WESTERN POWER DISTRIBUTION

Serving the South West and Wales

Report on 2009/10 work undertaken under Ofgem Innovation Funding Incentive

Western Power Distribution (South West) plc
Western Power Distribution (South Wales) plc

WESTERN POWER DISTRIBUTION

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(Cover page - Single antennae testing during feasibility trial of helicopter mounted partial discharge detection in Western Power Distribution. Reproduced by courtesy of Professor Phil Moore, Technical Director, Elimpus).

1.0 INTRODUCTION

1.1 Western Power Distribution (South Wales) plc and Western Power Distribution (South West) plc hold electricity distribution licences issued by Ofgem under the Electricity Act (as amended). For brevity, "WPD" is used to refer to both licenced areas in this report.

1.2 During 2004, the Energy Regulator, Ofgem introduced an "Innovation Funding Incentive" (IFI) to encourage Distribution Network Operators (DNOs) to apply innovation in the way they pursue the technical development of their networks. This report describes WPD's IFI activities in 2009/10 and provides additional comments on use of previous research & development (R&D). WPD are required under the IFI scheme to compete a number of pro-forma report sheets, and these are included in Section 6 of this report.

2.0 OFGEM INNOVATION FUNDING INCENTIVE

2.1 The introduction of the Ofgem IFI mechanism in 2004 recognised that the risk/reward balance for research, development and innovation, differed from that applying to normal Distribution Network Operator (DNO) core business. IFI funded projects had to meet eligibility rules set out in Ofgem / DNO agreed documents.

2.2 Qualifying IFI projects have to meet criteria set out in the Ofgem IFI Regulatory Instructions and Guidance (RIG) and a Good Practice Guide which had to be developed by IFI parties and agreed by Ofgem. IFI work is partially funded, on a reducing sliding scale. Whilst DNOs could submit their own individual GPGs, there has been collaboration between DNOs in consultation with Ofgem, and a common GPG produced, as Energy Networks Association Engineering Recommendation G85. which received Ofgem agreement.

2.3 Building on experience gained during these initial projects, the RIGs and GPG were revised, and issue 2 of Engineering Recommendation G85 was issued in December 2007. As a consequence, of this, we have projects in 2009/10 which were commenced under different GPGs, with different definitions and reporting requirements.

2.4 The RIGs published by Ofgem and applicable to the 2006/7 financial year provided the following definition of an Eligible IFI Project:

A project will qualify as an eligible IFI project provided that it is designed to enhance the technical development of distribution networks (up to and including 132kV). Eligible IFI projects will embrace all aspects of distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning.

2.5 The definition of technical development contained in the initial GPG, is as follows -

"In this context:

- "Technical" means "Being of a scientific and/or engineering nature and benefiting the design, construction, commissioning, operation, maintenance and decommissioning of the primary plant and equipment employed in the distribution of electrical energy and/or of the secondary plant and equipment employed to control, protect and maintain such Primary plant and equipment"

- "primary" means "heavy current equipment that carries power currents at voltages from LV up to and including 132kV"

2.6 Issue 2 of "G85" the definition of "technical" was revised as follows -

- Technical means "Being of a scientific and/or engineering nature and benefiting the design, construction, commissioning, operation, maintenance and decommissioning and / or improving the direct environmental interactions of the Primary plant and equipment employed in the distribution of electrical energy, transmission or electrical energy and transmission of gas and / or the secondary plant and equipment employed to control, protect and maintain such Primary plant and equipment"

2.7 Ofgem have -

- established new RIGs with a rolling 5 year commitment to IFI,
- introduced a constant % support rather than a sliding scale reduction

2.8 This 2009/10 WPD IFI report uses the relevant GPG depending on date the project was initiated.

3.0 WPD's APPROACH TO RESEARCH AND DEVELOPMENT

3.1 Having regard to the need for prudent investment and use of resource, WPD's approach is to undertake targeted research on a range of short to medium term projects not having a high cost / high risk profile, normally through collaborative projects or programmes to gain added value and gearing. However, it is sometimes the case that collaboration in more speculative and blue sky research is pursued where the programme content is appropriate and there is very high gearing. The Supergen V EPSRC funded Amperes programme and Meteorological Office lead research on climate change impacts have been examples. It is worthy of note that the Amperes programme was established under different EPSRC qualifying criteria than are now in place. Currently EPSRC focus is on Technology Readiness Levels (TRL) 1-3 where 1 is effectively "blue sky research" with no target development. The current GPG comments that Blue Sky research projects would not normally be considered eligible for IFI unless it can be demonstrated that there is an extremely good potential case and leverage from other funding is sufficiently great that it reduces the risk to the Network Operator to an acceptable and attractive level.

3.2 WPD have, in common with other DNOs, a long association of collaborative research working with EA Technology, Capenhurst, arising from the former Electricity Council Research Centre and the establishment of areas of UK expertise in specific and pertinent spheres of electricity distribution which are of relevance to WPD. Collaborative working has been undertaken with other UK DNOs and overseas partners in Strategic Technology Programme (STP) modules on substation, overhead line and underground cable subject areas. The costs of these are well below the de-minimis £80k per licence holder group as set in the GPG (section 5) for reporting at individual project level; programme level reporting is required.

3.3 In addition to work with EATL, WPD has previously engaged ERA Leatherhead and a wide range of other providers including Universities to undertake specific research work. In April 2005, WPD committed to supporting a large research proposal to EPSCR on Enhanced Management and Performance for a Sustainable UK Energy Infrastructure (Supergen V Amperes project), which was heavily geared and involved collaboration with the Universities of Edinburgh, Liverpool, Manchester, Queens Belfast, Southampton and Strathclyde together with Industrial partners and other UK DNOs and transmission companies. A proposal to renew this strand of work has been declined by EPSRC; it is understood partly because the research was viewed as being too applied, when assessed against current EPSRC criteria.

3.4 WPD recognises that it is sometimes valuable to commission research to provide a platform to facilitate debate on major issues. Examples are -

- The previous environmental life cycle WPD research project on overhead lines and underground cables undertaken by the University of Bath to provide data in support of network loss reduction issues. This project has generated some international interest, further non IFI funded research work and publication of papers.

- The previous WPD initiated research by University of Bath on charging methodologies.

- During 2009/10 collaborative projects through the Energy Networks Association (ENA) involving Engage Consulting on interactions between smart meters and smart grids, and with Imperial College on low carbon economy impacts on networks and the ability to offset these through smart grid actions.

3.5 It is recognised that whilst research can often lead in the long term to real financial benefits, there are also significant benefits to the wider community through -

- network performance - improved reliability and resilience
- environmental - emissions, waste, visual impact etc
- safety to employees and public
- external risk mitigation
- knowledge transfer - acquisition and dissemination of knowledge,
- creation of a platform for debate
- enhancing the quality and relevance of research through direct linkage with industry, development of the available “pool” of expertise, greater exposure of own staff to direct engagement with research activity

4.0 2009/10 PROJECTS

4.1 WPD’s 2009/10 IFI Programme contained the following projects -

EATL STP Module 2 - Overhead Networks
EATL STP Module 3 - Cable Networks
EATL STP Module 4 - Substations
ENA - Fault Level Monitor, Harmonic Modelling & Earthing projects
ENA - Engage Consulting and Imperial College work on smart metering
Met Office - climate change impacts on network resilience
University of Strathclyde - Radiometric arc fault location
Elimpus - Helicopter mounted partial discharge locator

ADAS / Bartlett - Use of Tree Growth Retardant
EATL - Integrated Condition Based Risk Management
Supergen Amperes - final year
WPD Smart Network Trial - final invoicing

Reports on these have been provided by research providers, collaborator partners and WPD, and are included in section 7 below. Additional comments and links to research partner web-sites are provided in the following paragraphs.

4.2 Further information on the EA Technology Strategic Research Programme (STP) can be found on -

www.eatechnology.com/strategictechnologyprogramme

and

www.stp.uk.net

4.3 Met Office research into network resilience and climate change impacts on energy

The collaborative work undertaken with the Met Office in 2009/10 is linked to earlier work on climate change impacts on energy -

In 2006 the Met Office and three leading energy companies launched a pioneering scoping study into climate change and its potential impacts on the UK energy industry. The study was the first nationwide attempt to identify how climate change will affect energy generation; distribution and transmission, and demand. As well as initial indications on how climate change could impact the industry over the next century, it also identified areas where further research was required.

Following the scoping study an industry-funded project (EP2) was set up, involving 11 UK energy companies, focusing on the priorities identified by the earlier study.

Supported by climate scientists, experts from the industry worked together to understand their precise requirements and developed practical applications and business strategies for a changing world.

That work, described in WPD's 2008/9 IFI report, included development of methodology of assessing the effects of various elements of climate change on different types of network assets. The following links provide further background -

www.metoffice.gov.uk/climatechange/buisinesses/casestudies/energy.html
www.metoffice.gov.uk/climatechange/science/projections/

and

http://ukcp09.defra.gov.uk

The new work undertaken by Met Office during 2009/10 commenced with a feasibility study on the ability to model the relationship between historic weather patterns and network fault performance and develop a tool to predict future network resilience. For example, how many HV or LV overhead line faults would be expected for a given wind speed or time of year. As a consequence of the feasibility study the project continued into the full "network resilience" project. The project has considered many millions of historic fault records with national coverage spanning some 20 years. The project is ongoing at July 2010 and initial draft outputs have produced. It provides a baseline to assess changes in network performance due to various elements of climate change.

This project and the earlier work referred to above, is very important in underpinning major elements of responses to a number of current DEFRA and Cabinet Office assessments of climate and natural hazards impacts on energy infrastructure, and providing a platform for statutory reporting on climate change adaptation under the Climate Change Act 2008.

For further information see - www.defra.gov.uk/environment/climate/index.htm

4.4 Collaborative research through ENA on smart meters / smart grids.

Collaborative research by Imperial College into low carbon economy impacts on electricity networks was commissioned via Energy Networks Association (ENA). This considered thermal and voltage limitations arising from a range of stresses including electric vehicles and heat pumps and assessed the degree by which use of smart technology might mitigate these. A copy of the summary report can be found on the ENA website smart meter page -

http://2010.energynetworks.org/smart-meters

Extensive further collaborative research was undertaken by Engage Consulting relating to the use of smart meters as part of a smart grid and included consideration of specification, user cases, traffic analysis etc. Copies of these reports can be found on the same page of the ENA website smart meter page -

http://2010.energynetworks.org/smart-meters

5.0 COMMENTARY ON PREVIOUS PROJECTS

5.1 In respect of previous EATL STP projects, examples of WPD adoption of outputs include -

- CRATER rating software used to update cable ratings and to inform on climate change impacts as part of statutory Adaptation to Climate Change Reporting Duty (ACR)
- Met Office climate change research impacts on assets also used in above ACR
- COST 727 ice loading study will inform future o/h line design requirements and also feeds into above ACR
- Use of new conductors for overhead lines (case study reported last year)
- Alternatives to wood poles study was used to inform response to EU Biocides Directive
- Long rod polymeric insulators - used in WPD specification
- Surge arrester study - used in WPD specification
- High resolution imaging of tower lines - WPD policy revised to use technique as part of Condition Based Risk Management, which is allied to future Ofgem condition reporting requirements

6.0 FORWARD VIEW OF 2010/11 PROJECTS

6.1 In addition to existing committed projects from 2009/10 that run into 20010/11 WPD currently anticipate engagement in projects relating to -

- Full development of CAA compliant helicopter mounted p.d detection by Elimpus in collaboration with Central Networks , Scottish and Southern Energy (South), and EDF Energy South and East Networks, following successful feasibility study in 2009/10.
- A collaborative project by British Geological Survey into earhing modelling and impacts of climate change, currently jointly with Central Networks, though other partners are envisaged.
- A project to investigate development of equipment and software that would permit existing LV MDI CTs to be used with dynamic error correction in smart grid applications.
- Subject to Government decisions on Electric Vehicle charging and “Plugged in Places” bids, work associated with intelligent battery charging at multi-vehicle charging sites.

7.0 PRO-FORMA REPORTS

WPD South West Summary report of IFI Project activities
year ending March 31st 2010

Number of active IFI projects	14
NPV of costs and anticipated benefits from committed IFI projects	NPV of costs - £ 592,046 NPV of benefits - £1,040,002 Positive NPV - £ 447,956 (rounded from information on following sheets)
Summary of other benefits anticipated from active IFI projects	Enhanced asset health condition knowledge to inform future safety, reliability and replacement policy. Establishment of integrated Condition Based Risk Management tool into asset management systems providing for consistent, more transparent, quicker and cheaper derivation of asset condition information for asset management and Regulatory reporting. Provision of timely expert information on climate change resilience impacts on electricity network assets to inform forward investment planning and debate, and respond to UK Government Adaptation Reporting requirements. Reductions in CMLs through improved reliability, resilience and speed. Maintaining or improving safety to the public and staff. Enhanced environmental risk management of oil filled cables. Development of modelling in support of core industry inputs to Government and Ofgem on smart meters and smart grids. Reduction in vegetation management cost / active intervention through use of tree growth retardents.
Total expenditure to date on IFI projects	£0.993 M up to end March 2010
Benefits actually achieved from IFI projects to date	Estimated £2.5M avoided capital cost through use of a novel overhead line conductor, deployed for the first time at 132kV, and, following tower strength assessments to BS EN 50341, needing minimal structural strengthening of existing towers. Knowledge on life cycle assessment carbon impact of 11kV o/h line and u/g cable has already proved valuable in DPCR5 discussion with Ofgem in EWG.

	The Climate Change impact collaborative Met Office project has provided a authoritative, fundamental, consistent industry wide basis for assessing future network rating impacts on the basis of best available forward projections. This work has been a key element of developing Statutory Reports to DEFRA on climate change risk assessment and adaptation reporting under the Climate Change Act, and in responding to Cabinet Office work on network resilience to natural hazards. The CRATER cables rating tool has been used to revise WPD cable ratings, and has also been used in the above development of Statutory reporting on climate change impacts. Similarly, EATL work related to the European COST 727 project on future patterns of ice loading of overhead lines is also contributing into climate change risk assessment. Economic Charging Method for Electricity Distribution Networks completed - Ofgem consulted and approved and now in use. Remote updating of switching schedules rolled out and delivering anticipated benefits in switching time. Changes to equipment specification. Use of high resolution imaging for tower health indices adopted into policy. Development of muti-mode condition monitoring techniques. WPD work on the Pontypool Smart Grid trial has proved valuable in facilitating debate on smart grids and the potential role of smart meters. Experience gained has fed into the development of WPD Tier 1 and Tier 2 Low Carbon Network Fund project proposals. Prior work with EATL on development of Condition Based Risk Management (CBRM) and Health Indices has fed into Distribution Price Control returns, and has formed a platform for the current project on Integrated CBRM, described in this report. Knowledge acquisition and transfer.

Regulatory report for DG incentive, RPZs and IFI
Reporting year 2009/10
Western Power Distribution - South West

Innovation Funding Incentive	**£M**
IFI carry forward (£m)	**0.518**
Eligible IFI expenditure (£m) *	**0.267**
Eligible IFI internal expenditure (£m)	**0.028**
Combined distribution network revenue (£m)	**236.4**
* includes internal expenditure	

WPD South Wales Summary report of IFI Project activities
Year ending March 31st 2010

Number of active IFI projects	14
NPV of costs and anticipated benefits from committed IFI projects	NPV of costs - £ 592,046 NPV of benefits - £1,040,002 Positive NPV - £ 447,956 (rounded from information on following sheets)
Summary of other benefits anticipated from active IFI projects	Enhanced asset health condition knowledge to inform future safety, reliability and replacement policy. Establishment of integrated Condition Based Risk Management tool into asset management systems providing for consistent, more transparent, quicker and cheaper derivation of asset condition information for asset management and Regulatory reporting. Provision of timely expert information on climate change resilience impacts on electricity network assets to inform forward investment planning and debate, and respond to UK Government Adaptation Reporting requirements. Reductions in CMLs through improved reliability, resilience and speed. Maintaining or improving safety to the public and staff. Enhanced environmental risk management of oil filled cables. Development of modelling in support of core industry inputs to Government and Ofgem on smart meters and smart grids. Reduction in vegetation management cost / active intervention through use of tree growth retardents.
Total expenditure to date on IFI projects	£0.993 M up to end March 2010
Benefits actually achieved from IFI projects to date	Knowledge on life cycle assessment carbon impact of 11kV o/h line and u/g cable has already proved valuable in DPCR5 discussion with Ofgem in EWG. The Climate Change impact collaborative Met Office project has provided a authoritative, fundamental, consistent industry wide basis for assessing future network rating impacts on the basis of best available forward projections. This work has been a key element of developing Statutory Reports to DEFRA on climate change risk assessment and adaptation reporting under the Climate Change Act, and in responding to Cabinet Office work on network resilience to natural hazards.

	The CRATER cables rating tool has been used to revise WPD cable ratings, and has also been used in the above development of Statutory reporting on climate change impacts. Similarly, EATL work related to the European COST 727 project on future patterns of ice loading of overhead lines is also contributing into climate change risk assessment. Economic Charging Method for Electricity Distribution Networks completed - Ofgem consulted and approved and now in use. Remote updating of switching schedules rolled out and delivering anticipated benefits in switching time. Changes to equipment specification. Use of high resolution imaging for tower health indices adopted into policy. Development of muti-mode condition monitoring techniques. WPD work on the Pontypool Smart Grid trial has proved valuable in facilitating debate on smart grids and the potential role of smart meters. Experience gained has fed into the development of WPD Tier 1 and Tier 2 Low Carbon Network Fund project proposals. Prior work with EATL on development of Condition Based Risk Management (CBRM) and Health Indices has fed into Distribution Price Control returns, and has formed a platform for the current project on Integrated CBRM, described in this report. Knowledge acquisition and transfer.

Regulatory report for DG incentive, RPZs and IFI
Reporting year 2009/10
Western Power Distribution - South Wales

Innovation Funding Incentive	**£M**
IFI carry forward (£m)	**0.422**
Eligible IFI expenditure (£m) *	**0.267**
Eligible IFI internal expenditure (£m)	**0.028**
Combined distribution network revenue (£m)	**185.5**
* includes internal expenditure	

Eligible IFI Internal costs

The 09/10 IFI year % of internal cost has been 10.4%

- WPD have taken Chair of EATL STP Module 4, resulting in increased internal costs representing other DNO partners

Individual project reports on the following pages

Please note that the financial data stated in the following pages are the totals for WPD South West and WPD South Wales. This data has been apportioned 50/50 in the above summary sheets.

Project Title	**Strategic Technology Programme Overhead Network Module 2 and Forum - 2009/2010**		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £ 5,382 External £47,428 **Total £52,810**	Expenditure in previous (IFI) financial years	Internal £ 8,093 External £86,020 **Total £94,113** NB only some projects span 08/09 and 09/10
Project Cost (Collaborative + external + [DNO])	**£324,785**	Projected 10/11 costs	Internal £ 7,000 External £48,900 **Total £55,900**
Technological area and / or issue addressed by project	The Module 2 programme for budget year 2009/10 aimed to reduce costs and improve performance of overhead networks by increasing understanding of issues that have a negative impact on costs and performance. Several of the projects contribute to the industry's knowledge of variation in climate change. 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 10)** S2126_5 Monitoring conductor temperature at fixed current - Stage 5: Set up two different-sized conductors at same design temperature S2154_3 Experimental investigation of novel conductors at Deadwater Fell - Stage 3: Repeat Vibration tests S2159_2 Low Voltage shrouding - Stage 2: Development of performance criteria S2160_1 Power frequency electrical withstand tests on new and used wood pole S2161_1 Site testing of load-lock anchors **Projects Still in Progress (March 10)** S2126_6 Monitor conductor temperature at fixed current - Stage 6 Monitor Pine and Hazel at same design temperature S2136_5 Measuring and forecasting atmospheric icing on structures - Stage 5: COST 727 in 2009 S2139_2 Evaluation of a new corona discharge camera system - Stage 2: Field trials S2156_2 Build & test three prototype field pole leakage current detectors - Stage 2: Field tests		

<table>
<tr><td></td><td colspan="4">S2164_1 Development of a probabilistic wind and ice map for UK - Stage 1: Project strategy

Updated information can be found at :- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">e.g. Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>12</td><td>8</td><td>20</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects in this module will significantly increase the performance 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 Member DNO to gain benefits including:

• Safe early detection of potential defects that can then be repaired in a planned and timely fashion;

• Cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults;

• A better understanding how overhead line assets perform in service which can be used to determine the overall asset management policy;

• Reduce levels of premature failure of assets;

• 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;

• Reduce lifetime costs by the appropriate use of alternative materials;

• Give Members a better understanding of novel conductors for new-build or re-conductoring lines that gives lower capital cost, minimum visual impact, environmental acceptance.</td></tr>
</table>

Expected Timescale to adoption	Range 1-7 years - dependent on project	Duration of benefit once achieved	Range 3-20 years - dependent on project
Probability of Success	Range 20-100% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£214,148
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 its inception.		
Project Progress to **March 09**	Several projects or project stages started in the module during 09/10 have been completed, but some projects span more than one year.		
Collaborative Partners	Other DNOs		
R&D Providers	EA Technology		

Project Title	**Strategic Technology Programme: Cables Module 3. and Forum (2009/10)**		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £ 4,378 External £56,873 **Total £61,251**	Expenditure in previous (IFI) financial years	Internal £ 4,352 External £105,797 **Total £110,149** NB only some projects span 08/09 and 09/10
Project Cost (Collaborative + external + [DNO])	**£391,415**	Projected 10/11 costs: £398,650	Internal £ 4,400 External £58,600 **Total £63,000**
Technological area and / or issue addressed by project	The STP Cable programme for budget year 2009/10 aimed at maximising any potential benefits as well as to reduce the costs and risks associated with moving to lower carbon network designs. The projects in the programme aim at preventing cable failure modes, improving safety and environmental performance. **Completed Projects Funded in 2009/2010 (March 10):-** S3132_12) Further developments in current ratings - Stage 13: CRATER for cable circuits in tunnels S3132_14 Further developments in current ratings - Stage 14: CRATER for submarine cables S3161_1 Decision making tool for the assessment of long MV and HV cable circuits: Study of issues S3167_1 HV and EHV sealing end failures S3176_1 Mechanical integrity of joints: Desktop study S3182_1 Performance of mains-to-service connectors S3185_1 Safe entry into ducted systems **Projects Funded in 2009/2010 Still in Progress (March 10):-** S3165_1 (REVISED) Performance ageing tests on polymeric terminations S3187_1 Polymeric sealants for ducted cable circuits S3188_1 Leak management of fluid filled cable circuits S3189_1 Setting pressures for pumping in fluid filled cable circuits S3198_1 Thermo-Mechanical Forces in LV Cables S3199_1 Developing an Automatic Update System for a Database of Fluid filled Cables		

<table>
<tr><td></td><td colspan="4">S3202_1 Performance Evaluation of Plastic Smoothed Walled and Corrugated Ducting Installed in Trefoil Formation: Creation of Test Rig and Testing</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">e.g. Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>7.5</td><td>20.5</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:

• Reduce risk in environmentally sensitive areas;
• A reduction in the number of accidents / incidents so increasing safety of staff and the public;
• Reduce excavation required in locating leaks from fluid-filled cables, reduce the times and costs of leak location, and also reducing outage times;
• A reduction in digging, causing less disruption to the public, reducing impact on the environment and avoiding disposal of soil to landfill;
• Offset future increases in CAPEX and OPEX;
• CI/CML savings per connected customer;
• Reduce cable purchase costs;
• Enforce Network resilience;
• Implement strategies for reducing cable failures, resulting from excessive forces;
• Reduction in number of cable faults;
• Reduce design costs.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Range 1-2 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 2-5 years - dependent on project</td></tr>
<tr><td>Probability of Success</td><td colspan="2">Range 54-96% - dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£122,659</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 its inception.</td></tr>
<tr><td>Project Progress to March 10</td><td colspan="4">Most projects or project stages started in the module during 09/10 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>

Project Title	**Strategic Technology Programme: Substations Module 4 and Forums 2009/10**		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £10,412 * External £50,150 **Total £60,562**	Expenditure in previous (IFI) financial years	Internal £11,578 External £77,303 **Total £88,881** NB only some projects span 08/09 and 09/10
Project Cost (Collaborative + external + [DNO])	**£333,612 (09/10)**	Projected 10/11 costs: £332,896	Internal £10,000 External £51,500 **Total £61,500**
Technological area and / or issue addressed by project	The STP Substations programme for budget year 2009/10 aimed at maximising any potential benefits as well as reducing costs and risks associated with moving to lower carbon network designs. The projects look at increasing reliability, optimising design, improving safety and reducing cost. * WPD provided Chairmanship for this Module resulting in higher internal costs **Completed Projects Funded in 2009/2010 (March 10):-** S4178_3 Extension of Trials: Impedance Testing of Substation Batteries S4181_4 Ongoing Programme Of Transformer Post Mortems 09/10 S4185_6 Asset Managers' Forum Membership 09/10 S4203_2 INSUCON Proceedings May 2009 S4234_2 Ferroresonance Seminar: Information Dissemination S4236_2 Extension of Trial of Aquagen® Recombination System S4238_2 Module 4 Information Dissemination: 09/10 S4252_1 Transformer OLTC Contact Wear Indication Techniques S4253_1 Plant Failures and Fire; the Release of Hazardous Emissions S4256_1 BATTCON 2009 S4262_1 Researching new Techniques for Optimising Battery Maintenance: Project Workshop **Projects Funded in 2009/2010 Still in Progress (March 10):-** S4164_7 Tap changer monitor stage 7: Modifications Based on Trial Experiences S4193_3 Switchgear Type Reference, Risk and Reliability		

<table>
<tr><td></td><td colspan="4">S4240_1 (REVISED) Scoping Project: Protective Devices and Technologies for Sealed Distribution Transformers

S4243_1 Commissioning and Testing Procedures for LV / HV Switchgear & Transformers

S4246_1 X/R Performance of Oil Circuit Breakers

S4248_1 Protection Testing and Maintenance Practices

S4249_1 (REVISED) Development of a SF6 Environmental Management Document: Including Review of Testing Methods and Equipment

S4254_1 Applied Research and Development of Tap Changer Maintenance Systems and Services: Standards & Design Review

S4254_2 Applied Research and Development of Tap Changer Maintenance Systems and Services: Modifications & Spares

S4259_1 Non Intrusive Volatile Gas Analysis of Oil Filled Switchgear</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">e.g. Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>16.5</td><td>9.5</td><td>26.0</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 substations in distribution networks in line with government policy.

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:

• Reviewing global developments in battery technology, test equipment, procedures and practice to ensure a safer and more reliable network;
• CI/CML savings per connected customer;
• Optimise safety and environmental requirements for management of SF_6;
• Liaison with International Utilities to share new technology and failure modes;
• Offset future increases in CAPEX and OPEX;
• Preventing failures of oil-filled equipment, tapchangers, earth switches increasing safety and avoid unnecessary scrapping of serviceable components will alleviate environmental impact;
• Extend serviceable life of switchgear and transformers;
• Further develop technical understanding of operational staff in complex electrical issues;
• Mitigate risk to environment;
• Increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
</table>

Expected Timescale to adoption	Range 1-4 years - dependent on project	Duration of benefit once achieved	Range 1-7 years - dependent on project
Probability of Success	Range 15-95% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£86,102
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 its inception.		
Project Progress to **March 10**	Most projects or project stages started in the module during 09/10 have been completed, but some projects span more than one year.		
Collaborative Partners	Other DNOs		
R&D Providers	EA Technology		

<table>
<tr><td>Project Title</td><td colspan="4">Investigation of use of Tree Growth Regulators (TGRs)</td></tr>
<tr><td>Description of Project</td><td colspan="4">The project proposes to investigate the effect of the plant growth regulator paclobutrazol (PBZ) on tree vitality and growth rates. Six field trial sites have been established, supported by thirteen observational sites throughout the UK to represent a diverse range of bio-climatic zones. There are two sites in each of the participating network operator’s licence areas. Tree species selected for PBZ evaluation were selected to represent those that occur commonly on or near overhead networks.</td></tr>
<tr><td rowspan="3">Expenditure for Financial Year</td><td>Internal</td><td colspan="3">£ 2,172</td></tr>
<tr><td>External</td><td colspan="3">£53,495</td></tr>
<tr><td>Total</td><td colspan="3">£55,667</td></tr>
<tr><td>Expenditure in Previous (IFI) Financial Years</td><td colspan="4">New Project 2009/2010</td></tr>
<tr><td>Total Project Costs (Collaborative + External</td><td>£715,000</td><td>Projected 2010/11 costs</td><td colspan="2">External £17,600
Internal £ 500
Total £18,100</td></tr>
<tr><td>Technological Area and/or Issue Addressed by Project</td><td colspan="4">Rate of vegetation growth and use of Tree Growth Regulators to reduce maintenance costs</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>Overall Project Score</td></tr>
<tr><td>15.4</td><td>-2</td><td>17.4</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected outputs from the project will be data and information on the effect of PBZ on tree growth rates across a range of species and bioclimatic areas. This data will comply with ORETO experimental requirements and will be used to apply for a licence for the use of PBZ for utility vegetation management.

PBZ could then be used as part of utility vegetation programmes to reduce growth rates on restricted cut sites and reduce overall vegetation management costs. This would also reduce the disturbance to landowners and the high costs of returning each year to maintain clearances from locations where only a restricted cut is possible.</td></tr>
<tr><td>Expected Timescale to Adoption</td><td>Adoption in 2013</td><td>Duration of Benefit Once Achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">>£1.0m</td></tr>
</table>

Potential for Achieving Expected Benefits	The purpose of the first year's measurements was to demonstrate whether over application of PBZ and subsequent phytotoxicity of leaf material occurred. No statistically significant difference was found between PBZ treated and control trees, which indicates that there were no phytotoxic symptoms in leaf tissue during the 2009 growing season. Supplementary data from each of the 13 observation site supports this conclusion. Consequently, all objectives stipulated in the year 1 IFI Research Project, The effects of Tree Growth Regulators (TGRs) on Fast Growing Trees and Application to Utility Arboriculture have been achieved. In addition, no particular factors can be foreseen which would result in delays in the achievements of any of the stated objectives in the original research proposal. Measurements in subsequent years will investigate the potential for reduction in utility tree growth rates.
Project Progress **June 2010**	Six field sites and thirteen observational sites have been set up and PBZ applied at recommended dosage rates. Initial observations have indicated no phytotoxic effects. The work has been set up to meet ORETO research guidelines. An audit carried by ADAS compliance team confirmed that the experiment complies with these guidelines. The project is scheduled to continue, with sampling and analysis over 5 years to September 2013.
Collaborative Partners	Scottish and Southern Energy WPD CE Electric Central Networks EDF Energy Networks
R&D Provider	Bartlett Tree Experts, ADAS

ENA R&D Programme 2009-10

<table>
<tr><td>Project Title</td><td colspan="6">Collaborative ENA R&D Programme 2009/10</td></tr>
<tr><td>Description of project</td><td colspan="6">The Energy Networks Association (ENA) represents all UK DNOs & National Grid. The project listed below has been initiated by the ENA R&D Working Group and has been funded through the IFI.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>FLM</td><td>HIM</td><td>Earthg</td><td>CC</td><td>SM</td></tr>
<tr><td>Internal</td><td>£0</td><td>£0</td><td>£1,722</td><td>£1,481</td><td>£6,187</td></tr>
<tr><td>External</td><td>£0</td><td>£0</td><td>£5,400</td><td>£6,994</td><td>£0 *</td></tr>
<tr><td>Total</td><td>£0</td><td>£0</td><td>£7,122</td><td>£8,475</td><td>£6,187</td></tr>
<tr><td colspan="6">* Invoicing for this work circa £25k will fall in 2010/11</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td colspan="4">£ 2,400 £0 £ 392</td></tr>
<tr><td>External</td><td colspan="4">£ 9,225 £8,997 £6,324</td></tr>
<tr><td>Total</td><td colspan="4">£11,625 £8,997 £6,716</td></tr>
<tr><td>Total Project Costs (Collaborative + external + WPD</td><td colspan="2">FLM £190,000
HIM £ 62,982
Earthg £ 28,722
CC £ 28,001</td><td colspan="2">Projected 2010/11 costs</td><td colspan="2">Earthg - £7,125 proposal only
CC - new project
SM £25,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">The projects listed below address real issues which have been identified by the ENA Working Groups as significant requiring technical investigation and development:

- Fault Level Monitor (FLM) - The objective is to develop a device that 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 be accurately correlated to a true network fault level for that location, providing near-real-time information to network control and planning engineers alike.

- Harmonic impedance modelling (HIM) - The project addresses the detailed modelling of cable and overhead line components, to develop cable models appropriate for distribution networks.

- Earthing Project - The aim is to develop new techniques to assess the impact of lower voltage earth electrodes on higher voltage ‘hot zones’ and to measure the resistance of distribution substation earth systems.

- Climate Change and Network Resilience Project (CC) - The objective of this project is to investigate whether the electricity (both transmission and distribution) networks’ risk to weather-related faults may change in the future as a result of climate change.

- Smart metering studies (SM) - ENA commissioned Engage Consulting Limited to undertake a comprehensive analysis of Networks" requirements for a smart metering system for electricity and gas.</td></tr>
</table>

<table>
<tr><td></td><td colspan="4">This project was split into 4 workstreams:

Ws 1 - ENA Smart Metering System Requirements
Ws 2 - Development of Appropriate Use Cases
Ws 3 - Performance Standards & Communication requirements
Ws 4 - Privacy & Security Considerations

A study was also carried out by Imperial College London to look at at the benefits of advanced Smart Metering for Demand Response based Control of Distribution Networks.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental innovation</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Fault Level Monitor:
The key output from this work was to ensure that the FLM is capable of delivering an assessment of both the source and motor infeed elements of fault level.

Harmonic impedance modelling:
The expected benefit of this project is the development of an Engineering Technical Report (ETR) type guidance note to supplement G5/4 (2001) and help reduce and simplify modelling requirements for relatively small capacity 33kV connections.

Earthing Project:
The expected benefits of this project are:
- To develop a test method of correctly calculating and measuring HV to LV transfer potentials and to consolidate this in standards via case study examples and simplified methods.
- To develop methods of calculating the earth return current that creates a voltage rise when cable circuits are used - particularly newer XLPE/Triplex/EPR cables for which there is no guidance in the standards.
- To develop safer and more cost effective substation earthing designs.

Climate Change and Network Resilience Project:
The result of this project and subsequent benefits will inform Licensee's strategy with regard to IIP performance incentives which impact on Price Controls, system planning studies and operational preparedness for extreme weather events.

Smart metering studies:
Analysis work by Imperial College into the expectation of demand increases due to the penetration of Electric Vehicles and Heat Pumps and impact on the network and the benefits of a smart grid.
The expected benefits include;

- To characterise and model demand response technologies including electric vehicles, smart domestic appliances, heat pumps and other electricity and storage based heating systems;</td></tr>
</table>

	- To develop appropriate network simulation models and future development scenarios to assess the impact of demand response technologies on the operation and design of future electricity distribution networks; - To carry out comprehensive impact assessments of smart grid technologies on future UK distribution networks under selected future development scenarios, focusing on potential savings in distribution network infrastructure requirements and while quantifying the impact on network losses and associated CO2 emissions. Smart metering and communication requirements by network operators to facilitate a robust smart grid for the future. This work was carried out by Engage Consulting Ltd and the expected benefits include development of - ENA requirements for electricity and gas networks and the future needs of smart grids into a focused set of Smart Metering - System Requirements - Appropriate Use Cases - Performance Standards & Communication Requirements - Privacy and Security Considerations		
Expected Timescale to adoption		Duration of benefit once achieved	
Probability of Success		Project NPV (Present Benefits – Present Costs) x Probability of Success	
Potential for achieving expected benefits	**Fault Level Monitor:** This specific work with EATL is now complete. No expected benefits. **Harmonic impedance modelling:** TNEI have completed the study and have provided three reports. Report 1. - Underground Cables and Overhead Lines Report 2. - Development of Network Reduction Methodology Report 3. - Stage 3A Methodology Using the output from the study reports work is currently ongoing to develop an ETR guidance document that will support ER G5/4 and help reduce and simplify modeling requirements for relatively small capacity 33kV connections. **Earthing Project:** The potential for achieving the expected benefits is very high and it is expected that they will be delivered in the summer of 2011. **Climate Change and Network Resilience Project:** The potential for achieving the expected benefits is very high and it is expected that they will be delivered in November 2010.		

	Smart metering studies: The potential for achieving the expected benefits is very high and it is expected that they will be delivered over the next three years under the auspices of the ENA Energy Networks Futures Group.
Project Progress **March 2010**	**Fault Level Monitor:** The results of the test carried out on the FLM show that it is capable of delivering an assessment of both the source and motor infeed elements of fault level. During the study It was identified that the EATL FLM was based on a hardware platform which is obsolete and no longer supportable. Stage 2 of the work carried out in conjunction with University of Strathclyde was intended to develop a new FLM. The report produced by EATL recommended that consideration should be given to the need to carry out further development of a new platform to collect and analyse the disturbance data. No further ENA collaboration work is anticipated on the EATL FLM. **Harmonic impedance modelling** Ongoing development of the proposed ETR including the addition of the Stage 3A methodology assessment to be included in Engineering Recommendation G5/4. **Earthing Project:** There are three parts to the project: - The first was to develop and test a method of correctly calculating and measuring transfer potentials. This has been achieved and further calculations are underway to consolidate this in standards via case study examples and simplified methods. It has already been used at several DNO sites to facilitate safe designs for a large housing development and commercial office complex. - The second part is to develop methods of calculating the earth return current that creates a voltage rise when cable circuits are used – particularly newer XLPE/Triplex/EPR cables for which there is no guidance in the standards. Methods have been developed under the project and satisfactorily deal with more than half of the 11kV cables required. Work is now starting on the remaining cables and their characteristics will be introduced into the already developed Excel routines. These will then be used in national standards. - The third part is to develop safer and more cost effective substation earthing designs. Again this work has proceeded to plan. These are to be further standardized during the next stages of the project. **Climate risk assessment on future network resilience:** Current work is focussing on quantifying the networks' baseline risk to climate. This has involved using statistical techniques to formalise the relationship between historical weather-related faults and weather patterns. A report detailing the networks' baseline climate risk will be issued at the end of June 2010. Following completion of this report, work will be undertaken to understand how the occurrence of faults may change in the future using data from the Met Office's regional climate model and the statistical relationships between fault and weather.

	Smart metering studies - Engage consulting: The first report on the output and progress of this project is available on the ENA Web site at the following link http://www.energynetworks.org/ena_energyfutures/ENACR006-002-1-1_Requirements_100412.pdf Further work will be carried out during 2010 -2011 **Smart metering studies - Imperial college:** The first report on the output and progress of this project is available on the ENA Web site at the following link http://www.energynetworks.org/ena_energyfutures/Smart_Metering_Benerfits_Summary_ENASEDGImperial_100409.pdf Further work will be carried out during 2010 -2011.
Collaborative Partners	National Grid, SP Energy Networks, Scottish and Southern Energy, Electricity North West, Western Power Distribution, Central Networks, CE Electric UK and EDF Energy Networks.
R&D Providers	TNEI, Engage Consulting limited, Imperial College London, Met Office, EATL, Earthing Solutions, SEDG

WPD SMART NETWORK TRIAL - Pontypool

<table>
<tr><td>Project Title</td><td colspan="5">Smart Network Trial</td></tr>
<tr><td>Description of project</td><td colspan="5">To equip all HV/LV pole and ground mounted distribution s/s fed from one 132/66/11 kV primary s/s, with measurement facilities to capture loading information and communicate back into WPD corporate systems including ENMAC scada.</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£0</td><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td>£ 53,100</td></tr>
<tr><td>External</td><td>£11,850</td><td>External</td><td>£ 44,000</td></tr>
<tr><td>Total</td><td>£11,850</td><td>Total</td><td>£ 97,100</td></tr>
<tr><td rowspan="3">Project Cost (Collaborative + external</td><td colspan="2" rowspan="3">£108,950</td><td rowspan="3">Projected 10/11 costs for WPD</td><td>Internal</td><td>£0</td></tr>
<tr><td>External</td><td>£0</td></tr>
<tr><td>Total</td><td>£0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">To trial and demonstrate acquisition of measurement quantities from existing legacy main network equipment, monitor and communicate back to WPD corporate IT systems including ENMAC scada system. The project work contains the following elements -

• Selection of appropriate readily available hardware units for monitoring, metering, communicating, and housing.
• Developing risk assessed installation techniques covering a wide range of legacy distribution system assets to which the above will be fitted
• Establishing communication links to a WPD data server
• Monitoring meter outputs / communication path continuity
• Provide rapid loss of supply indication
• Assessment against existing apportionment and modelling approaches</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Technological substitution from different application</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td></td><td>11</td><td>0</td><td colspan="2">11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• Enhanced Network Utilisation - savings to Customers
• Facilitating active network management, to deliver the management of substantially increased intermittency associated with expanded distributed generation, demand side management and wider use of electric vehicles
• Providing ready connections and comms link for distribution substations to be used as data aggregation hub for two way data collection / control of domestic smart meters
• Providing the data required for site specific cost benefit analysis of loss reduction measures, such as early replacement of higher loss distribution transformers
• Providing monitoring of voltage, power factor and harmonic content, leading to maintenance / improvement of power quality
• Enhanced speed of outage detection</td></tr>
</table>

Expected Timescale to adoption	1 year	Duration of benefit once achieved	40 year main equipment, 15 years technology refresh
Probability of Success	50%	Project NPV	£45k
Potential for achieving expected benefits	Utilisation and loss reduction benefits already demonstrated. The extent of use of the installations as part of active network management will be influenced by Government decisions on domestic smart meters, and initiatives for management of intermittency, and WPD are actively engaged in this debate.		
Project Progress **June 2010**	Technology & trials: The project was initiated in December 2008 and installations completed by 5th February 2009 with all data successfully flowing and assessed by 13th March 2009. Data display via Enmac demonstrated. A proposal for wide scale roll out was developed and a number of presentations and demonstrations been provided to senior staff of Ofgem DECC and the Energy Minister Lord Hunt (Autumn 2009). The subsequent development by Ofgem of the Low Carbon Networks Fund has now lead to the development of further LCNF Tier 1 and Tier 2 projects which draw on the experience gained in this IFI trial. The costs incurred in FY 2009/10 relate to FY 2009/10 invoicing (hence not included in the 2008/9 IFI costs) by EATL for work undertaken during 2008/9 and statistical analysis relating to errors on LV MDI CTs.		
Collaborative Partners	None for this demonstration trial. Collaborative LCNF projects have been developed.		
R&D Provider	EATL - work on statistics of CT accuracy.		

Radiometric Arc Fault Location

<table>
<tr><td>Project Title</td><td colspan="5">Radiometric Arc Fault Location</td></tr>
<tr><td>Description of project</td><td colspan="5">Applied research, and follow up installation of a system to triangulate fault locations on overhead lines from the high frequency radio wave signatures produced from an arcing fault.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £0
External £7,700
Total £7,700</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £ 1,213
External £15,950
Total £17,163</td></tr>
<tr><td>Project Cost (Collaborative + external + DNO</td><td colspan="2">£292,000</td><td>Projected 10/11 costs</td><td colspan="2">Internal £1,000
External £3,000
Total £4,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The principle of the technology is:
There is a correlation between RF discharges and network faults on overhead lines with the RF signal being picked up by a radio antenna up to around 70km away.
If antennae are spread across the network, a mesh is formed - in a similar manner to the GSM network.
If a fault can be accurately clocked, triangulation can be used from a number of base stations to give an approximate geographic location (accuracy ~300m) and linked to GIS / SCADA data to give a more accurate fault location.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">If successful, the use of radiometric ‘cells’ could be used to accurately locate fault locations on all overhead line networks within that zone.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="5">25%</td></tr>
<tr><td colspan="4">Project NPV (Present Benefits x Probability of Success) - Present Costs</td><td colspan="2">£45,787</td></tr>
<tr><td>Project Progress
June 10</td><td colspan="5">All 4 monitoring sites have been installed but due to ongoing hardware problems involving the supplier of industrial PCs, there has not been a sufficiently sustained period of simultaneous operation of all 4 stations to provide incontrovertible proof of the technology.

Using the 4 monitoring stations it has been possible to simultaneously detect at 3 to 4 monitoring stations the radiometric discharge from lightning strikes throughout the summer months of 2009. Using this data it was possible to test the ability to accurately locate the origin of the lightning by comparing the originating locations obtained using the time of arrival data gathered from the monitoring stations with the locations of the lightning strikes given in commercially available data used by Scottish Power. It was found that the range of the monitoring stations for this type of data covered a 50km x 50km square with the monitoring stations located in the middle of this square and that the locations calculated using the TOA data gathered by the radiometric monitoring system compared well with the locations given by the commercially available data. Two of these lightning strikes concurred with faults listed in the SP fault record. This has resulted in a conference paper that has been accepted for publication.</td></tr>
</table>

	Two 11KV o/h line faults were detected at the Shotts monitoring station in September 2009. It is theorized that the other stations were not able to detect this event as the signal would have decayed during propagation to a level too small to be detected. Following a review of the system performance in December 2009, a decision was made to design and install RF bandpass filters at all stations on the basis of a site survey of the signal spectrum. This was completed in May 2010 and has allowed the station sensitivities to be increased by factors of between 5 and 10 because of reduced noise and interference.
Potential for achieving expected benefits	The technology itself has good potential for providing the expected benefits. There is evidence of its capability in relation to lightning strikes and single-station detection of faults before filters were installed to improve sensitivity. It is hoped that the significant reduction of background noise achieved at the Bellshill and Shotts sites using filters will increase the likelihood of picking up sferic signals that may have been too weak to detect previously. The provision of 4 surplus PCs by SPEN will allow better onsite analysis of the data. The aim is to be able to identify and discard irrelevant data so that signal captures of interest can be focused upon, resulting in a more efficient system. The possibility of performing some controlled experiments to detect discharge sferics from 132kv switches is being investigated. Two issues remain to be addressed before a proper period of testing can take place: • The first of these is the return to 4 working stations with reliable hardware. • The second is to automate the analysis of RF signals at the stations. This must presently be carried out as a time-consuming manual process that prevents a quick response to system faults. Discussion is taking place between the collaborative partners and the University in relation to 2010/11 funding.
Collaborative Partners	Western Power Distribution, Scottish & Southern Energy, Central Networks, Electricity North West, CE Electric UK SPEN
R&D Providers	University of Strathclyde

INTEGRATED CBRM

Project Title	**Integrated Condition Based Risk Management (CBRM)**		
Description of project	Development of integration of CBRM models into asset management processes and IT systems to provide routine access to CBRM for use in future asset management and regulatory reporting.		
Expenditure for financial year	Internal £ 22,188 External £232,166 **Total £254,354**	Expenditure in previous (IFI) financial years	Internal £nil External £nil **Total** £nil
Project Cost (Collaborative + external + DNO	**£404,188**	Projected 10/11 costs	Internal £ 25,000 External £102,898 **Total £127,898**
Technological area and / or issue addressed by project	EA Technology (EATL) have previously worked with Western Power Distribution on developing Condition Based Risk Management (CBRM) models for a range of asset groups, with the exception of overhead lines. The models are however not integrated with each other, nor are they directly linked to WPD's asset databases. This results in high levels of expertise and extended durations being required to populate and subsequently refresh the CBRM models. Recent developments in Ofgem reporting requirements have resulted in a requirement for routine, consistent reporting of CBRM Health Indices and ageing. WPD invited EATL to develop a CBRM integration package that would develop a novel, new woodpole overhead line model and existing CBRM systems to a common platform, integrated with WPD's existing IT infrastructure. Due to the nature of the project it has been divided into a number of stages. 1 Integrated CBRM for Grid Transformers incl general review to confirm risk model for all subsequent asset groups) 2 Integrated CBRM for Switchgear & Distribution Transformer 3 Integrated CBRM for cables 4 Integrated CBRM for (wood pole) Overhead Lines incl Pole mounted transformers, pole mounted switchgear		

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

Expected Benefits of Project	Faster, user friendly and consistent provision of CBRM outputs for asset management and Regulatory Reporting. Reduction of risk by hard connection between systems via reduction in manual intervention and capturing existing highly skilled knowledge.		
Expected Timescale to adoption	1 Year	Duration of benefit once achieved	5 Years
Probability of Success	90%		

Project NPV	(Present Benefits x Probability of Success) - Present Costs	£523,000
Project Progress **June 10**	Stages 1, 2 and 3 described above undertaken and in test.	
Potential for achieving expected benefits	Very high	
Collaborative Partners	Western Power Distribution.	
R&D Providers	EA Technology	

HELICOPTER MOUNTED PARTIAL DISCHARGE DETECTION - FEASIBILITY TRIAL

<table>
<tr><td>Project Title</td><td colspan="5">Helicopter mounted partial discharge detection feasibility trial</td></tr>
<tr><td>Description of project</td><td colspan="5">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.</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£ 608</td><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td>£ 517</td></tr>
<tr><td>External</td><td>£5,000</td><td>External</td><td>£ 6,393</td></tr>
<tr><td>Total</td><td>£5,608</td><td>Total</td><td>£ 6,910</td></tr>
<tr><td>Project Cost (Collaborative + external</td><td colspan="2">£19,696</td><td rowspan="3">Projected 10/11 costs – follow on project</td><td>Internal</td><td>£ 3,000</td></tr>
<tr><td></td><td></td><td>External</td><td>£58,500</td></tr>
<tr><td></td><td></td><td>Total</td><td>£61,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Can ground source partial discharges in open terminal substations be reliably detected from a helicopter?</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>System prototype / trial</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td></td><td>10</td><td>-7</td><td colspan="2">17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">If so the project would offer the ability to quickly scan EHV open terminal s/s as part of routine overhead line patrols, offering improved reliability at low incremental patrol cost.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 years</td><td>Duration of benefit once achieved</td><td colspan="2">10 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td>Project NPV</td><td colspan="2">£5k</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">Asset health assessment is key to delivery of network reliability and safety performance. The feasibility trial employed existing technology, but stand off distance and disturbance from the helicopter and its systems, posed potential challenges. A minimal NPV has been included above, as a subsequent project would be needed to deliver a flight certified solution.</td></tr>
</table>

Project Progress **July 2010**	Technology & trials: Flight trial has demonstrated the ability to detect ground based discharge activity. Project worked up to pursue development of helicopter mounted directional discharge equipment pod having required EASA (airworthiness) certification, and recording software.
Collaborative Partners	Central Networks, Scottish & Southern, EdF Energy.
R&D Provider	Elimpus

<table>
<tr><td>Project Title</td><td colspan="5">Supergen V – AMPerES</td></tr>
<tr><td>Description of project</td><td colspan="5">Supergen is an EPSRC strategic partnership programme incorporating a collection of projects across a number of UK academic establishments. This fifth call, Supergen V is entitled Asset Management & Performance of Energy Systems (AMPerES).</td></tr>
<tr><td rowspan="3">Expenditure for financial year</td><td>Internal</td><td>£2,325</td><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>Internal</td><td>£ 20,445</td></tr>
<tr><td>External</td><td>£nil</td><td>External</td><td>£100,000</td></tr>
<tr><td>Total</td><td>£2,325</td><td>Total</td><td>£120,445</td></tr>
<tr><td rowspan="3">Project Cost (Collaborative + external + SP-EN)</td><td colspan="2" rowspan="3">£ 2,800,000</td><td rowspan="3">Projected 10/11 costs for WPD</td><td>Internal</td><td>£nil</td></tr>
<tr><td>External</td><td>£nil</td></tr>
<tr><td>Total</td><td>£nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">WP 1: Programme delivery, outreach and implementation
WP 2: Enhanced network performance and planning
WP 3: Adaptable protection and control techniques
WP 4: Infrastructure for reducing environmental impact
WP 5: Ageing mechanisms
WP 6: Condition monitoring techniques</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">The expected aims of the project are:
To deliver a suite of intelligent diagnostic tools for plant
To provide platform technologies for integrated network planning and asset management
To progress plans to develop and implement improved and reduced environmental impact networks
To develop models and recommendations for network operation and management</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">10 years</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td>Project NPV</td><td colspan="2">£62k</td></tr>
</table>

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 2010**	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. This 5 year programme comes to an end in 2010. A large number of papers have been submitted / published during the year, including the following topic areas - • Optimal asset replacement and network expansion methodologies • Optimising network security in on-line mode • minimisation of energy losses and dynamic ratings • Design and evaluation of loss of grid detection techniques

	• Protection and Control of Distribution Networks • Effect of loading, voltage difference and phase angle on the synchronization of a small alternator • "Observations of current transients in the small salient-pole alternator caused by sudden short-circuit and synchronisation events • Steady-State & Transient Performance of Biodiesel Fuelled Compression Ignition Based Electrical Generation • End-of-life modelling for power transformers in aged power system networks • Ageing mechanisms in plant for risk management in oil and epoxy based systems All publications and reports are available to all the partners from a secure web site: http://www.supergen-amperes.org/
Collaborative Partners	National Grid, Scottish Power, Scottish and Southern, ENW, Western Power Distribution, Central Networks, CE Electric, NIE, Advantica & EDF Energy Networks.
R&D Provider	Universities of Manchester, Southampton, Edinburgh, Liverpool, Strathclyde, Queens (Belfast).

8.0 NOTE ON NET PRESENT VALUE

8.1 There are several approaches to net present value assessments of research type work. One approach is to scale up test discount rates to reflect the “riskiness” of a project whilst another is to employ a standard test discount rate and employ a success probability factor, for example 25, 50 75% . The latter was described in a report commissioned by Ofgem on Innovation in Electricity Distribution Networks and prepared by Mott MacDonald/BPI in March 2004, and is the approach employed by WPD.

8.2 Experience of the typical payback of successful projects undertaken within an STP Module is typically in the range of 6 – 8 X investment, which success probabilities of the programme projects tends to be at the 25% band. Timescales of individual projects within an STP Module are of the order of 3 years, with break milestones built in. The test discount rate employed is the WPD cost of capital from DPCR4, i.e. 6.9%. The average duration of benefit once a successful project has been achieved has been assessed as 10 years.

8.3 Whilst it is possible that the effect of some financial benefits might be taken into account by Ofgem in a subsequent Distribution Price Control Review (DPCR), Customers would continue to receive the benefits of such successful research and so our NPV benefit calculations do not terminate at 2010, the date of the next DPCR.