
• Clearance time
• Reducing risk to supply
A key feature of SSE’s approach to network maintenance is that decisions are made in the field by maintenance staff. The guide must therefore be practical and easy to use, and use flow charts and decision trees to direct SSE staff to the correct decision. These will be backed up by text where appropriate, such as instructions on selecting herbicide type and application method.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Incremental and significant innovation to reduce the incidence of Customer Interruptions (CI’s) and resulting Customer Minutes Lost (CML’s)</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Reduction in Customer Interruptions and Customer Minutes Lost.
Production of field manual to assist operatives in the decision process whilst engaged in vegetation management.</td></tr>
</table>

Expected Timescale to adoption	3 years.		Duration of benefit once achieved		Lifetime of asset. – 40 years
Estimated Success probability (at start of project)	Success probability is expected to be 25% overall on the whole programme of projects.				
PV of Project Costs	£1,019,530	PV of Project Benefits	£1,143,990	NPV of Project	£133,048
Potential for achieving expected benefits	Limited benefits will be realised from this project. New information on herbicide will be useful otherwise limited scope to enhance efficiency.				
Project Progress **March 2009**	Project complete				

2007_11: Trenchless Washover System

Description of project	To develop and trial a system to allow in situ replacement of existing underground cables with new cables.				
Expenditure for financial year	Internal External Total	£30,000 £40,000 **£70,000**	Expenditure in previous financial years	Internal External Total	£30,000 £0 **£30,000**
Technological area and / or issue addressed by project	The replacement of underground cables is usually carried out by open excavation which creates significant disruption, incurs significant cost and has a significant impact on the environment. The general public and business community are increasingly less tolerant of road closures and delays due to infrastructure works.				
Type(s) of innovation involved	Incremental				
Expected Benefits of Project	Benefits are expected to be • Reduction in material sent to landfill • Reduction in costs • Less disruption to public				
Expected Timescale to adoption	3 years		Duration of benefit once achieved		5 years
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£60,441	PV of Project Benefits	£642,551	NPV of Project	£582,110
Potential for achieving expected benefits	Experience with use of washover techniques has shown that by selecting schemes for cable replacement where the washover system can be used, there is significant reduction in costs usually associated with conventional cable replacement.				
Project Progress **March 2009**	Progress is on track with further minor changes to the initial design of the washover head. The cable marker tape mechanism has also been developed to a third version, which is now pulling in tape above the cable in a consistent manner. Development is ongoing.				

2008_01: Supergen 1 - Flexnet

<table>
<tr><td>Project Title</td><td colspan="5">Supergen Flexnet</td></tr>
<tr><td>Description of Project</td><td colspan="5">FlexNet will 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.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £3,000
External £20,000
Total £23,000</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs</td><td colspan="2">£ 7.6M</td><td>Projected 2009/10 costs</td><td colspan="2">Internal £3,000
External £0
Total £3,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Some key questions to be addressed are:
o How can we judge the degree of flexibility needed?
o How can flexibility be achieved?
o How much flexibility should come from primary plant giving margin and how much from secondary plant giving enhanced controllability?
o 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 rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>8</td><td>-1</td><td colspan="2">9</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Each work stream is expected to deliver benefits;
o Shape & Size of Future Electricity Networks will continue to build on the FutureNet scenarios.
o Markets & Investments will investigate some of the economic issues of the electricity market.
o Power System Electronics will investigate why capital cost, cost of power losses and concerns over local network integration result in power electronic systems currently being restricted to voltage control. Smart, Flexible Controls will help network operators to understand the benefits of changing the network operation philosophy and the requirements for its implementation.
o Customers, Citizens & Loads will analyse potential contributions that customers and responsive demand can make towards enabling a more flexible energy system, to identify barriers to this participation and their possible remedies, and to analyse the place-related factors shaping public acceptance of a more flexible network infrastructure.</td></tr>
</table>

	o Validation and Showcase will provide the basis for testing the research outcomes in a representative environment and demonstrating their effectiveness in addressing problems central to the realisation of flexible power networks. o Future Energy Mix will consider possible changes in (UK) energy systems to 2050 and examine the impact of these changes on energy transportation networks. o Future LV Networks will investigate losses through auditing and analysing the relative impact of load-profile, sharing, imbalance and sag on losses. o Education, Deliberative Engagement and Public Acceptance of Future Network will inform many of the social issues and engagement.		
Expected Timescale to adoption	2012	Duration of benefit once achieved	20 Years
Probability of Success	0-20%	Project NPV = (PV Benefits – PV Costs) x Probability of success	£102,000
Potential for achieving expected benefits	The new researchers are now integrated in the consortium and working well. Industrial partners have been providing case studies and data to allow researchers to make specific assessments of technologies. The "validation and showcase" work stream is now producing detailed plans for its crucial role in promoting the benefits. Research topics within FlexNet have been identified as directly supportive of the ENSG 2020 Vision and efforts are underway to create some focused studies on this vision. Similarly, we expect benefits for future distribution network design based analysis of the evolution of demand in the electricity sector and demand side management.		
Project Progress **March 2009**	The Management Executive meets quarterly and receives detailed progress reports. Thirty PhD projects and 20 research assistants have started although slow recruitment means detailed plans have been adjusted in some cases. Good progress has been made on various forms of modelling: energy resource models, transmission system models and distribution planning models. On top of these there are now outputs to support transmission access review and the security and quality of supply standards. Generic approaches to distribution planning for high DG penetration are being advanced and new technologies such as soft normally-open points are being evaluated. Work on demand-side control has reviewed European experience and proposed operational and settlement options for the UK. Researchers on the Future Energy Mix workstream supported the LENS report with techno-economic appraisals and that work is now disseminated.		
Collaborative Partners	EPSRC, National Grid, Scottish and Southern Energy, Central Networks, EDF Energy Networks, Scottish Power Energy Networks, CE Electric UK, and Electricity North West.		
R&D Provider	Universities of Bath, Birmingham, Cambridge, Cardiff, Edinburgh, Manchester, Strathclyde and Imperial College London.		

2008_02: No Interruptions

<table>
<tr><td>Project Title</td><td colspan="3">No Interruptions</td></tr>
<tr><td>Description of Project</td><td colspan="3">The No Interruptions Project aims to investigate methods and technology which can be used to improve the quality of supply to the worst served customers within the LV distribution network which will lead to a reduction in CI's and CML's and also help to secure essential supplies to special needs customers.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £11,000
External £15,000
Total £26,000</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs</td><td>£592,600</td><td>Projected 2009/10 costs</td><td>Internal £5,000
External £2,000
Total £7,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">For rural customers power interruptions by re-closure are an accepted norm. The project aims to reduce the customer impact of these for the elderly and disabled by keeping the lights on during a power cut.

There are several areas which will need to be researched to determine the viability of this project prior to adopting it within SSEPD:

o Identify suitable technology which can be used to provide a supply of energy to consumers when there is a loss of supply.
o Identify the amount of power that the technology can supply in the occurrence of a loss of supply and the expected load and duration that it can supply when this occurs.
o Testing of the equipment to determine the reliability and operational time of the equipment under loss of supply conditions.
o Further development and testing to be undertaken to improve the duration and load that the equipment can handle.</td></tr>
<tr><td>Type(s) of innovation involved</td><td>Significant</td><td colspan="2"><table><tr><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr><tr><td>16</td><td>1</td><td>15</td></tr></table></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">o Financial - Financial benefits will be achieved from the reduction of CIs and CMLs that a customer will experience in a financial year. This reduction will be transferred into a net financial benefit for the company through the IIS.

o Knowledge Transfer - Significant development and transfer of knowledge from existing UPS technology will be required to adopt the current UPS tecnology from a large scale unit to a small scale unit which is not only economical to install and maintain but which can be fitted to the customers supply point within the distribution network.

o Safety - Benefits to the safety of personnel will be achieved from reduced instances of out of hours call outs for fault repairs.

o Environmental - A small increase in environmental benefit can be</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">accredited to the reduced number of instances when mobile diesel generation needs to be connected to the network to restore supplies. Reduced instances of handling generation units will reduce the risk of spillages.

o Network Performance - Significant improvement in CI's and CML's will be a direct benefit of the No Interruptions “Lights On” project by keeping consumers on supply in the event of a fault.

Benefits for customers will consist of increased safety; in terms of the “Lights On” project stage keeping the lights on during power outages will eliminate fire risk from the use of candles and remove domestic hazards resulting from poor lighting (i.e. tripping hazards). The improved service possible from this project will increase customer satisfaction and reduce the distress and anxiety that can be experienced by vulnerable customers during power cuts.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td>Duration of benefit once achieved</td><td>40 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of success</td><td>£274,729</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">The potential for achieving the above expected benefits is high based on the success of the first stage of the project, the “Lights On” trial, which, so far, has succeeded in delivering benefits to participating customers.</td></tr>
<tr><td>Project Progress
March 2009</td><td colspan="3">Stage 1 of the No Interruptions project was the Lights On trial. Initial customer surveys were conducted and combined with SSEPD research into available technologies to determine the best approach, which resulted in the Lights On trial focussing on keeping customers’ lights on with a UPS device.

Project partner, Xi Power, have – and are – providing testing of different technologies and devices to meet SSEPD stated requirements, reflecting customers’ needs.

The Lights On trial, involving 21 domestic customers, has been highly successful and well received, however a low fault rate has resulted in plans to end the trial in April 2009 being scrapped and the trial extended for another year. This will allow a more thorough assessment of the devices used, observing their performance over the winter period.

During summer 2009, maintenance will be undertaken on all the installed devices to aid in assessing the performance of the Lights On trial.

Preliminary work for Stage 2 of the No Interruptions project, “Power On” is now underway, which will aim to provide a solution to keep on several essential services during power outages.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="3">N/A</td></tr>
<tr><td>R&D Provider</td><td colspan="3">Xi Power</td></tr>
</table>

2008_03: IET Power Networks Research Academy

<table>
<tr><td>Project Title</td><td colspan="5">IET Power Networks Research Partnership</td></tr>
<tr><td>Description of Project</td><td colspan="5">The Power Networks Research Academy (PNRA) has been established through a strategic partnership agreement between; the Engineering and Physical Sciences Research Council (EPSRC), electricity transmission and distribution companies, related manufacturers and consultants, that will fund and support PhD researchers in power industry related projects and help maintain and improve the research and teaching capacity in power engineering subjects.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £5,000
External £20,610
Total £25,610</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs</td><td colspan="2">£1,915,014</td><td>Projected 09/10 costs</td><td colspan="2">Internal £5,000
External £37,000
Total £42,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The projects for the first cohort of Academy scholars are:
• Overhead Lines Measurement System
• System Impacts and Opportunities of HVDC Upgrades
• Application of Artificial Immune System Algorithm to Distribution Networks
• Circuit Breaker Condition Monitoring (No scholar recruited)</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant, Technological substitution and Radical innovations</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>9.4</td><td>0.0</td><td colspan="2">9.4</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">It is expected that the Academy will:
• promote a stronger, more active and robust R & D environment in power networks disciplines at UK universities;
• provide capacity and capability to undertake the specialist research needed by industry and wider stakeholders;
• strengthen the teaching capability at those institutions;
• focus on building the health of discipline across a number of power research universities;
• facilitate a resource of trained engineering staff with academic capability, who will be capable of tackling electrical power engineering challenges; and
• deliver research output that is industrially relevant.

See online for further information at:
http://www.theiet.org/about/scholarships-awards/pnra/</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2012 onwards</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of success</td><td colspan="2">£200,000</td></tr>
</table>

Potential for achieving expected benefits	**Overhead Lines Measurement System (Cardiff University)** The OHMS project aims to develop an on-line measurement system of voltage and current to be set up on the high voltage conductors. This will include development of specialised transducers, data acquisition and recording systems and a two-way communication system. It is envisaged that such overall system will be housed in purpose-built unit. Once fully developed the OHMS system will have applications in fault location, protection and control and will be particularly suitable for enhancing Smart Grids objectives. **System Impacts and Opportunities of HVDC Upgrades (Imperial College, London)** The HVDC project aims to establish how HVDC links and networks inset in AC systems could contributed to AC-system stability and enhanced transfer capacity beyond the simple added capacity of the links. The project will offer detailed assessment and quantification of the benefits of supplementary control in raising stability limits and will specifically address robustness to outages of lines and other equipment. **Application of Artificial Immune System Algorithm to Distribution Networks (Manchester University)** The AIS project aims to understand the feasibility of using AIS techniques to assist the detection of weak areas and faults within distribution networks. AIS based techniques will be compared with other techniques (for example neural networks and fuzzy logic) to evaluate any niches for AIS in power systems analysis. The AIS algorithm or methodology developed will assist with the diagnosis of a series of health criterion within the power network. The research will also use AIS data mining techniques to analyse real data to unearth previously hidden correlations, which may assist in the maintenance or operation of distribution networks.
Project Progress **March 2009**	In 2008 four projects for the first cohort of Academy scholars were selected from a number of submissions, using a two tier process. This process comprised; an initial sift to determine the project's industrial relevance and an independent peer review to determine their academic excellence. Scholars were subsequently recruited for three of these projects and a brief summary of the progress achieved to date are detailed below: **Overhead Lines Measurement System (Cardiff University)** A comprehensive survey has been carried out and was used to produce an initial design of the Overhead Lines Measurement System (OHMS) concept. This was summarised in a paper and presented in a poster at the 2nd UHVnet colloquium in January 2009. EDF Energy has provided technical guidance on the use of OHMS for optimising performance on the 11 kV networks. Initial modelling of PLC systems on the 11 kV network has also been carried out using ATP/EMTP software. Laboratory testing of PLC is ongoing and following advice from the magnetics group at Cardiff University group, the simple inductive couplers are being replaced by couplers exhibiting more desirable properties for narrowband PLC.

	Development of a suitable processing unit to integrate different sub-systems (multiple sensors, ADCs and PLC MODEM chips) into one stand-alone device working in real time is a challenge requiring both the development of the microelectronics and laboratory testing taking place concurrently with the sensor and PLC testing. **System Impacts and Opportunities of HVDC Upgrades (Imperial College, London)** The initial phase of the HVDC project has concentrated on developing understanding of the fundamental analysis techniques and tools. Using Power Factory DIgSILENT software (used by NG), a two-area AC system of 4-generators with an embedded HVDC link was modelled. The small signal stability was analysed by evaluating a series of non-linear simulations and modal analysis under various contingencies. Due to the limitations of the software, alternative methods using system identification are being explored to obtain the state-space matrices which will allow for designing controllers to improve the damping of inter-area oscillations. A larger power system with 14-generators, consisting of 5 areas has been developed for similar analysis. **Application of Artificial Immune System Algorithm to Distribution Networks (Manchester University)** A comprehensive survey of research on artificial immune systems (AIS) and their application to power systems problems has been completed. An AIS algorithm to cluster arbitrary data sets and detect groupings has been designed and its performance evaluated using a variety of initialisation methods. An AIS based methodology for detection of overloaded lines and voltage weak buses within power system networks has been designed, while a basic negative selection algorithm to detect critical loading in small power systems has been designed and built. The AIS algorithms have been hybridised with other techniques such as support vector machines to produce a classification algorithm and the performance of AIS algorithms compared with neural networks. Power system network data has been obtained from Central Networks to use for a knowledge discovery experiment, where this will be mined using AIS techniques to find patterns. A paper entitled “Application of AIS Based Classification Algorithms to Detect Overloaded Areas in Power System Networks” has been written and submitted to the 8th International Conference on Artificial Immune Systems 2009 (ICARIS) to be held in York, UK in August 2009.
Collaborative Partners	EPSRC, National Grid, Scottish and Southern, Central Networks & EDF Energy Networks.
R&D Provider	Universities of Cardiff, Manchester, Queens (Belfast), Southampton, Strathclyde, and Imperial College London.

2008_04: Helicopter Mounted PD – Stage 1

Project Title	Helicopter Mounted PD Detection				
Description of Project	To fit the Elimpus Partial Discharge (PD) locator onto a helicopter to enable an aerial survey to be undertaken to reliably detect and locate PD for air insulated high voltage equipment.				
Expenditure for financial year	Internal £3,000 External £6,000 Total **£9,000**	Expenditure in previous (IFI) financial years		Internal £0 External £0 Total **£0**	
Total Project Costs	**£ 200,000**	Projected 2009/10 costs		Internal £3,000 External £30,000 Total **£33,000**	
Technological area and / or issue addressed by project	Detection of incipient faults using partial discharge location equipment mounted on a helicopter.				
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**	
		10	-6	16	
Expected Benefits of Project	Detection of partial discharge from a helicopter will enable proactive measures to prevent faults occurring leading to an improvement in CI/CML performance and a reduction in equipment costs. The abilty to scan open terminal substations during routine overhead line patrols means a low incremental cost will be incurred.				
Expected Timescale to adoption	2 Years	Duration of benefit once achieved		10 Years	
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of success		£195,000	
Potential for achieving expected benefits	The University of Strathclyde and the spin off company Elimpus, have developed ground based systems for locational detection of partial discharges using time of flight systems. One of these utilises an array of aerials contained within a van mounted “roof box”; a size compatible with the aerial separation that might be achieved between the skids of a typical Jet Ranger or Squirrel helicopter employed by DNOs for overhead line patrols. A small feasibility trial was undertaken to asses the viability of a larger IFI project that would entail development of equipment suitable for CAA flight certification.				
Project Progress **June 2009**	The feasibility study has shown that it is practical to fit the Elimpus equipment to a helicopter and a flight trial has demonstrated the ability to detect ground based discharge activity.				
Collaborative Partners	Western Power Distribution, Central Networks				
R&D Provider	Elimpus, University of Strathclyde				

2008_05: Radiometric Arc Fault Location

Project Title	Radiometric Arc Fault Location		
Description of Project	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.		
Expenditure for financial year	Internal £2,000 External £16,000 Total **£18,000**	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Total Project Costs	**£292,000**	Projected 2009/10 costs	Internal £5,000 External £15,000 Total **£20,000**

Technological area and / or issue addressed by project	The principle of the technology is: • There is a correlation between RF discharges and network faults on overhead lines with the RF signal being picked up by a radio antenna up to around 70km away • If antennae are spread across the network, a mesh is formed – in a similar manner to the GSM network If a fault can be accurately clocked, triangulation can be used from a number of base stations to give an approximate geographic location (accuracy ~300m) and linked to GIS / SCADA data to give a more accurate fault location.			
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		9	-2	11
Expected Benefits of Project	If successful, the use of radiometric 'cells' could be used to accurately locate fault locations on all overhead line networks within that zone.			

Expected Timescale to adoption	3 Years	Duration of benefit once achieved	10 Years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of success	£137,242
Potential for achieving expected benefits	The project has achieved a degree of success already and the analysis of the data collected so far is ongoing. As the project has progressed and more 'in the field' experience has been gathered it has become possible to make changes to the equipment setup which allow the sensitivity of the equipment to be increased and data to be gathered more quickly thus increasing the chances of success.		

Project Progress **June 2009**	3 of the 4 monitoring sites have been brought into service: Shotts – Dec 2008; Kirkintilloch and Bellshill Feb 2009, with Dealain House to be brought online in May 2009 (some equipment problems are delaying this last site being commissioned) • All 3 are collecting large amounts of radiometric data, • A number of correlations have been made between SP fault records and the data collected
Collaborative Partners	Western Power Distribution, Scottish & Southern Energy, Central Networks, Electricity North West, CE Electric UK
R&D Provider	University of Strathclyde

IFIT_2007_02: Flow Battery Trial

<table>
<tr><td>Description of project</td><td colspan="5">The provision of standby ac and dc supplies at transmission substation sites have almost exclusively been provided by a combination of generators and lead acid batteries. New technologies are now emerging which may offer superior performance with reduced maintenance and installation costs but to date there has been no operational experience within the UK. An early review of the available options was completed during 2006 as part of an internal innovation initiative and this has suggested that modular flow battery technology is currently one of the most suitable options sufficiently advanced to be considered for a trial installation.

The study will initially comprise an evaluation of existing flow battery technologies and manufacturers to determine any safety or environmental constraints. A contract will be placed with a suitable supplier to provide and install a complete system connected as the standby supply for ac supply. The performance of the battery and control systems will be monitored remotely by a consulting engineering company for a period of one year. Maintenance activities will be recorded and the consultant will produce a report detailing how the unit has performed. The suitability of the technology will be fully discussed and recommendations for future flow battery installations shall also be included.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal
External
Total</td><td>£4,000
£82,000
£86,000</td><td>Expenditure in previous financial years</td><td>Internal
External
Total</td><td>£3,900
£84,000
£87,900</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">There are five main objectives of the study:
1. To establish the suitability of a flow battery for providing substation ac and dc supplies as an alternative to conventional generators and lead acid batteries.
2. Gain operational experience in the operation and maintenance of an established flow battery technology.
3. Test the viability of monitoring conventional and new battery technologies remotely using proprietary software and a data link.
4. Validate the round trip efficiency claims for this type of energy storage device.
5. Determine the economic and operational benefits of using flow battery technology in existing substation asset replacement programmes.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Technological Substitution</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Provision of an alternative standby supply for substations where supplies would traditionally have been provided by either a discreet network connection which may require extensive works to provide the supply. Or from a standby generator installation at site.

Environmental and safety benefits are expected from the deployment of the system due to the outdoor location.

Financial benefits will result in the reduction of construction costs for the building due to the outdoor location of the units.

The deployment of the system will allow a greater insight into other possible applications for the flow battery technology which is used within the PB150</td></tr>
</table>

Expected Timescale to adoption	2 Years		Duration of benefit once achieved		10 Years
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£165,525	PV of Project Benefits	£277,230	NPV of Project	£115,137
Potential for achieving expected benefits	Initial site commissioning and proving runs have produced encouraging data at present which indicates that there is potential for the project to meet expected probability of success which in turn should see the project meet expected benefits.				
Project Progress **March 2009**	Site installation is now complete with final commissioning and proving runs also being completed. A detailed test plan has been developed and agreed with the manufacturers including evaluation of data to determine key performance parameters. This will enable potential applications for the unit to be evaluated within SSE Power Distribution.				

IFIT_2007_03: 275kV Alternative Conductor

Description of project	An overhead line project has been identified which requires a second circuit to be strung to allow for the export of power from the wind farm connections. Planning's request was for 700mm^2 AAAC operating at 50Deg C giving 1240A pre-fault continuous rating (1470A post fault). Tower analysis revealed that the conductor would overload the towers and would have approx. 50 ground clearance issues requiring towers to be increased in height. This proposal is to cover the development of an alternative conductor to reduce the clearance issues and reduce the loading on the towers without decreasing the rating.				
Expenditure for financial year	Internal External Total	£15,000 £79,000 **£94,000**	Expenditure in previous financial years	Internal External Total	£16,400 £130,600 **£147,000**
Technological area and / or issue addressed by project	1) Produce conductor systems and testing specifications and procedure for declaration of conformity for conductors operating at 132kV and above to allow tendering process to take place. 2) Use a consultancy engineering company to advise and carry out study to determine possible currently available conductor options available and provide engineering brief to aid tendering process if a new/novel conductor is required. 3) Identify through tender process a conductor manufacturer able and willing to develop conductor to suit the Project specific data and loading conditions. 4) Conductor manufacturer and fittings manufacturer to produce conductor sample, carry out type testing of conductor, associated insulators and fittings to ensure project specification met. 5) Use a consultancy engineering company to advise and assist with conductor development and to carry out quality control throughout the difference phases of conductor development and testing. 6) Carry out engineering design checks to determine effect of new conductor on the L3 tower suite to identify and include solutions for: ground clearance issues; tower member strengthening; foundation reinforcement requirements.				
Type(s) of innovation involved	Incremental/ Technical Substitution				
Expected Benefits of Project	1) A specification for the procurement of a new conductor will result from a successful output from the project which includes verification of conformity and testing specification. 2) Conductor and fittings manufacturers will be identified for the supply of the conductor and fittings for future use. 3) Upgrading of transmission circuits without the requirement for major infrastructure development is expected. The project will have addressed the issues surrounding ground clearance, tower strengthening and foundation reinforcement requirements along with associated financial cost benefits.				

Expected Timescale to adoption	3 Years		Duration of benefit once achieved		30 Years
Estimated Success probability (at start of project)	85%				
PV of Project Costs	£233,163	PV of Project Benefits	£678,773	NPV of Project	£476,357
Potential for achieving expected benefits	1) This aspect is nearing completion and no issues are expected. 2) Already completed however this will not restrict future tenders. 3) This aspect is not complete but will aid the upgrading process for future projects by identifying best practice for resolving issues. The foundation reinforcement works in particular are difficult to quantify so further assessments may be required to fully develop this area.				
Project Progress **March 2009**	Lamifil are nearing the end of the 625mm^2 AAAC compact conductor testing process. A late change was made to the outer layer of the conductor to resolve the issue of strands opening up when the conductor was under tension running through the proposed wedge clamp. This is being closely monitored to determine if the increase in stranding will solve this issue. A final round of tests to be carried out on the conductor once the final samples have been produced. Testing of the fittings and joints are now completed with no issues identified to date. Type registration paperwork to be provided for final approval and sign off. SSEPD specification SP-PS-363 is in draft format and will be reviewed and updated with a final version authorised and issued following completion of this type registration process.				

IFIT_2007_04: 132kV Trifurcating Joint

Description of project	It is proposed to develop a new 132kV 3 core fluid filled cable to single core polymeric cable trifurcating joint.				
Expenditure for financial year	Internal External Total	£4,000 £54,000 **£58,000**	Expenditure in previous financial years	Internal External Total	£5,900 £89,100 **£95,000**
Technological area and / or issue addressed by project	The manufacture of 3 core fluid filled cables has cease in August 2008 when Prysmian closed the factory at Eastleigh, Hampshire. There are currently two manufacturers providing a joint for this purpose but both joints are very large and require a joint hole about 12 metres long and 3 metres wide. The practicality of installing these joints in built up areas will be very difficult and may entail laying long lengths of cable to find suitable joints bays. The aim of this project is to develop a new joint that can be installed in a much shorter joint bay and use a plug and socket connection for the polymeric cable. Most of the components used in the joint have already been designed and type tested but have not been used in this combination before. The project is to design a suitable joint with the design, testing and manufacture of the joint carried out by G&W in USA.				
Type(s) of innovation involved	Incremental				
Expected Benefits of Project	Development, testing and production of a full specification for the manufacture of a 138kV transition joint for oil filled cable systems to XLPE cable systems. Environmental benefits are expected from the reduction in leakage rates from the oil filled cables in use.				
Expected Timescale to adoption	3 Years		Duration of benefit once achieved		10 Years
Estimated Success probability (at start of project)	75%				
PV of Project Costs	£115,116	PV of Project Benefits	£185,240	NPV of Project	£32,202
Potential for achieving expected benefits	Although there have been minor delays to the progress of this project it is expected to deliver the benefits envisaged at inception.				
Project Progress **March 2009**	The Project has been delayed due to the difficulties in acquiring a suitable length of oil cable. This in turn had an affect on the availability of the testing facilities. The test joint has been made. Testing scheduled for July August 2009. Project completion scheduled for October 2009.				

IFIT_2007_05: Dynamic Sag Monitor

Description of project	There has been growing interest in the use of dynamic ratings for transmission circuits. This is the concept of varying the thermal rating of part or all of a circuit according to the ambient conditions. A number of systems have now been developed varying in complexity from using macro weather data to online dynamic measurements of circuit parameters. This project will assess current available technologies and how these can be integrated within the system operator's display and functional tools. The implications of deploying these systems will be investigated with regards to load management and system planning.				
Expenditure for financial year	Internal External Total	£4,000 £42,000 **£46,000**	Expenditure in previous financial years	Internal External Total	£4,900 £96,000 **£100,900**
Technological area and / or issue addressed by project	o Understand the available technologies for dynamic load monitoring and their capabilities. o Understand the benefits and risks for different parts of the business. o Trial selected technologies and evaluate their performance.				
Type(s) of innovation involved	Incremental				
Expected Benefits of Project	• A review of the currently available technologies. • Determination of how dynamic circuit ratings can be used in control rooms and by planners and the implications. This will include any changes in structure or new information sharing that may be required. • Investigate the benefits and any additional risks associated with dynamic ratings • Investigate how the software associated with different dynamic ratings can be incorporated into SSE network management systems. • Identify a suitable trial site for dynamic circuit ratings and select the dynamic rating system(s) to be used. • Install the dynamic rating equipment and monitor for 12 months. • Evaluate the additional capacity achieved with the equipment. • Make recommendations as to the addition or different modelling planners may have to carry out when developing new parts of the network. • Make recommendations as to how extensively the technology can be used and in what areas of the network. Make an estimation of the resulting savings in capex and opex.				
Expected Timescale to adoption	1-3 Years		Duration of benefit once achieved		2-7 Years
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£152,504	PV of Project Benefits	£197,481	NPV of Project	£48,465

Potential for achieving expected benefits	Data from the Valley Group CAT-1 installations indicates that the system has performed within expected parameters. The system will be developed further to enhance the application of the devices on the network which should lead to the project delivering expected benefits.
Project Progress **March 2009**	Data collection from the installed Valley Group CAT-1 units has continued for a 12 month period with the collected data being used to run models to determine theoretical rating which could have been applied to the circuits being monitored. Data for calibration was also provided from historic load data which was held for the circuits to be included in the modelling. Initial results has shown that increased capacity was available on the circuits under test with further evaluation at present being undertaken The next stage of the project will be to install additional systems on alternative circuits with the installations being developed to give real time information.

IFIT_2008_01: Multi Terminal DC Micro Grid

Project Title	Multi Terminal DC Micro Grid		
Description of Project	The objective is to research a unidirectional dc current link system capable of reliably parallel connecting any number of wind energy electrical sources and transporting that energy as dc to a single dc to ac grid interface converter, which can be based on existing reliable hvdc technology.		
Expenditure for financial year	Internal £6,000 External £0 Total **£6,000**	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Total Project Costs	**£1.258M**	Projected 2009/10	Internal £5,000 External £5,000 Total **£10,000**
Technological area and / or issue addressed by project	Embedded generation, and in particular wind energy, covers a power range from a few hundred Watts to 100's of Megawatts. This project is concerned with the parallel connection of the electrical outputs of wind turbines and the subsequent grid interfacing. The proposed unidirectional dc current link approach involves high power electronics and ac grid interfacing. The novel approach is applicable from the few kW level to GWs.		

Type(s) of innovation involved	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
Radical	9	3	6

Expected Benefits of Project	Initially the technology developed in this project will promote the take-up of small scale embedded generation. Distributed Generation (specifically wind and wave) gain by utilising simpler and cheaper power conditioning and interface equipment. Electricity users gain a more reliable, lower cost electricity supply. Local energy storage offers continuous supply to critical loads during network interruptions. We will benefit from increased embedded generation and being able to ensure that all grid requirements are satisfied.		
Expected Timescale to adoption	6 yrs	Duration of benefit once achieved	40 yrs
Probability of Success	10%	Project NPV = (PV Benefits – PV Costs) x Probability of success	-£88,000
Potential for achieving expected benefits	Standard dc transmission systems are bi-directional hence involve identical converters at both transmission ends. Source end converter bidirectional complexity is to be replace by unidirectional, interleaved, single-end boost converters, incorporating an innner voltage loop and an outer current loop. By using a current source approach, parallel, controllable connection of generating sources is achievable. The key feature of a single-ended approach is reliability, since at 100's of kV, series connection of semiconductor devices does not involve any potential semiconductor short circuit fault paths. This dc concept readily scales and is viable from a few kW to 100's of MWs.		

Project Progress **March 2009**	Good progress has been made and work has started on the development and construction of 100kVA Demonstrator.
Collaborative Partners	Proven Energy Ltd.
R&D Provider	University of Strathclyde

IFIT_2008_02: Western Isles Generation Capacity Studies

Project Title	Western Isles Generation Capacity Studies				
Description of Project	Assess the capability of the existing Western Isles link and identify any potential enhancements to accept additional renewable generation capacity.				
Expenditure for financial year	Internal £2,000 External £55,000 Total **£57,000**		Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**	
Total Project Costs	**£712,000**		Projected 09/10 costs	Internal £5,000 External £50,000 Total **£55,000**	
Technological area and / or issue addressed by project	There may be a need for network reinforcement on the islands of Lewis and Harris stemming from a requirement to provide improved voltage regulation as a result of potential additional renewable generation schemes on the islands. As indicated by network studies, this may need to take the form of distribution connected, fast acting voltage/reactive response devices. SHETL's initial studies confirm the existing voltage regulation on the 132/33kV tap-changers at Ardmore, Harris and Stornoway are inadequate and too slow to support the output changes associated with additional connected generation capacity.				
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**	
		12	-6	18	
Expected Benefits of Project	Successful completion of this project will lead to the connection of additional renewable generation capacity on the Western Isles, allowing exploitation of the vast renewable resource available in this area. This will include releasing the potential for marine development on the west coast of Lewis, where it is currently not possible to offer connections to existing interested parties due to the network's voltage restrictions.				
Expected Timescale to adoption	4 – 6 years dependent on project	Duration of benefit once achieved	Assumed to be 10 years		
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of success	£2,762,987		
Potential for achieving expected benefits	The potential for achieving the expected benefits will be measured against a similar project development on Orkney. Given the high interest in renewable generation on the Western Isles, if the project is successful it is expected that the benefits stated above shall be realised.				
Project Progress **March 2009**	A study has been undertaken by PB Power to assess the capability of the existing network and the report on this is due by July 2009. Once the results are reported the study will be extended to assess the impact of additional generation.				
Collaborative Partners	n/a				
R&D Provider	PB Power				

IFIT_2008_03: Western Isles Cable Studies

Project Title	Western Isles Cable Studies		
Description of Project	Using a test cable installation, this project aims to assess thermal resistivity and environmental impact in peat moorlands.		
Expenditure for financial year	Internal £5,000 External £30,000 Total **£35,000**	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Total Project Costs	**£45,000**	Projected 09/10 costs for SHETL	Internal £5,000 External £15,000 Total **£20,000**
Technological area and / or issue addressed by project	SHETL are seeking to reinforce the transmission system to the Isle of Lewis to accommodate large renewable generation developments. The transmission link will require a HVDC (high voltage direct current) link which is intended to operate entirely on cable circuits, underground and subsea. The cables will cross areas of moorland including extensive areas of peat. Peat is known to be a very difficult substance to work with as it has a poor thermal resistivity when dried out and can "die" when disturbed leading to long term changes in the vegetation. The HVDC cables will run at temperatures of up to 70 ℃ which may exacerbate the drying out process, increasing the thermal resistivity and changing the flora in the vicinity of the cable route. It is also recognised that the installation style, depth and backfill materials could also impact on the hydrology of the peat, again increasing the tendency to dry out. The test installation involves the installation of sections of heating cable, designed to emit heat to match the anticipated losses on the HVDC cable circuit. There are four sections of cable, each installed using different installation methods to allow comparisons to be made. In addition, there are two control sections where the ground has been disturbed but no cable installed. The Scottish Agricultural College have been employed to monitor the effect on the soil and flora. ABB Power Technologies have been employed to provide the necessary heating cable, temperature sensors and expertise in calculating the thermal resistivity. The project aims are: 1. To establish a suitable thermal resistivity for peat moorlands to facilitate cable design. 2. To establish the environmental impact of a cable installation across peat moorlands. 3. To assist in the preparation of method statements to minimise the overall environmental impact.		

Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	Overall Project Score
		12	-4	16

Expected Benefits of Project	It is expected that the project will yield the following benefits: o Assist in gaining consent in areas of environmental designation. o Obtain information that will improve the reinstatement of cable trenches and reduce overall environmental impact. o Assist with the design of cable trenches to minimise cost and environmental impact. o If the test installation results in the selection of a different thermal resistivity then it will be possible to realise savings in the capex cost of the HVDC cable by reducing the required cross-sectional area.		
Expected Timescale to adoption	3 years	Duration of benefit once achieved	40 years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of success	£208,112
Potential for achieving expected benefits	There is a high potential that as a result of this project a lower resistivity can be selected following proof that the peat will not be subjected to a drying out process. As it is difficult to simulate the installation process for full project installation, obtaining information that will improve the reinstatement of cable trenches and reduce overall environmental impact will be less likely. However, given that the project has nonetheless allowed SHETL to demonstrate serious regard of environmental impact in this area, the likelihood of gaining consents has increased, with this benefit already evident as environmental consents are being gained. Work on cable trench design is ongoing but even so indications are the results will be successful in design optimisation.		
Project Progress [March 2009]	On the basis of the project interim report a lower thermal resistivity has been selected. Issues have been encountered in terms of assessing environmental impact as failure of a heating element necessitated revisiting the site to carry out repair works. The disturbance caused has reduced the value of the assessment however the scope has now been extended to trial reseeding areas of unsuccessful reinstatement.		
Collaborative Partners	n/a		
R&D Provider	ABB Power Technologies AB / Scottish Agricultural College		

IFIT_2008_05: Tower Loading Risk Assessment

Project Title	Tower Loading Risk Assessment		
Description of Project	Non intrusive techniques to ascertain the strength and integrity of underground steel and concrete components of overhead tower foundations.		
Expenditure for financial year	Internal £8,000 External £49,000 Total **£57,000**	Expenditure in previous (IFI) financial years	Internal £25,753 External £258,265 Total **£284,018**
Total Project Costs	**£267,429**	Projected 2009/10 costs	Internal £3,000 External £0 Total **£3,000**
Technological area and / or issue addressed by project	Corrosion of steelwork in tower foundations has been a concern for some time as many steel overhead towers are more than fifty years old. The project will investigate the use of non-intrusive techniques to ascertain the strength and integrity of both underground steel and concrete components of the tower foundations of a representative sample of the Scottish and Southern overhead power distribution network. The investigation will be undertaken on the foundations of approximately 120 overhead towers to assess the feasibility of two complimentary techniques: 1. Polarisation Resistance Measurements to obtain an instantaneous value of the steel foundation corrosion rate that is based on the consideration of the electromechanical mechanisms involved in corrosion. These measurements will provide information on the state of the tower foundations and aid in identifying foundations that are most likely to have suffered significant corrosion damage. 2. Transient Dynamic Response to assess the integrity of both pre-cast and cast in situ concrete piles and foundations. The method is based on measuring the frequency and amplitude response of a concrete foundation based on an impulse wave being passed through it The response contains information which is related to the integrity of the concrete foundation. The Transient Dynamic Response techniques have not been used by UK DNO companies to assess tower foundations, but other types of business have found them to be useful for assessing concrete foundations. The project objectives are: o To undertake an initial investigation of 120 overhead tower lines using both techniques. o To assess the feasibility and benefits of using this approach to assess all overhead tower assets. o To analyse the data gained from the site surveys to provide a subset of towers where further investigation is recommended. o To undertake witnessing of tower foundation excavation works where further investigation is recommended. o To provide an assessment of the viability and effectiveness of the use of non-invasive assessments of tower foundations using Polarisation Resistance and TDR. The report on the findings details the severity of		

	any corrosion and/or concrete damage.		
Type(s) of innovation involved	Technological Substitution		
Expected Benefits of Project	Financial benefits are expected to be derived from a reduction in unnecessary works on tower foundations. A reduction in the use of invasive techniques will also prevent reduction in the ground integrity around foundations, which can effectively derate foundations.		
Expected Timescale to adoption	3 Years	Duration of benefit once achieved	25 Years
Probability of Success	50 %	Project NPV = (PV Benefits – PV Costs) x Probability of success	£213,504
Potential for achieving expected benefits	The TDR technique has proven effective in confirming the PRM results for one tower suffering poor construction. However, overall results demonstrate the TDR is not effective in assessing tower foundations. A positive result is anticipated for the PRM results given this technique correctly identified the poorly constructed tower mentioned above, hence the potential for achieving the expected benefits is still high.		
Project Progress **March 2009**	One tower invasive check has been untaken to confirm the TDR and PRM results, giving an initial indication of the success of these techniques. Testing on 120 towers using the TDR and PRM techniques has been completed. The next stage is to conduct invasive testing to confirm the non-invasive test results and assess the effectiveness of the techniques overall.		
Collaborative Partners	None		
R&D Provider	EA Technology		

Appendix 1: Summary Listing of IFI Project Costs

DISTRIBUTION: SHEPD & SEPD

Reference	Project Title	SHEPD		SEPD		SSEPD
		Int	Total	Int	Total	Total Cost
2004_01	STP2 Overhead Network Module	1,800	14,850	4,200	34,650	49,500
2004_02	STP3 Cable Networks Module	1,800	17,550	4,200	40,950	58,500
2004_03	STP4 Substation Module	1,800	13,350	4,200	31,150	44,500
2004_04	STP5 Distr. Energy Resources Module	1,800	17,250	4,200	40,250	57,500
2004_05	PD User Group	900	2,700	2,100	6,300	9,000
2004_06	Protective Coatings Forum	900	2,700	2,100	6,300	9,000
2004_11	ENA Projects	600	3,300	1,400	7,700	11,000
2005_14	Orkney ANM	3,000	25,500	7,000	59,500	85,000
2006_01	SuperGen 5	1,800	9,300	4,200	21,700	31,000
2006_03	LVSure	1,200	15,600	2,800	36,400	52,000
2006_05	Distribution Network Analysis	1,800	1,800	4,200	4,200	6,000
2006_06	Crow Control	3,600	3,600	8,400	8,400	12,000
2006_07	GIS Tree Clearance	10,200	23,453	23,800	54,723	78,175
2006_08	HVSure	1,500	6,300	3,500	14,700	21,000
2007_01	DG and ARM Strathclyde	1,800	14,100	4,200	32,900	47,000
2007_02	PD Mini Monitor	2,700	12,075	6,300	28,175	40,250
2007_03	Self tuning Petersen	1,500	9,300	3,500	21,700	31,000
2007_07	IntelliTeam DA	3,000	30,600	7,000	71,400	102,000
2007_08	Live Line Tree Felling	1,500	5,850	3,500	13,650	19,500
2007_09	Ultra TEV Alarm	900	900	2,100	2,100	3,000
2007_10	Integrated Vegetation Management	1,500	1,500	3,500	3,500	5,000
2007_11	Trenchless Wash Over System	9,000	21,000	21,000	49,000	70,000
2008_01	Supergen 1 - Flexnet	900	6,900	2,100	16,100	23,000
2008_02	No Interruptions	3,300	7,800	7,700	18,200	26,000
2008_03	IET Power Networks Research Academy	1,500	7,683	3,500	17,927	25,610
2008_04	Helicopter mounted PD - stage 1	900	2,700	2,100	6,300	9,000
2008_05	Radiometric Arc Fault Location	600	5,400	1,400	12,600	18,000

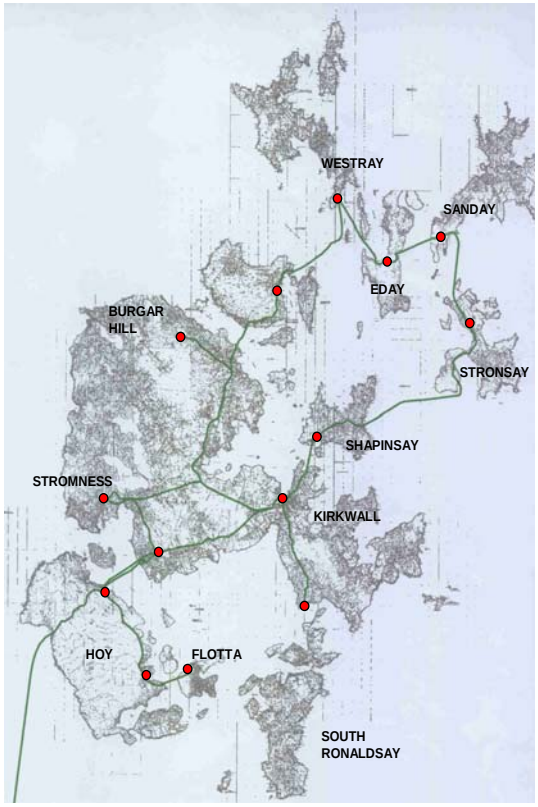
TRANSMISSION: SHETL

Reference	Project Title	SHETL	
		Int	Total
IFIT_2007_02	Flow Battery Trial	4,000	86,000
IFIT_2007_03	275kV Alternative Conductor	15,000	94,000
IFIT_2007_04	132kV Trifurcating Joint	4,000	58,000
IFIT_2007_05	Dynamic Sag Monitor	4,000	46,000
IFIT_2008_01	Multi Terminal DC	6,000	6,000
IFIT_2008_02	Western Isles Generation Capacity Studies	2,000	57,000
IFIT_2008_03	Western Isles Cable Studies	5,000	35,000
IFIT_2008_05	Tower Loading Risk Assessment	8,000	57,000

Appendix 2: Orkney ANM

Background

In recognition of the vast renewable resource that exists in the north of Scotland, the Orkney Isles are the focus of significant activity in the development of generation of electricity from renewable resources. The Orkney distribution network is connected to the Scottish mainland network via two 33kV submarine cables.



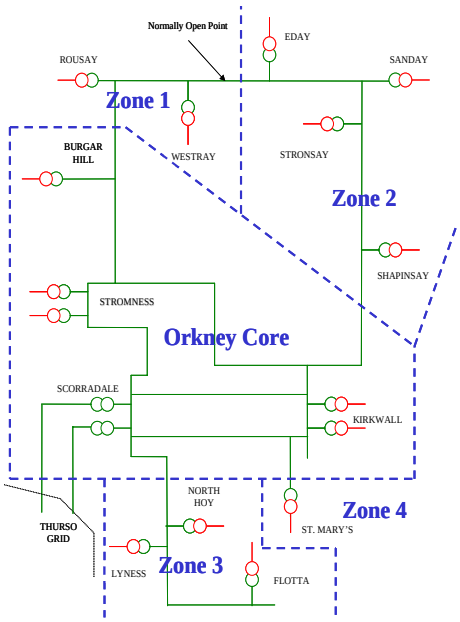
In 2000, the high level of interest in renewable generation on Orkney resulted in the prospective capacity of renewables exceeding the network capacity available under normal planning standards. As conventional reinforcements were uneconomic (namely the installation of a third 33kV submarine cable), non-firm (inter trip) arrangements were offered, however, by 2003/04 the non-firm capacity limits were also exceeded.

To find a solution that would facilitate the increased connection of renewable and distributed generation to the Orkney Isles, Scottish Hydro Electric Power Distribution (SHEPD) and the University of Strathclyde completed a scoping study in 2004. The resulting solution – the application of Active Network Management (ANM) – formed the basis for an application to Ofgem in 2006 to designate Orkney as a Registered Power Zone (RPZ). This successful application paved the way for the trial and detailed design of the ANM scheme, allowing development and application of constraint analysis tools, and necessitating the support and expertise of a spin off company, Smarter Grid Solutions Ltd. (SGS).

In 2007, budget quotations were issued to prospective developers, conditional on developments receiving full planning consent. This requirement was included in the RPZ proposal in order to ensure that the limited capacity available was taken up by developers who were best placed to use it immediately, and was approved by Ofgem.

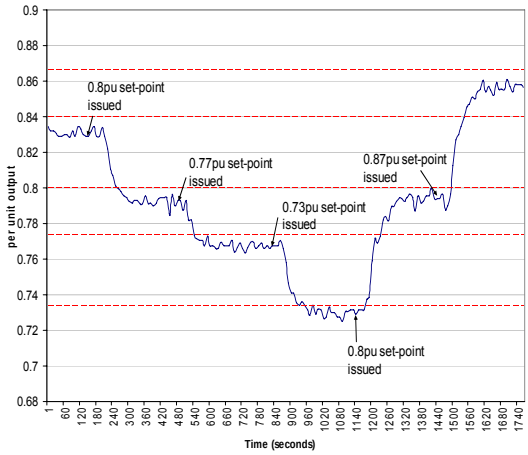
By 2008, the hardware and software systems for the ANM scheme had been developed; the generation developers had obtained consent and were provided with formal quotations.

The Orkney ANM System



The Orkney network is divided into five zones with a thermal limit imposed on the generation output from each, which is managed through real time control systems. To protect the submarine cables connecting the Orkney network to the mainland, there is a limit on the whole Orkney system. Reactive power compensation is already in place to manage voltage levels.

An operational trial was carried out which successfully proved that the ANM system can be used to vary the output of a wind farm in real time. This demonstrated that closed-loop control had been achieved and allowed communications and control logic to be proven.



Currently, SGS are deploying the ANM system on the Orkney Isles for the first two generators. Further schemes are being consented and formal offers issued, with four offers accepted and other acceptances imminent.

Future Development

Progress with the Orkney ANM Scheme has so far yielded the UK's first closed loop trial and aims to result in the UK's first scheme to manage multiple generators, with multiple constraints. The technical performance of the ANM system will be corroborated during 2009.

With good feedback from generation developers and the continued input of SGS, the longer term arrangements for ANM are being considered to ensure effective and optimised operation of the system, and to develop new systems.

Moving forward, SHEPD envisages that the ANM scheme will be applied to other parts of our network, following corroboration of this first scheme on Orkney, and that the experience gained will aid in resolving the commercial issues highlighted by the project.

Appendix 3: IntelliTeam DA

Background

Improvements in quality of supply through reductions in customer interruptions and customer minutes lost can be achieved by using automatic network reconfiguration in the event of a fault on the network. This can be carried out using a number of methodologies and Southern Electric Power Distribution (SEPD) is trialling the next generation of Distribution Automation (DA) technology using IntelliRupter devices embedded in the network with the IntelliTeam distributed artificial intelligence running software to undertake autonomous actions.

High specification peer to peer communications are necessary for the scheme to operate effectively and our pilot scheme is being run on the Isle of Wight to evaluate the performance of these devices to automatically reconfigure the network into isolatable sections in our IntelliTeam DA project.

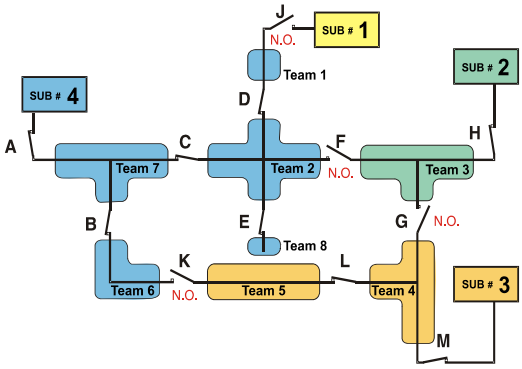
The pilot scheme will evaluate both overhead and underground plant functionality and the interaction on mixed overhead and underground networks.

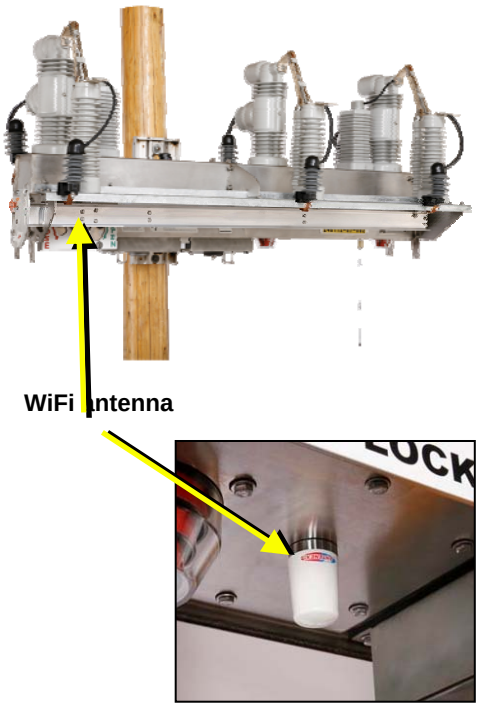
Located on the Isle of Wight, the project will utilise 37 IntelliRupter and 17 Universal Interface Modules and IntelliTEAM II devices. These will be subjected to a one year evaluation to determine actual network improvements, with new features implemented throughout the period.

IntelliTEAM II

Using peer to peer communication technology, IntelliTEAM II, operates at feeder level to improve network restoration times for multiple events using priorities based on line loading or critical customers, without the need for intervention by control engineers.

The demonstration project goes further than ever before with the highest level of IntelliTEAM II devices ever used in one system and allows integration of the feeder circuit breaker located at the substation.





IntelliRupter

Introduced in 2007, the benefits of the IntelliRupter include:

- Tighter control and fitting of application curves, allowing for more devices to be employed in series. By enhancing the communication specification, even more devices can be connected in series.
- Employing the novel technology of “Pulse Closing”, faults are prevented from being introduced back onto the system.
- Through the use of integrated power modules separate power connections are rendered unnecessary.
- Safety and ease of use are improved through the use of WiFi communication for control and operation.
- Pulse Finding allows restoration of systems on loss of communication.
- Software upgrading of the devices can be undertaken remotely.
- Health check and self healing capabilities are provided.

Universal Interface Module

With the Universal Interface Module, existing circuit breakers can be used with the feeder team to allow real time loading information to be measured and used during restoration.

Future Development

This demonstration project is expected to deliver:

- Reduction of restoration times for single and multiple events to less than 3 minutes by using feeder peer to peer communication at 11kV feeder level.
- Fewer customers affected by a fault through better segmentation of feeders, achieved by coordinating a higher number of devices using IntelliRupter and communications.
- Reduction in electrical and mechanical system stresses through Pulse Closing.
- The ability to restore systems on loss of communications.
- Inclusion of existing protection equipment with the peer to peer restoration scheme through the use of Universal Interface Modules.