WESTERN POWER DISTRIBUTION

Serving the South West and Wales

Report on 2005/06 work undertaken under Ofgem Innovation Funding Incentive

Western Power Distribution (South West) plc

Western Power Distribution (South Wales) plc

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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.

2.0 OFGEM INNOVATION FUNDING INCENTIVE

During 2004, Ofgem consulted upon and introduced an "Innovation Funding Incentive" (IFI) to encourage the DNOs to apply innovation in the way they pursue the technical development of their networks Ofgem recognised that innovation has a different risk/reward balance compared with a DNO's core business. The incentives provided by the IFI mechanism were designed to create a risk/reward balance that is consistent with research, development and innovation. (Similarly "Registered Power Zones" (RPZs) were introduced, though WPD is not currently pursuing any RPZ registrations). IFI came fully into effect in April 2005 .

2.1 Having introduced IFI, previous funding of research activity was removed and only projects which met criteria set out in the Ofgem IFI Regulatory Instructions and Guidance (RIG) and an Ofgem agreed Good Practice Guide would be partially funded, on a reducing sliding scale. DNOs who wished to undertake work under IFI were required to prepare and submit a Good Practice Guide (GPG) to Ofgem for agreement. That GPG had to meet Ofgem requirements, in particular relating to project eligibility and also in respect of net present value. 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. This has received Ofgem agreement.

2.2 The RIGs published by Ofgem provide 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.

2.3 The definition of technical development, contained in the GPG, was the subject of considerable discussion with Ofgem before it was agreed and 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"

2.4 The Ofgem website contains both a brief description of the IFI and RPZ processes and the June 2004 DPCR consultation which includes further detail.

2.5 This report on WPD IFI activity for the year ending 31st March 2006, has been prepared in accordance with the RIGs and GPG.

3.0 WPD's APPROACH TO RESEARCH AND DEVELOPMENT

3.1 Having regard to the need for prudent investment , 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 is a current example..

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 £40k per licenced DNO set in the GPG (para 3.4) 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. Since April 2005, WPD has committed to supporting a large research proposal to EPSCR on Enhanced Management and Performance for a Sustainable UK Energy Infrastructure (Supergen V), which would be heavily geared and involve collaboration with six leading UK Universities, together with Industrial partners and other UK DNOs and transmission companies.

3.4 During the year, DNOs and Ofgem have had discussions over the operation of the IFI scheme and it is understood that a review by Ofgem will be advanced to Autumn 2006. Amongst the aspects that WPD would wish to be explored further are –

- IFI eligibility criteria, which are believed to be too constrained, for example in the areas of safety, reliability, resilience, environmental performance, or security
- Projects which do not show a real financial NPV benefit rather than an " equivalent financial benefit" (RIG para. 3.2 and GPG para. 3.2.3). (There is currently a recognised disparity between the RIG requirement that a project should have an expectation of a positive present value (PV) , whilst the GPG expects that the primary driver of more than 50% of projects should be financial benefits and that the overall programme should show a positive PV.)
- The handling of NPV benefits when real financial benefit may be removed from a DNO at the next five yearly Ofgem Distribution Price Control Review, where a project would continue to deliver ongoing financial benefit to Customers if it were to be undertaken. This is further complicated by the application of the IFI reducing sliding scale of DNO cost recovery .
- The establishment of a realistic and fair approach to the "z" factor cap, which recognises that the ratio can, and will, justifiable vary not only

between DNOs but from year top year depending on mix and maturity of the IFI programme content
- Ensuring that administrative overhead burdens of the IFI scheme are not disproportionate

4.0 2005/6 PROJECTS

WPD's 2005/6 IFI Programme contained the following projects -

- EATL STP Module 2 - Overhead Networks
- EATL STP Module 3 - Cable Networks
- EATL Module 4 - Substations
- Bath University – Network charging methodology
- Supergen V Amperes – extensive EPSRC joint funded programme
- GE Energy, Yambay – Mobile SCADA
- ENA – Fault Level Monitor
- ENA – Lightning Protection ETR 134
- ENA – Loss of mains relay (ROCOF)
- ENA – Earthing
- EATL – Underground cable condition based risk management (CBRM)

Further details on each of these are included later in this Report.

The management of these activities necessarily involves a level of WPD internal cost. Where these costs are directly associated with one of the projects, costs have been included with that project. There are some costs, amounting to some £5,600 in total, which span multiple projects and are included only at the Licence summary report stage.

5.0 NET PRESENT VALUE

5.1 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.

5.2 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

5.3 The RIG and GPG required aggregate and programme reports follow overleaf.

WPD South West Summary report of IFI Project activities year ending March 31st 2006

Number of active IFI projects	11
NPV of costs and anticipated benefits from committed IFI projects	NPV of costs - £ 1.0135 M NPV of benefits - £ 1.3571 M Positive NPV - £ 0.3441 M (rounded from information on following sheets)
Summary of other benefits anticipated from active IFI projects	Reductions in CMLs through improved reliability, resilience and speed Maintaining or improving safety to the public and staff. Reduction of environmental risk of oil loss from plant and cables.
Total expenditure to date on IFI projects	£0.3269 M up to end March 2006
Benefits actually achieved from IFI projects to date	De-minimis to date

Regulatory report for DG incentive, RPZs and IFI **Reporting year 2005/06** **Western Power Distribution – South West**	
Innovation Funding Incentive	**£m**
IFI carry forward (£m)	**0.498**
Eligible IFI expenditure (£m) *	**0.2933**
Eligible IFI internal expenditure (£m)	**0.0457**
Combined distribution network revenue (£m)	**199**
* includes internal expenditure	

WPD South Wales Summary report of IFI Project activities
Year ending March 31st 2006

Number of active IFI projects	11.
NPV of costs and anticipated benefits from committed IFI projects	NPV of costs - £ 1.0135 M NPV of benefits - £ 1.3571 M Positive NPV - £ 0.3441 M (rounded from information on following sheets)
Summary of other benefits anticipated from active IFI projects	Reductions in CMLs through improved reliability, resilience, and speed Maintaining or improving safety to the public and staff. Reduction of environmental risk of oil loss from plant and cables.
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Benefits actually achieved from IFI projects to date	De-minimis to date

Regulatory report for DG incentive, RPZs and IFI
Reporting year 2005/06
Western Power Distribution – South Wales

Innovation Funding Incentive	**£m**
IFI carry forward (£m)	**0.403**
Eligible IFI expenditure (£m) *	**0.2933**
Eligible IFI internal expenditure (£m)	**0.0457**
Combined distribution network revenue (£m)	**161**
* includes internal expenditure	

WPD S West and WPD S Wales *
IFI Project report for Year ending March 31st 2006

Description of project	Strategic Technology Programme Module 2 Overhead Networks
Expenditure for financial year	External costs - £18,000 per WPD Licence Internal costs - £1,920 per WPD LIcence
Technological area and / or issue addressed by project	The STP overhead network programme for budget year 2005/6 aimed to reduce costs and improve performance of overhead networks by increasing understanding of issues that have a negative impact on costs and performance. The programme is expected to also have a positive impact on safety and environmental performance. The projects all address real problems that have been identified by the module steering group members as significant and which require technical investigation and development. The projects within the programme aimed to: • S2120_2 - Improve detection of defective surge arresters in-situ with selection and evaluation of the most promising solutions. • S2126_2 - Undertake long-term monitoring of conductor temperature by obtaining and analysing 12 months trial data. • S2132 - Validate current and proposed new ice accretion models • S2133 - Investigate the use of sacrificial anodes for protecting tower foundations to defer or remove the need for full foundation refurbishment. • S2134_1 - Determine the susceptibility of currently used surge arresters to the principal modes of failure • S2135 - Evaluate the life expectancy of copper conductors. • S2136 - Participate in European Project COST 727: Measuring and forecasting atmospheric icing on structures. • S2138_1 - Investigate live-line jumper-cutting limitations Stage 2 is to define a realistic experimental programme. • S2139 - Begin to evaluate a new corona discharge camera system. • S2140 - Explore possible means of checking the foundations of newly installed poles

<table>
<tr><td>Type(s) of innovation involved</td><td colspan="3">Technical Substitution / Radical</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Due to the age profile of system equipment it is inevitable that, unless significant new technology is used to extend asset life, CAPEX and possibly OPEX will need to increase significantly to maintain the present level of network reliability and safety.

If these projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain benefits including:
avoid redesign, reconstruction or refurbishment of overhead lines where this is driven by a perceived need to increase ratings or strengthen lines, and is required to conform with existing standards but which may be unnecessary;
reduce levels of premature failure of assets;
provide more cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults;
confidently extend the service life of towers and reduce potential levels of tower failures;
reduce lifetime costs by the appropriate use of alternative materials.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-7 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 2-10 years -dependent on project</td></tr>
<tr><td>Estimated Success probability (at start of project)</td><td colspan="3">Range 5-20% - dependent on project</td></tr>
<tr><td>PV of Project Costs</td><td>£19,920
(nb. This is identified early stage cost. It does not reflect the likely full costs of implementation. These will be</td><td>PV of Project Benefits</td><td>£27,300</td></tr>
</table>

	identified providing the outcome of the early stage is positive.)		
Commentary on project progress and potential for achieving expected benefits	Some projects within the programme are at an early stage, whilst others are complete. Issues have been identified relating to both operational and capital expenditure which, if successfully addressed, would enable the expected benefits to be achieved. • *S2120_2 - Improve detection of defective surge arresters with selection and evaluation of the most promising solutions.* Laboratory tests have determined the most effective techniques and these have been presented to members with recommendations for further action. • *S2126_2 - Undertake long-term monitoring of conductor temperature by obtaining and analysing 12 months trial data.* The trial is continuing with the expectation that the results will indicate it should be possible to re-rate (up-rate) some overhead line circuits in certain circumstances. • *S2132 - Validate current ice accretion models.* The data currently being collected will be used to revise national overhead line design standards • *S2133 - Investigate the use of sacrificial anodes for protecting tower foundations to defer or remove the need for full foundation refurbishment.* A practical reference document has been produced to assist in the application and specification of such devices • *S2134_1 - Determine the susceptibility of currently used surge arresters to the principal modes of failure.* The findings provide a review of the capabilities of a range of surge arresters, allowing informed and more cost effective specification of these devices. • *S2135 - Life expectancy of copper conductors.* The results of initial laboratory testing of samples of varying age provided from UK distribution networks will be available shortly. They should allow an initial assessment of the overall condition of copper based conductors to be made. • *S2136 - Measuring and forecasting atmospheric icing on structures.* This is part of a much larger European collaborative project aiming to provide more accurate mapping of ice prone areas. This in turn will allow the most appropriate structure to be		

	constructed. • *S2138_1 - Investigate live-line jumper-cutting limitations.* Controlled testing regime has been specified and this should lead to improved working practices being adopted. • *S2139 Begin to evaluate a new corona discharge camera system.* This project is at a very early stage. • *S2140 Explore possible means of checking the foundations of newly installed poles.* An initial review of worldwide practice and commercially available techniques has begun.

***The above figures are the same for each licence area. Ofgem have agreed (meeting 09-08-05) that both may be shown together**

WPD S West and WPD S Wales *
IFI Project report for Year ending March 31st 2006

Description of project	Strategic Technology Programme – Module 3 Cable Networks
Expenditure for financial year 2005/06	External cost - £18,000 per WPD Licence Area Internal cost - £1,823 per WPD Licence Area
Technological area and / or issue addressed by project	The STP cable network programme for budget year 2005/6 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. Eight new projects were approved during the year (shown in bold below). The projects undertaken within the programme during 2005-06 (include some approved in previous years) aimed to: • S3100_2 – Define better functional requirements for link boxes. • S3108_2 – Produce software for assessing earthing practice on PME systems. • S3115 – Determine the corrosion resistance of aluminium foil cables. • S3120 – Assess novel flame retardant coatings for cables in basements. • S3121 - Produce a fable fluid sniffer Stage 1(b) Feasibility study. • S3123 – Produce a guide and specify functional requirements for the selection of cable ducts. • S3125 - Assess new degreasing products form MV and LV cables. • S3126 - Explore issues associated with the use of polyurethane and development of alternative jointing resins. • S3131 – Produce a summary of CIGRE issues relating to HV cables. • S3113_2 - Addition of duct bank modelling functionality within CRATER cable rating software. • S3113_3 - Addition of paper cable modelling within CRATER

	cable rating product. • S3132_1 - Addition of HV polymeric cable modelling functionality within CRATER cable rating software. • S3132_2 - Addition of LV cable modelling functionality within CRATER cable rating software. • S3132_3 - Addition of cyclic and emergency rating modelling functionality within CRATER cable rating software. • S3132_4 - Addition of limited time rating of mixed circuit modelling functionality within CRATER cable rating software. • S3132_5 - CRATER cable rating software, overview report. • S3132_6 - Addition of single core MV paper cable modeling functionality within CRATER cable rating software. • S3132_7 - Addition of cable crossing modelling functionality within CRATER cable rating software. • S3140_1 – produce a spreadsheet tool for pulling-in of cables into ducts. • S3144_1 – Evaluate the Hydragel process for the treatment of redundant fluid filled cables.		
Type(s) of innovation involved	Technical Substitution / Radical		
Expected Benefits of Project	If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain the following benefits, including: • offset future increases in CAPEX and OPEX; • savings of the order of 0.25 CML per connected customer; • increased safety of staff and public by reducing the number of accidents / incidents.		
Expected Timescale to adoption	Range 1-5 years - dependent on project	Duration of benefit once achieved	Range 2-10 years -dependent on project
Estimated Success probability (at start of project)	Range 2-30% - dependent on project		
PV of Project Costs	£19,823 (nb. This is	PV of Project Benefits	£29,750

	identified early stage cost. It does not reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive.)		
Commentary on project progress and potential for achieving expected benefits	Some projects within the programme are at an early stage, whilst others are complete. Issues have been identified relating to both operational and capital expenditure which, if successfully addressed, would enable the expected benefits to be achieved. • *S3100_2 – Define better functional requirements for link boxes.* A document that defines functional requirements for LV link boxes has been produced for member companies. Previously such a document did not exist. • *S3108_2 – Software for earthing practice on PME systems.* An assessment tool has been produced for earthing practice on PME systems which evaluates the compliance with regulations and practices, carries out a check of LV cable circuit design. • *S3115 – Corrosion resistance of aluminium foil cables.* Tests have shown that corrosion of the laminated aluminium foil sheath is likely if the outer sheath of the cable is damaged leading to moisture penetration to the cable core. • *S3120 – Flame retardant coatings for cables in basements.* Findings recommended the use of a system consisting of a water-based intumescent coating and an associated water resistant topcoat. This should give valuable long-term fire protection to PE cables in basements and substations. • *S3121 - Cable fluid sniffer Stage 1(b) Feasibility study.* Laboratory familiarisation has been carried out and field trials are being undertaken. • *S3123 – Guide and functional requirements for the selection of cable ducts.* A report giving some advice on the use of plastic ducts in heavily loaded circuits has been produced. • *S3125 - Degreasing products for MV and LV cables.* The project		

	defined a suitable wet-wipe that will ensure satisfactory cleaning of LV, MV and HV cables without adversely affecting their performance. • *S3126 - Explore issues associated with the use of polyurethane and development of alternative jointing resins.* The project concluded that under current legislation, and provided employers comply with the requirements of the COSHH Regulations, the continued use of polyurethane resin systems is acceptable. Alternative systems are available, but currently more expensive than polyurethane resins. • *S3131 – Summary of CIGRE issues relating to HV cables.* An extensive report (140 pages) provides a comprehensive picture of work carried out by Cigré over the past 5 years, as well that currently underway and some that is planned. This places the work of the Module in an international context. • *S3113_2 - Addition of duct bank modelling functionality within CRATER cable rating software.* The spreadsheet produced is a valuable tool for cable engineers. It ensures correct rating of cables installed in non-standard ducts and conditions. • *S3113_3 - Addition of paper cable modelling functionality within CRATER cable rating software.* A user-friendly spreadsheet tool for the cable engineer was created to determine sustained, cyclic and distribution current ratings for MV paper cable ratings, using approved methods of calculation. • *S3132_1 - Addition of HV polymeric cable modelling functionality within CRATER cable rating software.* A user-friendly spreadsheet tool for the cable engineer was created to determine sustained, cyclic and distribution current ratings for HV polymeric cable ratings, using approved methods of calculation. • *S3132_2 - Addition of LV cable modelling functionality within CRATER cable rating software.* A user-friendly spreadsheet tool for the cable engineer was created to determine sustained, cyclic and distribution current ratings for LV cable ratings, using approved methods of calculation. • *S3132_3 - Addition of cyclic and emergency rating modelling functionality within CRATER cable rating software.* A user-friendly spreadsheet tool for the cable engineer was created to determine cyclic and emergency current ratings for most practical

	mixed circuit problems. • *S3132_4 – Addition of limited time rating of mixed circuit modelling functionality within CRATER cable rating software.* The basic functionality is now incorporated into CRATER and operation with grouped circuits is being developed. • *S3132_5 - CRATER cable rating software, overview report.* The report, which is in preparation, will cover a range of practical applications for CRATER. The intention is that the report will form a handy reference to be used in conjunction with the basic operating manuals. • *S3132_6 - Addition of single core MV paper cable modeling functionality within CRATER cable rating software.* Preliminary scoping work has been carried out and a questionnaire sent out to ascertain user requirements. • *S3132_7 - Addition of cable crossing modelling functionality within CRATER cable rating software.* The method for calculating ratings of cable crossings has been established and development work is on-going. • *S3140_1 – produce a spreadsheet tool for pulling-in of cables into ducts.* Proprietary software is being evaluated for this project, which is at an early stage. • *S3144_1 – Evaluate the Hydragel process for the treatment of redundant fluid filled cables.* Information has been collected on the two available processes and further information is being gathered from members.

*** The above figures are the same for each licence area. Ofgem have agreed (meeting 09-08-05) that both may be shown together**

Description of project	Strategic Technology Programme Module 4 Substations
Expenditure for financial year 2005-06	External cost - £18,000 per WPD Licence Area Internal cost - £1,692 per WPD Licence Area
Technological area and / or issue addressed by project	Issues with the age profile of substation assets within the UK electricity distribution system are well known. Also, both regulatory and shareholder pressures preclude substantial investments of the large scale that was seen in the 1950's to 1970's. The challenge is to constantly review and innovate new solutions to monitor and define asset condition thereby allowing risks to be clearly defined and sound investment decisions to be taken The programme of projects which were approved for funding from the STP substations module budget and were undertaken in 2005/06 encompass both developing new innovative asset management processes and practices and developing innovative diagnostic techniques. The aim is to develop already well established themes such as life extension of aged assets within legal and heath and safety constraints, examination of new technologies, developing an understanding of, and innovative solutions for, the impact on substation assets of increasing levels of distributed generation on networks and condition monitoring techniques. Eighteen new projects were approved during the year (shown in bold below). The projects undertaken within the programme during 2005-06 (include some approved in previous years) aimed to: <u>In progress Projects</u> • S0499 - Extend the TASA tap-changer diagnostic Trial. • S4107_2 – Field test on a sample of switchgear. the headspace gas testing technique to indicate the condition of oil filled switchgear • S4180 – Develop an indicator to detect discharge activity in

	substations. • S4172 – Follow-up of S0455 paint preparation for tanks to determine the longer term performance of the technique. • S4173 – Enhance the Transformer thermal rating assessment system. • S4178 – Testing and management of substation standby batteries. • S4181 – Ongoing programme of transformer post mortems to provide better correlation between condition assessment tests, true condition and remaining life. • S4182 – Develop a better understanding of frequency response analysis of transformers. • S4186 – Study of PM cast resin VTs. • S4188_1 – Assess replacement insulator grease. • S4189_1 – Examine substation noise. • S4190_1 - Review of pad mounted substations. • S4193_1 - Develop a common approach to risk and reliability. <u>Completed Projects</u> • S0497 – Transformer post mortems to assist estimation of remaining life from non-invasive tests. • S4130_4 – Assess wipes for HV oil filled equipment. • S4149 - Assess the quality, performance and longevity of recent substation equipment. • S4155 - Investigate ester based insulating oils. • S4162 – Extend the range of non-intrusive PD for > 90kV switchgear. • S4164 – Feasibility study into on-line tapchanger monitoring. • S4167 – Improve CBRM by use of better understanding of degradation processes. • S4172 – Scoping studies on transformer refurbishment, fault passage indicators, out of phase switching and fire legislation for substations. • S4174 - Compare a range of power system protection software. • S4175 – Assess circuit breaker cleaning techniques and materials. • S4176 – Compare available earth testing instruments.

	• S4179 - Explore in-situ testing of vacuum interrupters. • S4187_1 – Hold a risk modelling workshop**.**		
Type(s) of innovation involved	Incremental / Significant / Technological Substitution / Radical		
Expected Benefits of Project	Due to the age profile of the current system assets it is inevitable that unless significant new technology is used to extend asset life, CAPEX and possibly OPEX will need to increase significantly to maintain the present level of network reliability and safety. If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain the benefits including: • Offset future increases in CAPEX and OPEX • Increased safety of staff and public by reducing the number of accidents/incidents; • Both preventing disruptive failures of oil-filled equipment to reduce land contamination and avoiding unnecessary scrapping of serviceable components will alleviate environmental impact.		
Expected Timescale to adoption	1-5 years - dependent on project	Duration of benefit once achieved	2-7 years - dependent on project
Estimated Success probability (at start of project)	1-20% - dependent on project		
PV of Project Costs	£19,962 (nb. This is identified early stage cost. It does not reflect the likely full costs of implementation. These will be identified providing the	PV of Project Benefits	£32,100

	outcome of the early stage is positive.)		
Commentary on project progress and potential for achieving expected benefits	Some projects within the programme are at an early stage, whilst others are complete. Issues have been identified relating to both operational and capital expenditure which, if successfully addressed, would enable the expected benefits to be achieved. <u>In progress Projects</u> • S0499 - Extend the TASA tap-changer diagnostic Trial. The original trial had a low sample population and this work aims to increase the sample size. If earlier results are confirmed then the technique offers the potential for non-invasive condition assessment of tapchangers, with consequent improvements in network performance due to avoided failures and reduced OPEX from better targeted maintenance. • S4107_2 - Headspace gas testing of oil filled switchgear. Working closely with members, the project aims to collect headspace gas samples from units within the field and resolve any GCMS issues. If correlation is successful then the project offers the prospect of targeted maintenance and reduction of invasive inspections. • S4180 – Develop an indicator to detect discharge activity in substations. Results suggest the device in its present form cannot reliable detect/indicator discharge activity in many substation environments. This development will not be pursued within STP, but related trials of an electronic NO_x detector are being undertaken by the Discharge User Group. • *S4172 – Follow-up of S0455 Surface preparation of tanks.* The performance of the paint systems are being reviewed as a follow-up to earlier work. • *S4173 – Transformer thermal rating system.* This project is to re-develop the current Transformer Thermal Rating software to enable members to assess BSP Transformer safe loading limits. • *S4178 – Testing and management of substation standby batteries.* The project aims to assess the effectiveness of Battery Impedance testing methods to replace traditional discharge testing.		

	• *S4181 – On-going programme of transformer post mortems.* Further work in this area to build on the good results obtained in an earlier project, where a good correlation between non-invasive tests and internal examinations had been shown • *S4182 – Understanding frequency response analysis.* Frequency Response Analysis is a potentially useful condition assessment technique that can be significant in identifying and defining end of life for grid and primary transformers. Initial tests have produced some good results. • *S4186 – Study of PM cast resin VTs.* Members are completing an issues questionnaire and testing regimes are being developed. • *S4188_1 – Assess replacement insulator grease.* The project is to compare the performance of Insojell Grease with its proposed replacement, Dow Corning 3099 HVIC by performing a number of pre-specified accelerated aging tests. • *S4189_1 – Examine substation noise.* The project is investigating and clarifying the issues surrounding substation noise and develop a common, agreed framework to enable members to assess noise issues and take appropriate actions. • *S4190_1 - Review of pad mounted substations.* The project will provide an overview of members experience and identify any issues that may be arising through changing legislation. • *S4193_1 - Develop a common approach to risk and reliability.* The objective of this initial stage of work is to quantify the information requirements and determine its availability. An outline of the approach to be adopted has been produced and is currently being refined. <u>Completed Projects</u> • *S0497 – Transformer post mortems to assist estimation of remaining life from non-invasive tests.* A good correlation between non-invasive tests and internal examinations has been shown. This will assist in interpreting on-going non-invasive testing of other transformers. • *S4130_4 – Assess wipes for HV oil filled equipment.* Final development and testing of a new 3rd party high

	performance wipe, which was specially developed to the specification, which was developed in early stages of the project, was undertaken. This is now a product available for members • *S4149 - Assess the quality, performance and longevity of recent substation equipment.* An analysis of failure rates and reliability of modern substation equipment was undertaken and has highlighted a number of issues which warrant further investigation. • *S4155 - Investigate ester based insulating oils.* The project concluded that both natural and synthetic ester oils offer advantages over mineral oil in terms of biodegradability and electrical performance although oxidation stability and viscosity are poor. • *S4162 – Extend the range of non-intrusive PD for use on > 90kV switchgear.* The work identified the population of equipment suitable for PD testing, concluding that some types would benefit from such testing. • *S4164 – Feasibility study into on-line tap-changer monitoring.* The project concluded that it is possible to consistently characterise the operation of such devices using acoustic emissions techniques. • *S4167 – Improve CBRM by use of better understanding of degradation processes.* Mathematical models of asset ageing have been refined and calibrated in order to improve the accuracy of CBRM results. • *S4172 – Scoping studies on transformer refurbishment, fault passage indicators, out of phase switching and fire legislation for substations.* A series of short projects that allowed specific issues to be examined before deciding if a larger project in that area is appropriate. • *S4174 - Compare a range of power system protection software.* The available power system protection software was ranked in terms of its functionality, cost and ease of use. This will be used to assist members in making informed decisions. • *S4175 – Assess circuit breaker cleaning techniques and materials.* This project assessed different techniques and materials for cleaning circuit breaker contacts. A number of materials have been recommended together with a working

	practice. • *S4176 – Compare available earth testing instruments.* The project examined the operation of a number of simple clamp-on instruments and compared their effectiveness. The results showed that several instruments were quite inaccurate and could give misleading results. • *S4179 - Explore testing of vacuum interrupters.* The project investigated current and alternative methods of testing vacuum interrupters. It concluded that routine loss of vacuum testing would provide little benefit. It would be more appropriate to determine “at risk” interrupters and inspect these more frequently. • *S4187_1 – Hold a risk modelling workshop.* A workshop for members and experts to discuss risk quantification was held.

* **The above figures are the same for each licence area. Ofgem have agreed (meeting 09-08-05) that both may be shown together**

WPD S West and WPD S Wales *
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<table>
<tr><td>Description of project</td><td colspan="5">WPD – Bath University
Charging methodologies for use of WPD network</td></tr>
<tr><td rowspan="2">Expenditure for financial year per WPD Licence area</td><td>Total</td><td>External</td><td>Internal</td><td rowspan="2">Expenditure in previous financial years</td><td rowspan="2">£0</td></tr>
<tr><td>£38,017</td><td>£30,000</td><td>£8,017</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">• To develop a model of the WPD distribution network for the purpose of evaluating different methodologies for charging for use of the distribution system.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Radical</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">The delivery of a charging model which will enable analysis of
• Use of system by customers by time of year and day
• Take account of reactive power flow
• Take account of load profiles / characteristics and generation
• Enable incremental analysis
• Effectiveness of varying charging methodologies
• Assessment of overall revenue recovery
• Sensitivity

This work will provide a number of alternative charging methodologies that satisfy relevant licence objectives, with the goal of delivering a single efficient charging model that is simple to use, transparent, repeatable, capable of audit and able to recover the overall revenue permitted under Price Control.

The issues identified during the work will be documented in a commentary.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</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">50%</td></tr>
<tr><td>PV of Project Costs</td><td>£35,500</td><td>PV of Project Benefits</td><td>£39,000</td><td>NPV of Project</td><td>£3,500</td></tr>
<tr><td>Commentary on project progress and potential for achieving expected benefits</td><td colspan="5">Model is completed.</td></tr>
</table>

WPD S West and WPD S Wales *
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Description of project	SuperGen V Amperes		
Expenditure for financial year 2005-06	External cost - £12,500 per WPD Licence Area Internal cost - £1,164 per WPD Licence Area		
Technological area and / or issue addressed by project	The EPSRC (Engineering and Science Research Council) is the major research-funding agency for Universities in its area, and is run by DTI. One of its initiatives is funding work in the area of Sustainable Power Generation and Supply. A call was put out in 2004 and EPSRC have put together a group of universities to address the UK energy infrastructure. EPSRC, which addresses UK emission targets, produces step changes in technology, and has active collaboration with UK industry. This call is intended to focus on plant, systems aspects having been addressed in other Supergen calls. The Universities involved in the £2.8M proposal are; Manchester University: the management hub for this activity Southampton University; the finance hub Edinburgh University, Liverpool University, Strathclyde University Queens University, Belfast In essence there are 5 main activities: improving knowledge of plant ageing developing condition monitoring techniques developing plant with reduced environmental impact developing new protection and control techniques enhanced network performance and planning tools Further detailed information will be available for view on a joint website being set up by the above Universities.		
Type(s) of innovation involved	Technical Substitution / Radical		
Expected Benefits of Project	The consortium expect to deliver: a suite of intelligent diagnostic tools for plant integrated network planning and asset management improved and reduced environmental impact plant models and recommendations for network operation and management		
Expected Timescale to adoption	12 Years	Duration of benefit once achieved	20 Years
Estimated Success probability (at start of project)	25%		

PV of Project Costs	£99,384	PV of Project Benefits	£141,073	NPV of Project	£41,689
Commentary on project progress and potential for achieving expected benefits	Initial meetings has been held between Universities and Network Operators (NO) to discuss each work pack, activities, Steering Group members, NO project champions, reporting structure and deliverables. There is a strong focus in delivering a network demonstrator from outputs of each work package.				

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Description of project	Mobile SCADA – "Enmac mobile"				
Expenditure for financial year 2005-06	External cost - £125,00 per WPD Licence Area Internal cost - £27,800 per WPD Licence Area				
Technological area and / or issue addressed by project	The development of facilities to enable remote updating of switching schedules by staff in the field without involving Control Engineers				
Type(s) of innovation involved	Technical Substitution / Radical				
Expected Benefits of Project	Reduction in CMLs, both during routine work and improved Customer information during high volume fault situations in storms.				
Expected Timescale to adoption	< 1 Year			Duration of benefit once achieved	20 Years
Estimated Success probability (at start of project)	95%				
PV of Project Costs	£412,600	PV of Project Benefits	£491,600	NPV of Project	£79,000
Commentary on project progress and potential for achieving expected benefits	.The project has now rolled out with to 850 units and implemented.				

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Description of Project	ENA - Fault Level Monitor				
Expenditure for financial year per WPD Licence area	Total £4,000	External £4,000	Internal £*	Expenditure in previous financial years	£0

* The internal costs for these ENA projects relate to meetings which cover multiple projects. The internal costs of all of those for both WPD S Wales and S West amounts to only £2,800 each which is added at Company summary level.

Technological area and/or issue addressed by Project.	The objective of this proposal is the development of an instrument that can successfully measure fault level on a distribution network with repeatability and reliability. This instrument, to be known as the Fault Level Monitor (FLM), will be developed to the specification agreed by the ENA's Operations and Systems Group (OSG). The FLM's measurements will be based on normally occurring events, so no customer supply interruption will be required. The technical development risks are reduced as the underlying methodology has been proven with EA Technology's existing Extended Supply Monitor.
Type(s) of innovation involved	Incremental
Expected Benefits of Project	The main benefits that a FLM will bring to the Distribution Network Operators (DNOs) are: • it will allow the DNOs to accurately assess fault infeed levels and design distribution networks appropriately; • it will facilitate the connection of distributed generation by providing a standardised and accurate method of assessing network fault levels; • it will enable an ongoing assessment of the effects of distributed generation to be made; • it will help to satisfy generator developers that decisions to upgrade networks are not subjective but based on objective measurement.

Expected Timescale to adoption	3 years		Duration of benefits once achieved	20 years	
Estimated Success probability (at start of project)	75%				
PV of Project Costs	£226,272	PV of Project Benefits	£344,589	NPV of project	£118,317

Commentary on project progress and potential for achieving expected benefits	Phase I of the project requires the collection of data from a small number of major substations, preferably with different load types and profiles.

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Description of project	ENA ETR 134 - Lightning Protection				
Expenditure for financial year per WPD Licence area	Total	External	Internal	Expenditure in previous financial years	£0
	£1,050	£1,050	£*		
* The internal costs for these ENA projects relate to meetings which cover multiple projects. The internal costs of all of those for both WPD S Wales and S West amounts to only £2,800 each which is added at Company summary level					
Technological area and / or issue addressed by project	Produce a new ETR on lightning protection with a Scope that covers: • background information on the lightning density across the UK and the year to year variation as a result of factors such as sun spot activity • catalogue current practices and procedures – with an explanation of pros and cons • provide a view on international practices / procedures • reference to peripheral issues such as earthing and protection, however the ETR should avoid trying to provide in-depth information on these matters • provide a list of reference documents				
Type(s) of innovation involved	Incremental				
Expected Benefits of Project	• Reduction in Failure/faults due to lightning • Improved risk assessment • Reduction in CML's				
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	£151,561	PV of Project Benefits	£152,335	NPV of Project	£773
Commentary on project progress and potential for achieving expected benefits	Document is close to completion.				

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Description of project	ENA - Functional Spec - ROCOF Relay				
Expenditure for financial year per WPD licence area	Total	External	Internal	Expenditure in previous financial years	£0
	£1,750	£0	£ *		

* The internal costs for these ENA projects relate to meetings which cover multiple projects. The internal costs of all of those for both WPD S Wales and S West amounts to only £2,800 each which is added at Company summary level

Technological area and / or issue addressed by project	Studies have been carried out to assess the capabilities of loss of mains relays to withstand system disturbances, whilst this is an important characteristic to maintain generation as systems move increasingly towards active networks the prime consideration in determining a suitable setting must be safety and compliance with regulations. The stability setting requirements to ride through anticipated system disturbances may form the minimum desired setting. Previous work carried out on testing the stability of relays to genuine network disturbances, show that there is a wide variation in the response of relays from different manufacturers to the disturbances. The results also show that relays from the same manufacturers have different responses at different settings. **Issues** It is equally important to understand how sensitive a loss of mains relay is to a genuine loss of mains. • How many cycles are required to detect the condition i.e. how many cycles does the relay need to sample before it can detect a loss of mains? • What percentage change or mismatch of load compared to generator rating is required for the relay to detect a loss of mains? This can vary with construction and size of generator? ENA Members need to have confidence in a loss of mains relay to demonstrate that they meet the Environmental Test Requirements of ENA TS 48–5 and have a time delay setting from 0-60 seconds. ENA Members require an Engineering Report that captures the issues above and the terms of reference below. From which a new Engineering Recommendation will be written.

Type(s) of innovation involved	Incremental
Expected Benefits of Project	**Use of more effective settings** On completion of the work there will be an improved understanding of loss of mains relays and how they respond to system disturbances and genuine loss of mains, which will enable more effective settings to be applied to relays. More effective settings will reduce the number of spurious trips of generator installations due to system disturbances. Estimating 60 unwanted trips throughout the UK per year due to system disturbances and assuming that more effective settings will reduce these by 50% the number of spurious trips will be reduced by 30 per year. Fewer generation trips will result in fewer disturbances to other connected customers improving quality of supply. A matrix of recommended settings and an improved confidence in the quality of loss of mains relays will reduce the time for producing a scheme design. Reducing the cost producing a quote to generators. **More effective Use of Loss of Mains relays** An improved understanding of and confidence in loss of mains relays will result in the more effective use of them as interface protection between DNO and generator replacing the need for inter-tripping in some situations.
Expected Timescale to adoption	3 Years — Duration of benefit once achieved: 10 Years
Estimated Success probability (at start of project)	25%
PV of Project Costs	£1,637 — PV of Project Benefits: £10,472 — NPV of Project: £8,835
Commentary on project progress and potential for achieving expected benefits	Draft final report received by the Protection Assessment Panel in April for review and comment. Initial review of the report shows some very useful findings which are quite different to the approach currently taken for Loss of Mains settings. The final report will form the basis of a change in the way that these settings are applied across the electricity network. It is anticipated that use of these new setting guidelines will enable the majority of the perceived benefits to be achieved.

WPD S West and WPD S Wales *
IFI Project report for Year ending March 31st 2006

<table>
<tr><td>Description of project</td><td colspan="5">ENA - Earthing Projects</td></tr>
<tr><td rowspan="2">Expenditure for financial year per WPD licence area</td><td>Total</td><td>External</td><td>Internal</td><td rowspan="2">Expenditure in previous financial years</td><td rowspan="2">£0</td></tr>
<tr><td>£1,600</td><td>£1,600</td><td>£*</td></tr>
<tr><td colspan="6">* The internal costs for these ENA projects relate to meetings which cover multiple projects. The internal costs of all of those for both WPD S Wales and S West amounts to only £2,800 each which is added at Company summary level</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">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.
• The advantage of this work will be that if successful the project will deliver a clear rationale describing the correct location of LV earth electrodes with respect to HV earth electrodes. This will have potential benefits in improving understanding of the safety of the earth installations. ESQRC Regulation 8(2) (b) requires that HV electrodes are installed and used in such a manner so as to prevent danger in the LV network due to a fault in the HV network. Currently the safety of the LV electrode is assured by maintaining a separation between the HV and LV earth electrode such that the LV earth electrode is situated outside the 430V Rise of Earth Potential (ROEP) contour. This is based on longstanding requirements to ensure that the LV electrode has <430V imposed upon it under HV fault conditions.
• 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</td></tr>
</table>

	maintain.				
Type(s) of innovation involved	Incremental				
Expected Benefits of Project	This 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.				
Expected Timescale to adoption	3 Years	Duration of benefit once achieved	40 Years		
Estimated Success probability (at start of project)	75%				
PV of Project Costs	£1,497	PV of Project Benefits	£5,869	NPV of Project	£4,372
Commentary on project progress and potential for achieving expected benefits	Initial research work was completed to determine whether there was a need for further work in this area. The outcome of this justified further work being carried out. The earthing consultant has been in discussions with the various DNOs to identify suitable sites for testing to be carried out. Sites have been made available within Central Networks and Western Power and the testing work commenced. It is not yet known whether savings will be achieved until the outcome of the testing work is known.				

WPD S West and WPD S Wales *

IFI Project report for Year ending March 31st 2006

<table>
<tr><td>Description of project</td><td colspan="6">EATL - Condition based risk management of underground cable systems (CBRM)</td></tr>
<tr><td rowspan="2">Expenditure for financial year per WPD licence area</td><td>Total</td><td>External</td><td>Internal</td><td rowspan="2">Expenditure in previous financial years</td><td rowspan="2">£0</td></tr>
<tr><td>£18,181</td><td>£17,675</td><td>£506</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">The creation of condition based risk management model that develops theoretical concepts into a real application covering all WPD underground cable systems</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="6">Incremental and radical</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">1. To move CBRM from the theoretical base to real use, requiring significant and innovative steps. (The knowledge gained by EATL will also assist other DNOs.)
2. To target future investment on cable systems to deliver required performance and risk at minimum cost.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Years 1</td><td>Duration of benefit once achieved</td><td colspan="2">40 Years</td></tr>
<tr><td>Estimated Success probability (at start of project)</td><td colspan="6">75%</td></tr>
<tr><td>PV of Project Costs</td><td>£ 25,344</td><td>PV of Project Benefits</td><td>£83,048</td><td>NPV of Project</td><td>£58,161</td></tr>
<tr><td>Commentary on project progress and potential for achieving expected benefits</td><td colspan="6"></td></tr>
</table>