United Utilities

IFI Annual Report 2005/06

CONTENTS

1. FOREWORD

The Innovation Funding Incentive has reinvigorated research and development in the electricity distribution network. This stimulation of the research and development activity has benefited all parties involved and the benefits can be seen at two distinct levels. On a direct tactical level the services and products that are being developed can and should enable the electricity industry to improve its customer service and efficiency. At a more strategic level this boost to R&D will allow both manufacturers and academia to start to rebuild the knowledge and human infrastructure that a long term R&D programme across an industry needs. Even at this early stage of the scheme the level of R&D work on top of business as usual is causing some of our partners to bring in additional resources.

Our strategy has been a proactive one, actively seeking further ideas and projects but with a strong focus on benefits realisation. Establishing strong project management is key to achieving results, with named managers having personal responsibility for realisation of benefits and outcomes. However, it is important to factor into personal accountability the risky and speculative nature of R&D projects. Overall we are keen to support the IFI scheme and would welcome further discussion with Ofgem on how to strengthen the scheme.

In order to ensure that the IFI scheme can mature and to give the maximum opportunity to achieve its full potential we would offer the following areas for change:

> The limit on internal DNO time spent on R&D projects is rapidly becoming a constraint to achieving full benefits realisation. As we move into the adoption phase of projects, the value of the engagement of internal resources is seen most clearly. Projects which have been partly delivered by internal resources can be more readily adopted as business as usual. The artificial restriction on internal resources within IFI can therefore become a hindrance to realising benefits.
>
> Early confirmation of the arrangements for IFI beyond 2010 are needed if there is not to be a significant reduction in R&D in the latter years of the current price control period. Many projects run for several years and we are already beginning to plan projects that will not be completed until the next price control period. These are less likely to proceed unless we have confidence that IFI will be retained after 2010.

To date the IFI scheme has been a great success and our aim in suggesting these changes is to ensure that this can continue into the future.

2. INTRODUCTION

In this first full year of the Innovation Funding Incentive, United Utilities has worked on developing internal policies and procedures that align with the Engineering Recommendation G85 and Regulatory Information and Guidance for both the management of R&D projects and regulatory reporting. A balanced portfolio of R&D projects has been selected and approved with the aim of delivering short and medium term benefits to customers.

There has been a strong focus on collaborative projects to reduce financial risk and share experience or knowledge. This has involved a variety of collaborators and the right commercial partnerships, which has taken time to negotiate for the protection of all parties. In some cases, projects have started with one collaborator and expanded to reduce financial risk to the customer.

A total of 25 active projects have started with durations of between one to four years. United Utilities' IFI expenditure for 2005/06, including the early start in 2004/05, is slightly under the 0.5% allowable cap with a small carry forward to 2006/07. It is projected that expenditure for 2006/07 will be also around the 0.5% cap and it is anticipated that some projects will be completed ready for adoption during the year. It is intended to move the successful projects smoothly into the business and biannual Benefit Realisation meetings will be held with relevant business managers to aid the adoption process. However, it can not be guaranteed that all projects will be successful. By the very nature of Research and Development some will fail.

The Innovation Funding Incentive has breathed life back into R&D in electricity distribution and will deliver benefits to United Utilities and customers alike. Due to the uncertainties surrounding the next regulatory review period and whether there will be any equivalent IFI mechanism, we can already see constraints emerging on projects that would extend beyond 2010.

3. INNOVATION FUNDING INCENTIVE (IFI)

IFI is intended to provide funding for technical projects in the development of the distribution network, up to and including 132kV and to deliver value (i.e. financial, supply quality, environmental and safety) to customers. IFI projects can embrace any aspect of the distribution system from asset management through to design, construction, commissioning, operation, maintenance and decommissioning of primary and secondary networks. The detail of the IFI mechanism is set out in the Special Licence Condition C3 and the IFI Regulatory Instructions and Guidance (RIG). In addition Distribution Network Operators (DNOs) follow the Energy Networks Association's (ENA) Engineering Recommendation G85 “Innovation in Electrical Distribution Network Systems; A Good Practice Guide”(GPG).

A DNO is allowed to spend up to 0.5% of its Combined Distribution Network Revenue on eligible IFI projects. The GPG provides guidance on the characteristics of such eligible projects. The DNO is allowed to recover from customers a significant proportion of its IFI expenditure. This proportion is set at 90% in 2005/06 reducing in equal steps to 70% in 2009/10.

Ofgem do not approve IFI projects, but are willing to give guidance on eligibility for larger projects. DNOs have to report openly their IFI activities on an annual basis. Ofgem reserves the right to audit IFI activities if this is judged to be in the interest of customers.

4. UNITED UTILITIES R&D PROCESSES

Internal policies and procedures have been developed and issued to ensure R&D/IFI projects are managed from inception through the whole lifecycle, including post-adoption review. In addition, internal and external reporting requirements are detailed with timescales and internal responsibilities. The purpose of these documents is to provide guidance to those within United Utilities involved in the management and reporting of R&D/IFI projects to meet the requirements of ER G85 and IFI regulatory instruction and guidance.

4.1. Engineering Policy Decision 030: Research & Development

This policy defines the focus of research and development (R&D) activities required to deliver value to shareholders and to the end customer. R&D will generally aim to provide benefits that improve safety, reduce costs and improve customer service. R&D projects shall be assessed, approved and managed in accordance with CP030. Where possible a collaborative approach shall be applied to R&D activities to ensure maximum benefit for United Utilities' investment. The policy follows the principles set out in the industry guidelines within ENA Engineering Recommendation G85 "Innovation in Electrical Distribution Network Systems; A Good Practice Guide".

United Utilities will aim to supplement the funding of R&D activities from external funding sources and where appropriate take advantage of the Innovation Funding Incentive (IFI) introduced by Ofgem. Where appropriate, R&D activities will be reported annually to Ofgem in accordance with the Regulatory Information and Guidance (RIG). The application of the RIG for the IFI within United Utilities is described in CP031.

The policy embraces all R&D activities for the management and technical development of the electricity distribution networks up to and including 132kV, with the objective of delivering financial, supply quality, environmental and safety benefits to stakeholders. It shall be applied to the life management of R&D activities including:

- Innovation
- R&D providers
- Funding
- Approvals
- Project management
- Reporting

4.2. Code of Practice 030: Approval and Management of Research and Development Projects

This documents summarises and provides guidance to United Utilities project managers on the main points detailed in ENA Engineering Recommendation G85 "Innovation in Electrical Distribution Network Systems; A Good Practice Guide". The procedures are provided to ensure a consistent approach to the R&D process.

Suitable projects are assessed by the R&D Panel through a 'virtual sitting' by email voting. The R&D Panel is formed from eight members with a variety of backgrounds including Management, Electrical, Regulation, Financial and R&D. This virtual sitting ensures the approval process is time efficient, however, occasionally larger and more complex projects have required face to face meetings.

The Project Record Sheet, as provided to the R&D Panel for approval and covers the lifecycle of the projects, is divided into the following parts:

- PART A – Project Initiation
- PART B – Risk Assessment
- PART C - IFI Eligibility Assessment
- PART D – Project Approval
- PART E – Project Milestones Reviews
- PART F – Project Adoption
- PART G – Project Completion/Appraisal (including 12 month post-adoption review)

Code of Practice 030 concludes with the responsibilities, procurement of R&D, funding, budgets and internal reporting.

4.3. Code of Practice 031: Application of the regulatory information and guidance for the Innovation Funding Incentive

CP 031 describes the procedures to be adopted for the application of the Innovation Funding Incentive Regulatory Information and Guidance within United Utilities including reporting, timescales and responsibilities.

5. COLLABORATION

R&D/IFI projects will be completed internally or externally to United Utilities. This will depend on the stage within the innovation process, but it is more likely for projects at the demonstration phase to be undertaken internally. External R&D providers shall have the necessary depth of knowledge and experience to undertake an R&D project.

Where practicable, United Utilities have taken a collaborative approach to all R&D activities as this reduces the cost and risk involved. Consequently, it is expected that the majority of United Utilities' R&D projects will be collaborative. However, demonstration projects have incurred more internal costs as this involves trialling of equipment on the network and requires technical and practical activities.

Collaboration may take several forms including partnerships with:

- EA Technology Ltd
- Other research organisations
- Other Distribution Network Operators (either directly or via the EA Technology Strategic Technology Programme)
- Universities
- Manufacturers
- Consultants
- Internal United Utilities departments

Commercial agreements have been signed for various collaborative projects. A collaborative R&D programme with all other DNOs has been continued under the Strategic Technology Programme managed by EA Technology. Further projects have been formed with a smaller number of DNOs and single manufacturer developing a product or application to be utilised on the distribution network. Trials of new products or developed products that are new to the UK are being evaluated and in some cases this has lead to further development projects due to feedback from DNO's. IFI has initiated a spirit of 'working together' to develop new and re-engineer products with DNO's and manufacturers.

Whilst it is important to develop new or existing products and trial those products, it also important to collaborate with universities, as this valued applied research feeds into products and applications developed by manufactures and DNOs. United Utilities is presently working with a number of Universities, manufacturers and DNOs on several IFI projects. Many of these projects have additional funding via other sources and collaboration is high resulting in a reduced risk and provides a high gearing to the individual collaborator. It is hoped that some of these projects will produce bench-top demonstrations and lead on to further projects.

Departments and sections within United Utilities have been collaborating to trial products on the network. Feedback from operational staff has been relayed back to external collaborators. It has been important to involve field staff at the start of the projects to ensure there is a business need, to seek their view of the potential applications and to provide the highest likelihood of the business successfully adopting products.

Projects that show a high probability for adoption during the demonstration phase have lead to discussions with potential business adopters, in United Utilities, to determine the likely requirements for business cases and future budgets. This is to ensure a smoother and faster adoption process by the business and realisation of benefits to customers.

6. OUTLOOK

Projects initiated in 2005/06 will continue through into 2006/07 and even 2007/08 or beyond. It is planned for the IFI expenditure to be around the 0.5% allowable cap for 2006/07 based on the achievement of project milestones. However, project timescales may slide on some projects and milestone deliverables may not all be met. Projects may be closed or re-scoped in these cases. A number of new projects will be submitted for approval to United Utilities R&D Panel during 2006/07.

It is anticipated a number of projects will be completed. Some of the projects may be closed with no future work at that stage, whilst some will feed into other projects at various phases of the innovation cycle. A numbers of projects will be adopted by the business and a 12-month post-adoption view will be carried out by the business. It is planned that no projects will be adopted in 2006/07, but it is likely that a small number will be adopted 2007/08.

Projects that are likely to be adopted are:

- Voltage Regulator
- LineTracker
- Rezap Fault Master
- Distributed IO

7. CONSTRAINTS

Over recent years the R&D intensity had reduced to 0.1% of UUE turnover and the natural pressures from the RPI-X mechanism to encourage short term cost reductions were making it less likely that new R&D projects would be adopted. IFI has now stimulated R&D activity, including collaboration with R&D providers, manufacturers, academia and other DNOs. This report demonstrates we have projects already planned or committed that will take up the most of the IFI allowance for both this year and next. It is hoped that this level of expenditure could be sustained in the future by continuation of IFI, moderating the general pressure arising from price cap regulation on R&D expenditure.

Turning now to the constraints we wish to identify in the current design of the IFI scheme.

Turnover cap

The current scheme is only specified up to March 2010. The uncertainty as to what, if any, mechanism will apply in the next review period is going to very rapidly lead to a constraint in accepting new projects that run over a period of years. From next year (06/07) we will only be able to consider projects of 3 years duration or less if we want to be assured of funding. In order to provide some certainty a commitment from Ofgem for the next review period would be required. The tapering of the value of IFI compounds this problem – in the years when projects are most likely to run over the 2010 cliff-face, the proportion of costs that are recoverable is reduced. Without confidence in the post 2010 regime, we may find it much more difficult to identify projects that use our allowance in the final years of the current scheme.

In this environment, we would prefer to have more flexibility on the sculpting of our expenditure across the five years, whilst recognizing that an overall cap applies for the five year period. This would be likely to bring forward the schedule of R&D projects and therefore the timing of likely customer benefits. An alternative would be to increase the 0.5% turnover cap in the expectation that it would not be reached in the later years of a price control period. The overall five year R&D total spend would not necessarily be any higher but more of the spend would happen earlier, bringing forward the timing of customer benefits.

Internal funding

In our experience, the limit on internal expenditure set at 15% is a constraint on efficient R&D. In order for companies to extract the greatest benefit from R&D projects they need to be championed internally and not just bought in from external providers. Furthermore, the ultimate intention will always be to adopt the results of the research project for application within the company. This process is easier and less costly if there has been involvement in the project from the internal teams who will eventually have to lead the adoption process. This all increases the amount of internal costs for the project and we expect that, as a general rule, internal costs will fall between 20-30%. At present there is a process for applying to Ofgem and approval to be given for any internal costs

above 15%. However, if it is expected that internal costs are routinely above 20% then it seems sensible to revise this limit to that which reflects good practice and experience.

Adoption costs

A significant part of the total costs of converting R&D into operational practice is the cost of adoption. Once a new device or procedure has been proven in a test environment, it will often need to be rolled out across a whole network in order to achieve the full benefits. In our view, the approach to project review in the Good Practice Guide is flawed because the forecast adoption costs are not incorporated in the NPV calculation. If the benefits of implementation are to be claimed, then so must the costs of achieving the roll-out that releases those benefits. There is otherwise a danger that the NPV calculations artificially inflate the likely benefit of any particular project.

8. CONCLUSIONS

United Utilities have been pro-active in developing and issuing internal policies and procedures that align with national documents. The processes now in place ensure an effective and efficiently managed programme of 25 projects. Further projects will be added to the portfolio of R&D projects during 2006/07. United Utilities have a strong focus on the whole project lifecycle and in particular the realisation of project benefits when adopted by the business. All layers of management within United Utilities are committed to maximising the benefits of IFI and R&D projects.

Whilst there are constraints with the IFI mechanism (2010 'cliff-face', Turnover and Internal Cap) it is hoped the positive impact on R&D would be able to continue beyond 2010 and an early indication would ease concerns within Untied Utilities.

The introduction of the Innovation Funding Incentive has stimulated R&D back into the industry. DNOs, manufacturers and academia are actively working closer together to develop ideas, solutions and products to benefit customers. In particular, the barrier of financial risk has been reduced to the manufacturer and DNO, which has resulted in more product developments that meet the needs of United Utilities. These strong partnerships will lead to further projects and United Utilities has put in place a number of R&D Framework Agreements to help develop ideas quickly. Without IFI none of this would have happened.

A1. INDIVIDUAL IFI PROJECT REPORTS

Throughout 2005/06 United Utilities have had 25 active projects. Work has focused on technical and commercial approval of projects. Considerable resources have been involved in working on and agreeing collaboration agreements with R&D providers and manufactures, which have delayed the start up of some projects.

UU1 to UU 4 forms the core of R&D activities in the industry with the majority of DNO's participating. The output from these activities result in improvements to maintenance processes, company specification, services and products. UU16-UU19 are projects managed by Steering Groups at the Energy Networks Association (ENA). The remaining projects are either project managed in-house or R&D providers/manufactures, while the whole IFI/R&D programme is managed in-house.

<table>
<tr><td>Description of project</td><td colspan="5">UU1 - Strategic Technology Programme Overhead Network Module</td></tr>
<tr><td rowspan="2">Expenditure for financial year</td><td>Total</td><td>External</td><td>Internal</td><td rowspan="2">Expenditure in previous financial years</td><td rowspan="2">£19,250</td></tr>
<tr><td>£40,000</td><td>£36,000</td><td>£4,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">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</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Technical Substitution / Radical</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">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.</td></tr>
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	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			
Expected Timescale to adoption	Range 1-7 years - dependent on project		Duration of benefit once achieved	Range 2-10 years - dependent on project	
Estimated Success probability (at start of project)	Range 5-20% - dependent on project				
PV of Project Costs	£40,000	PV of Project Benefits	£54,600	NPV of Project	£14,600
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.

<table>
<tr><td>Description of project</td><td colspan="5">UU2 - Strategic Technology Programme Cable Module</td></tr>
<tr><td rowspan="2">Expenditure for financial year</td><td>Total</td><td>External</td><td>Internal</td><td rowspan="2">Expenditure in previous financial years</td><td rowspan="2">£19,250</td></tr>
<tr><td>£40,000</td><td>£36,000</td><td>£4,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">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.

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 cable 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 for 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.</td></tr>
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	• 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 5-30% - dependent on project				
PV of Project Costs	£40000	PV of Project Benefits	£59,500	NPV of Project	£19,500
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.

<table>
<tr><td>Description of project</td><td colspan="5">UU3 - Strategic Technology Programme Plant Network Module</td></tr>
<tr><td rowspan="2">Expenditure for financial year</td><td>Total</td><td>External</td><td>Internal</td><td rowspan="2">Expenditure in previous financial years</td><td rowspan="2">£19,250</td></tr>
<tr><td>£40,000</td><td>£36,000</td><td>£4,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">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.

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.</td></tr>
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	• 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 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	Range 1-5 years - dependent on project	Duration of benefit once achieved	Range 2-7 years - dependent on project

Estimated Success probability (at start of project)	Range 1-20% - dependent on project				
PV of Project Costs	£40,000	PV of Project Benefits	£64,200	NPV of Project	£24,200
• 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 reliably detect/indicate 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.

<table>
<tr><td>Description of project</td><td colspan="5">UU4 - Strategic Technology Programme Distributed Generation Module</td></tr>
<tr><td rowspan="2">Expenditure for financial year</td><td>Total</td><td>External</td><td>Internal</td><td rowspan="2">Expenditure in previous financial years</td><td rowspan="2">£19,250</td></tr>
<tr><td>£40,000</td><td>£36,000</td><td>£4,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The projects undertaken through budget year 2005/6 were aimed at enabling cost effective connections and ensuring techniques are in place to plan, operate and manage networks with significant amounts of generation. Most projects also had positive impacts on safety and environmental performance. The projects all addressed real problems that had been identified by the module steering group members as significant and which required technical investigation and development.

The projects undertaken within the programme during 2005-06 (include some approved in previous years) aimed to:
<u>Projects in Progress</u>
• S5138 – Review of Industry Codes
• S5147_3 – Monitor Microgenerator Clusters
• S5149_4 – Explore Active Voltage Control
• S5150_2 – Review G59/1 and G75 Protection and identify improvements
• S5151_3 – Model Network Risk
• S5142 – Define Generator Data and Structure for DG Connection Applications
• S5154_1 – Develop a Voltage Control Policy Assessment Tool on the IPSA Platform
• S5155_1 – Explore Lower Cost Connection Solutions for Distributed Generation
• S5157_1 – Evaluate the Performance of Small Scale Reactive Power Compensators
<u>Completed Project Stages</u>
• S5144 – Workshop on Regulatory and Economic Issues
• S5145 – Dynamic Circuit Ratings
• S5147_1 - Microgeneration Clusters
• S5149_1 - Active Voltage Control
• S5150 Stage 1 – G59 and G75 Protection
• S5151_1– Network Risk Modelling
• S5133 – Tapchangers Reverse Power Capabilities
• S5143 – Produce a Draft Code of Practice on Stability
• S5149 Stages 2 & 3 - Active Voltage Control
• S5151 Stage 2 – Network Risk Modelling
• S5152_1 – Examine the Latest Developments in the Connection of Distributed Generation</td></tr>
</table>

Type(s) of innovation involved	Incremental / Significant / Technological Substitution				
Expected Benefits of Project	With government policy driving significant increases in generation connection to distribution networks the members need a range of innovative solutions to connection and network operation issues that are cost effective and which maintain the present level of network reliability and safety. If the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain benefits including: • Reducing the probability of voltage supply limit excursions resulting from increased distributed generation (eaVCAT interface to IPSA software tool); • Improving quality of supply and reducing risk of component failure (by understanding the effect and optimising use of impedance in the system); • A better understanding of the risk presented by the distribution assets when considered as a network rather than discrete components.; • Greater use of distributed generators to meet current DNO obligations (by assessing, from a DNO perspective, the implications of pending Distribution Code provisions relating to distributed generation); • Reducing the amount of reinforcement needed (by use of dynamic ratings to allow network components to be used to their full capability) - the use of dynamic circuit ratings is a vital step in the move towards active management of networks.				
Expected Timescale to adoption	Range 1-5 years - dependent on project		Duration of benefit once achieved	Range 2-7 years - dependent on project	
Estimated Success probability (at start of project)	Range 1-20% - dependent on project				
PV of Project Costs	£40,000	PV of Project Benefits	£57,100	NPV of Project	£17,100
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. • *S5147_3 – Microgenerator Clusters.* Installation of monitoring points is currently underway and a new substation is being commissioned. Monitoring will commence upon completion of installation and commissioning.				

	• *S5149_4 – Explore Active Voltage Control.* Modelling of typical radial and interconnected networks in preparation for flexing key parameters to examine limits of active voltage control. • *S5150_2 – G59/1 and G75 Protection.* An initial review is complete and further work is pending results from allied university project. • *S5151_3 – Model Network Risk.* Following establishment of user requirements and review of available risk models and approaches is being undertaken. • *S5142 – Define generator Data and Structure for DG Connection Applications.* The generator data has been identified and a data structure agreed. Rationalisation of this data should now be considered. • *S5154_1 – Develop a voltage Control Policy Assessment Tool on the IPSA Platform.* The interface between the existing eaVCAT software and the widely used IPSA power system analysis software has been developed and is currently being tested. • *S5155_1 – Explore Lower Cost Connection Solutions for Distributed Generation.* This project is at the information gathering stage, but intends to identify lower cost solutions. • *S5157_1 – Performance of Small Scale Reactive Power Compensators.* Four devices have been identified and detailed information is being collated. User requirements are being sought from members. <u>Completed Project Stages</u> • *S5144 – Workshop on Regulatory and Economic Issues.* A workshop to ensure the regulatory and economic environment is fully understood to assist selection of most appropriate technical developments. • *S5145 – Dynamic Circuit Ratings.* A report has been produced which summarises international work to date, evaluates available technologies and examines how these could be applied to UK distribution networks. • *S5147_1 – Monitor Microgeneration Clusters.* The Project Initiation Document has been prepared and approved. • *S5149_1 – Explore Active Voltage Control.* The Project Initiation Document has been prepared and approved. • *S5150 Stage 1 – G59 and G75 Protection.* The Project Initiation Document has been prepared and approved. • *S5151_1– Model Network Risk.* The Project Initiation Document has been prepared and approved. • *S5133 – Tapchangers Reverse Power Capabilities.* It was concluded that under certain conditions there is an increased probability of internal flashover for single compartment tap-changers with single transition resistors. Steps should be taken to increase the maintenance frequency or de-rate the tap-changer to negate these affects.

	• *S5143 – Draft Code of Practice on Stability.* The draft code of practice can be used to develop policy within each member company. It will facilitate the connection of distributed generation by providing a guideline on stability issues. • *S5149 Stages 2 & 3 - Active Voltage Control.* An overview of current control practices and how distributed generation impacts on them has been produced and a workshop held to explore the specific issues. This provides a firm basis for in depth studies of how active voltage control can be implemented and its advantages and disadvantages in different situations. • *S5151 Stage 2 – Model Network Risk.* The user requirements of a network risk model have been defined, documented and agreed and will be used to direct subsequent stages of the project. • *S5152 – Latest Developments in the Connection of Distributed Generation.* Regular updates on new developments have been provided to members to help inform and influence the research programme.

Description of Project	UU5 - Condition Based Risk Management (CBRM)				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£15,000
	£16,041	£13,697	£2,344		
Technological area and/or issue addressed by Project.	Condition Based Risk Management (CBRM) is a methodology that uses all available knowledge, experience and information relating to physical assets in order to define the present condition of the asset and then estimate future performance on the basis of ongoing degradation				
Type(s) of innovation involved	Incremental Innovation				
Expected Benefits of Project	Financial - better targeting of Asset Replacement, methodology to justify reduction in Capex whilst maintaining fault rates at their current level. Supply Quality, Environmental and Safety - removal of assets most likely to fail				
Expected Timescale to adoption	3 years	Duration of benefits once achieved	5 years		
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£157,474	PV of Project Benefits	£353,678	NPV of project	£196,204
Commentary on project progress and potential for achieving expected benefits	Considerable work has been completed in-house in developing the Health Index algorithms for 33/11kV switchgear, and in identifying and developing the way forward for the remaining asset groups. Work has started to specify work packages for the development of HIs in some asset groups. In addition we have been working with EA Technology to develop a clearer understanding of the probability of failure. The Condition Data Capture system has been developed and fully implemented for distribution substations, and work has progressed on the development of the grid and primary and wood pole CDC systems.				

Description of Project	UU6 - Criticality Assessment				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£9,500
	£62,887	£55,822	£7,065		
Technological area and/or issue addressed by Project.	The key elements of this approach are Investment, Maintenance, Operation and Service and their effect on Company risk and profit. Criticality assessment helps to identify the optimum intervention strategy for an asset, a combination of investment in new assets, maintenance and operation, to deliver the desired level of service for the business.				
Type(s) of innovation involved	Incremental Innovation				
Expected Benefits of Project	Financial - better targeting of Asset Replacement which may result in reduced network investment Supply Quality, Environmental, Operational and Safety - removal of assets most likely to fail				
Expected Timescale to adoption	3 years	Duration of benefits once achieved	5 years		
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£159,282	PV of Project Benefits	£353,678	NPV of project	£194,396
Commentary on project progress and potential for achieving expected benefits	It has taken longer than expected to carry out a pilot project based on distribution substation sites and to modify the corporate asset record systems. This pilot has identified the efficiencies that can be obtained from information held and managed by UU ADR (Asset data records), these lessons will be used more extensively as the project develops.				

Description of Project	UU7 - Alternative Oils for Transformers				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£10,400
	£21,040	£17,740	£3,300		
Technological area and/or issue addressed by Project.	Evaluation of the characteristics of alternative oils for retro-filling power transformers and for use in new transformers				
Type(s) of innovation involved	Technological substitution				
Expected Benefits of Project	The benefits of using alternative oils in transformers are based around two main points, safety/environment and lifetime ageing performance				
Expected Timescale to adoption	7 years	Duration of benefits once achieved	20 years		
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£24,057	PV of Project Benefits	£40,429	NPV of project	£16,372
Commentary on project progress and potential for achieving expected benefits	Work has been completed on the impact of moisture on dielectric strength of mineral oil, Midel and natural ester oil. A methodology for ageing the oils has been developed and the effect on chemical stability, breakdown voltage and impulse strength investigated. The next stage is to carry out studies into the performance of the various oils on impregnated cellulose and large gaps.				

Description of Project	UU8 - GROND - Assessment of HV Network and Policy Module				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£10,300
	£11,100	£9,300	£1,800		
Technological area and/or issue addressed by Project.	Carry out a full assessment of HV network performance for all parts of the network where improvements in performance can make a significant contribution to overall network performance. It is intended that the methodology used could be repeated at intervals to review improvements due to investment and or increased operating efficiency as well as deterioration caused by ageing of the network				
Type(s) of innovation involved	Incremental Innovation				
Expected Benefits of Project	Ensuring that capital expenditure on improving the performance of the network will be optimised both in respect of applying the expenditure to circuits where the greatest benefit can be obtained and also in respect of the number and location of switching and protection devices applied to those circuits				
Expected Timescale to adoption	3 years	Duration of benefits once achieved	5 years		
Estimated Success probability (at start of project)	75%				
PV of Project Costs	£18,334	PV of Project Benefits	£371,362	NPV of project	£353,028
Commentary on project progress and potential for achieving expected benefits	The final report, together with software enhancements to GROND, have been delivered. Effective implementation can be expected and is now dependent on the application of the recommendations and software within the business.				

Description of Project	UU11 - Reference Networks - Phase 2				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£16,000
	£55,660	£54,360	£1,300		
Technological area and/or issue addressed by Project.	Phase II of the project will produce a practical software tool to create optimum disaggregation groups and analyse existing networks and proposed performance improvement strategies				
Type(s) of innovation involved	Incremental				
Expected Benefits of Project	Ensuring that capital expenditure on improving the performance of the network will be optimised both in respect of the type of improvement work to be considered and in applying the improvements to circuits where the greatest benefit can be obtained. Providing a standardised method for comparing the performance of different types of circuit, both internally within United Utilities and externally between DNOs.				
Expected Timescale to adoption	3 years	Duration of benefits once achieved	5 years		
Estimated Success probability (at start of project)	75%				
PV of Project Costs	£52,689	PV of Project Benefits	£318,310	NPV of project	£265,621
Commentary on project progress and potential for achieving expected benefits	Good progress is being made in ensuring that the reference networks derived by the developing software are truly representative of the real networks from which they are derived. Following the analysis of the representation of underground networks and overhead networks, work on mixed networks has highlighted the benefits of dividing circuits into protections zones for analysis. This will have some repercussions on the methods to be used for non-mixed networks. United Utilities has now supplied the data about its network, as has Central Networks, East. An additional DNO (2 Licences) is now expected to join the project and arrangements are expected to be put in hand for the supply of its data. The project remains on-track to achieve the expected deliverables in October 2006. Some additional data analysis is then expected to follow at no cost to UU.				

Description of Project	UU12 - Distribution Transformer with on-load tap changer				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£0
	£52,414	£46,114	£6,300		
Technological area and/or issue addressed by Project.	Increased penetration of DG on the LV network, particularly domestic combined heat and power (DCHP) units, is expected to have a significant adverse affect on the voltage regulation. This is a concern especially when a large number of DCHP units are installed in existing properties within a small geographical area. The LV network would be established, and not therefore designed to accomodate the potential voltage effects of the generation.				
Type(s) of innovation involved	Significant				
Expected Benefits of Project	If successful the distribution transformer with on-load tap-changer facility would provide a simple solution to the problem and minimise the disruption to customer supplies. This solution would also negate the requirement to install new distribution substations and associated cable, therefore reducing costs and the environmental impact.				
Expected Timescale to adoption	3 years		Duration of benefits once achieved	5 years	
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£210,103	PV of Project Benefits	£409,913	NPV of project	£199,810
Commentary on project progress and potential for achieving expected benefits	Project Inception meeting held to confirm scope, specification and plan. Work Package 1 "Design, Simulation and Specification" has been completed and work is underway on Work Packages 2 and 3.				

Description of Project	UU13 - NaFIRS HV Fault Data				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£0
	£26,572	£25,272	£1,300		
Technological area and/or issue addressed by Project.	The main aim was to identify and capture key specific parameters from the NaFIRS and related data, which can be used to improve modelling studies of the HV network and which can also be used to monitor changes in the long term condition of the HV network and identify poorly performing components and network. For the latter it was especially important that the statistical variation was established so that significant changes could be recognised and action taken where necessary.				
Type(s) of innovation involved	Incremental				
Expected Benefits of Project	Ensuring that the fault performance of the network will be optimised both in respect of the operational techniques to be applied and in the collection of statistical data relevant to the performance of individual circuits. Consistently poor performance of particular circuits and types of equipment will be identified, leading to the identification of cost-effective methods of performance improvements.				
Expected Timescale to adoption	3 years		Duration of benefits once achieved	5 years	
Estimated Success probability (at start of project)	75%				
PV of Project Costs	£25 272	PV of Project Benefits	£660 000	NPV of project	£634 728
Commentary on project progress and potential for achieving expected benefits	The final report has been produced. The benefits will be obtained, only after the report has been assimilated by United Utilities and the indicated actions determined and completed.				

<table>
<tr><td>Description of project</td><td colspan="5">UU 14 - SuperGen V</td></tr>
<tr><td rowspan="2">Expenditure for financial year</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>£52,800</td><td>£50,000</td><td>£2,800</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The EPSRC (Engineering and Physical Sciences 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</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Technical Substitution / Radical</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">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</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">12 Years</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
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Estimated Success probability (at start of project)	25%				
PV of Project Costs	£86,628	PV of Project Benefits	£160,119	NPV of Project	£73,491
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.				

<table>
<tr><td>Description of project</td><td colspan="5">UU15 - Fibre Comms</td></tr>
<tr><td rowspan="2">Expenditure for financial year</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>£13,334</td><td>£8,617</td><td>£4,717</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The project is a trial of new technology numeric line current differential relays using digital communications over UUE’s SDH fibre network.

Project Aims

• To trial the relays using a number of different communications configurations and paths. This will inform on the use of such relays over the UU SDH network and the actual communications requirements. The trial will include direct fibre, multiplexed fibre and mixed fibre/copper communications paths.

• To ensure that the relays trialled using digital communications operate correctly for in zone and are stable for out of zone faults. (The circuits chosen have poor fault history and are associated with other circuits with poor fault history)

Project Objectives

• To ensure that with an ageing population of traditional relays and pilot cables, there will be an option that provides a completely new system of unit protection not relying on unsupervised copper pilot cables.

At 132kV, protection commonly uses rented BT circuits. This is used for line current differential, distance protection and intertripping. Experience gained in the trial will assist in the migration of these functions to the UUE fibre network. This is particularly important as proposed changes to the BT system (21st Century Network) may render it unusable for protection schemes.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Technical Substitution / Radical</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Financial

• There are about 30 pilot faults per annum at a cost of £11k per annum (Likely to rise with lane charging). Most of this cost could be avoided as protection is migrated to the SDH network.

• There are a number of important pilot cables reaching the end of their life and some will need replacement in the near future unless alternatives are available. The SDH network provides an</td></tr>
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	existing alternative that can be utilised once the equipment has been trialled. If the replacement of a single pilot cable can be avoided, the saving could be in the order of £500k. **Supply Quality/Safety/Operational.** Benefits in all the above areas will be achieved by continued correct operation of protection.				
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	£18,868	PV of Project Benefits	£1,003,380	NPV of Project	£984,512
Commentary on project progress and potential for achieving expected benefits	Equipment has been installed at trial sites and is operating without problem. A programme of testing and using alternative communication paths is ongoing. High potential for achieving expected benefits.				

Description of project	UU16 - Lightning Protection				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£0
	£1,800	£0	£1,800		
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	£324,932	PV of Project Benefits	£380,403	NPV of Project	£55,471
Commentary on project progress and potential for achieving expected benefits	Document is close to completion.				

Description of Project	UU17 - Fault Level Monitor				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£0
	£5,800	£4,000	£1,800		
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	£790,556	PV of Project Benefits	£322,347	NPV of project	£92,049
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. As a matter of expediency, it is expected that these substations will be chosen within the United Utilities and Manweb Distribution Licence areas. Progress to date has been restricted to discussion of the specification of suitable power quality measuring instruments and potential substation sites.				

<table>
<tr><td>Description of project</td><td colspan="5">UU18 - Functional Spec - ROCOF Relay</td></tr>
<tr><td rowspan="2">Expenditure for financial year</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>£1,800</td><td>£0</td><td>£1,800</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">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.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Incremental</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">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</td></tr>
</table>

	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)	75%				
PV of Project Costs	£3,208	PV of Project Benefits	£90,378	NPV of Project	£87,170
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.				

<table>
<tr><td>Description of project</td><td colspan="5">UU19 - Earthing Projects</td></tr>
<tr><td rowspan="2">Expenditure for financial year</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>£6,800</td><td>£5,000</td><td>£1,800</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 either the hazard posed by such an earth electrode or the possible effects of the earth when connected to a distributed system on the ROEP contours.

• This project will if successful determine these effects and provide a means to provide cost effective safe earthing systems without the need for extensive separations between HV and LV electrodes which in a PME system may be impractical to achieve and maintain.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Incremental</td></tr>
</table>

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	£24,137	PV of Project Benefits	£110,534	NPV of Project	£91,581
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.				

<table>
<tr><td>Description of project</td><td colspan="5">UU20 - LineTracker Trial</td></tr>
<tr><td rowspan="2">Expenditure for financial year</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>£31,610</td><td>£24,190</td><td>£7,420</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The LineTracker is a fault and load monitor device, whereby data is downloaded by wireless radio link either up to 100m away or back to the control room or office via GSM PMR etc. The LineTracker can be installed and removed live on HV overhead lines by Gripall Live Line rods up to 11kV. The technology has been designed and manufactured in Australia.
The key aims:
Trail LineTracker on United Utilities overhead network to assess the potential benefits to United Utilities. The devices will be assessed in reinforcement assessment, HV unbalance, operation and grading of overhead protection devices, assessment of the operation of HV voltage stabilisers and intermittent, transient and permanent faults.
Develop a Live Line trial procedure for installation/removal of the LineTracker by a single line team. It is intended to only install the device on 'Clean poles'.
Train a small number of engineers to download data and Line teams to install/remove devices from live overhead conductors (6.6/11kV) to allow for trials on the overhead distribution network in a variety of situations and location through United Utilities.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Technological Substitution</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• Deferred/part Reinforcement resulting in financial saving of £30,000pa
• Confirmations of outage circuit loading where circuit ratings are near capacity in an outage. Reduce stressing of the network in an outage.
• Checking Unbalance on the Overhead network, which may be overloaded in normal running or outage. Checking unbalance with the operation of trial HV Voltage Stabilisers in the Great Eccleston, Near Preston. Improved Power Quality. Reduction in customer complaints.
• Intermittent, transient and permanent faults.
• Correct operation of GVR/protection and grading. LineTracker senses voltage on or off and load/fault current between 5-25,000 Amps.</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>
</table>

Estimated Success probability (at start of project)	75%				
PV of Project Costs	£28,035	PV of Project Benefits	£139,043	NPV of Project	£111,008
Commentary on project progress and potential for achieving expected benefits	Three sets of Linetrackers , Datalink and Live Line (LL) Rods have been purchased for the trial. A LL procedure was developed and appropriate linesman and engineers have been trained. Some units have been installed for power quality problems, however, there are difficulties in obtaining sufficient trained linesmen to install the LineTrackers and additional linesmen have been trained. There haven't been enough installations to assess the potential applications or benefits to date.				

Description of project	UU21 - LineTracker Development				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£0
	£111,742	£106,442	£5,300		
Technological area and / or issue addressed by project	The LineTracker is a fault and load monitor device, whereby data is downloaded by wireless radio link either up to 100m away or back to the control room or office via GSM PMR etc. The technology has been designed and manufactured in Australia. A trial of the 'standard' LineTracker is being carried out under UU20 - LineTracker Trial. The objective is to develop LineTracker to assist in determining dynamic conductor ratings. The key aims are to add conductor and ambient temperature, upto 132kV voltage and larger conductor applications. Present conductor ratings based on the load current and typical ambient temperature in winter, spring/autumn and summer. The table rating of conductors are defined in ENA Engineering Recommendation P27, which was based on experimental work carried out some years ago. Actual temperature measurements and profiles would assist in determining maximum conductor loading for specific overhead lines and defer or reduce investment in load related cases.				
Type(s) of innovation involved	Incremental Development				
Expected Benefits of Project	The temperature and ambient enhancement would give the following benefits: • Record a profile of temperatures and load currents • Allow the maximum load flow through conductors • Reduce the capital investment of reinforcing overloaded circuits at 11/33/132kV • Assist the connection of Distributed Generation				
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	£128,337	PV of Project Benefits	£1,019,646	NPV of Project	£891,308
Commentary on project progress and potential	United Utilities has agreed the development of LineTracker and collaboration agreement with Gridsense. Formal reporting has being provided at each milestone and the project is progressing to the				

for achieving expected benefits	scheduled timescales and costs. Collaboration is expanding to include Scottish Power-Manweb and this is nearing conclusion. The project should be completed in July 2006 with a number of prototype units available for trial. It may be necessary to purchase additional devices to allow a reasonable assessment of the developed devices in various applications. This will give a greater understanding of the potential benefits, which will be needed to build a case for adoption. There is clearly a link between the trial work carried out under UU20 and the communication development of the ihost platform carried out in UU27. It is anticipated that United Utilities and Scottish Power will collaborate in a trial of the developed devices and share the experience of the trial.

<table>
<tr><td>Description of project</td><td colspan="5">UU22 - Distributed IO</td></tr>
<tr><td rowspan="2">Expenditure for financial year</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>£91,556</td><td>£88,756</td><td>£2,800</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">In order to rationalise substation design the use of distributed fibre optic communications is to be proven via trialling.
Key aims:-
• Bench test the new RTU equipment (standalone)
• Test with existing 132kV substation control system
• Test with fibre communications
• Extended trial to include distributed RTU's

The latest fibre comms technology to be used within BSP Grid and Primary substation design means the current MICROSOL RTU needs to be deployed using a distributed I/O approach. This requires development of remote cell technology. A cell would be installed in each protection cabinet, communicating via a fibre ring back to the main and standby comms cabinet. The cell would interface to the Substation plant locally within each protection bay via klippon links eliminating the need to hardwire back to the MICROSOL cabinet via a marshalling cabinet. This would initially be as stand-alone but with the capability to integrate directly to the RTU subject to the interface protocol being agreed.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Technological Substitution</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Development of a distributed I/O technology enables a standard build to be used for all new Substation installations resulting in the following benefits:-
• The use of distributed RTU's and fibre communication will greatly reduce the amount of hardwiring required. Savings are achieved by not having to hard wire each individual plant item back to a single RTU cabinet.
• Saving in installation/commissioning costs of £1,278,000
• It is anticipated the installation/commissioning time-scales would be reduced with the installation of Distributed IO and a Fibre Ring.
• The capability for future integration to intelligent protection devices would enable relay management and retrieval of substation data to be achieved both locally and remotely.</td></tr>
</table>

	• A fibre-based system does not suffer from electrical interference or induced voltage resulting in less potential mal-operations of relays and communication systems, plus a safer system of work.				
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	£328,430	PV of Project Benefits	£665,132	NPV of Project	£336,702
Commentary on project progress and potential for achieving expected benefits	As the current central system database restricted the maximum number of cells in a RTU to six, it was agreed to expand this to 32 cells to cater for any future distributed installations. Each of the cells would be capable of supporting 64 digital inputs, 32 digital outputs and 32 analogue inputs. The cells were to be capable of being distributed throughout a substation, initially located within protection panels hardwired to the relays, but with the capability of being deployed in remote installations on the site connected by fibre. Orders were placed with THALES the central system supplier and VERTEX the user database maintainer, and work was initiated on the above work package. UUNW and contract staff were engaged and work started on base-lining the existing non-distributed system for performance and stability benchmarks. Further to technical meetings with MICROSOL, our existing RTU supplier, orders were placed for fibre interface modules, patch cords, attenuators, test equipment and RTU hardware to enable a test bed to be set up in the workshop. Work was started on the test bed build, utilising a mixture of fibre and screened twisted pair RS-485 communication methods.				

Description of project	UU23 - Vista (Mapping Underground Assets)				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£0
	£2,182	£382	£1,800		
Technological area and / or issue addressed by project	UKWIR successfully bid for DTI funding and will be project managing the £2.4 million VISTA project. It will investigate the use of global navigation satellite technology linked to existing asset records to produce 3-D images of utilities' underground assets The project is supported by £0.9 million of DTI funding with over 20 collaborators, covering a wide range of utilities in the UK.The project will be carried out by the Universities of Leeds and Nottingham				
Type(s) of innovation involved	Radical				
Expected Benefits of Project	• The timing of the research is opportune given that the *Traffic Management Act* will require all utilities to exchange digital (GIS) asset location information by June 2008 • Utilities open up 4 million holes in UK streets each year at an estimated cost of £1bn with indirect costs of £4bn. With 750,000 km of water mains and sewers, there are large potential savings to be made by UKWIR members and other utilities in rapidly and accurately locating assets without inflicting third party damage				
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	£18,394	PV of Project Benefits	£288,487	NPV of Project	£270,094
Commentary on project progress and potential for achieving expected benefits	A small sample data has been collected from utilities and a further larger sample will be required once the format of data is understood.				

<table>
<tr><td>Description of project</td><td colspan="5">UU24 - Fault Master</td></tr>
<tr><td rowspan="2">Expenditure for financial year</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>£106,376</td><td>£101,576</td><td>£4,800</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Kelman Ltd has developed a new version of the rezap with additional potential beneficial features. It is proposed to trial the new equipment by installing units on transient LV faults.
Aims:-
• Controlled trial and development of the Re-zap Fault Master on LV Transient Faults
• Develop Firmware/software interface to CRMS/Cifms
• Develop additional features ie Mobile phone control, Auto-reset
Objectives:-
• Develop accuracy and effectiveness of distance to fault location.
• Assess effectiveness of Fault Thumping mode
• Assess/develop effectiveness of location tracking mode
• Develop/assess effectiveness and compatibility when used with other fault location devices produced by Kelman and others
• Develop remote/auto resetting and re-closing fault Master. Both Remote via Rezap Control software and Mobile phone technology.
• Modular Rezap for Outdoor Substations</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Technical Substitution / Radical</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Financial
Could reduce the number of joint holes required during fault location.
Quality of Supply
A reduction in joint holes would save 1.5 hrs /hole. Assuming average of 30 customers /fault. 45 CML/fault, 11250 CML/annum. If the rezap FM could be reset remotely or Auto-reset this would reduce the number of CI and CML's except in situation in which the fault condition changes to a permanent fault. In this case the rezap may be re-closed remotely under certain criteria, which would need a risk assessment and a change in operational policy.
Safety.
Reducing excavations and live jointing reduce the risk
Environment
Reduction in joint holes saves environmental impact on landfill.</td></tr>
</table>

Expected Timescale to adoption	3 Years		Duration of benefit once achieved	10 Years	
Estimated Success probability (at start of project)	50%				
PV of Project Costs	£92,204	PV of Project Benefits	£387,929	NPV of Project	£295,726
Commentary on project progress and potential for achieving expected benefits	United Utilities and Kelman have agreed an R&D Framework agreement to develop a number of additional features on the Rezap Fault Master. UU have agreed to collaborate with Kelmans (manufacturer) and EDF in a trial on the Rezap Fault Master and additional Rezap FM developments.				

<table>
<tr><td>Description of Project</td><td colspan="5">UU25 - LV Voltage Regulator</td></tr>
<tr><td rowspan="2">Expenditure for financial year</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>£1,300</td><td>£0</td><td>£1,300</td></tr>
<tr><td>Technological area and/or issue addressed by Project.</td><td colspan="5">The Low Voltage (LV) voltage regulator is a single-phase voltage regulator, has been adapted for mounting on a wood pole and connected into the LV line to providing fast response voltage compensation for both over and under-voltages. Two Prototype units from US manufacturer MicroPlanet have been used in a limited trial on the SP-Manweb network in collaboration with SP PowerSystems.

Aims

This project seeks to undertake an extended field trial with detailed monitoring in UU to ascertain the devices short / medium term performance and potentially the full type approval of the device. It is envisaged that this device will primarily used as a means of rapidly resolving voltage complaints in rural areas. It may be capable of both temporary and permanent solutions dependent on the type of complaint and the economics of the situation. Where there is a clear case for network reinforcement, which would require time to engineer, the voltage regulator could be used to resolve the complaint whilst a reinforcement scheme is designed, wayleaves negotiated and construction undertaken. Where the voltage complaint is due to disturbing loads or unidentified causes it could provide a permanent solution due to the fast response of the device to voltage dips and sags. Where voltage rise is caused by Small Scale Embedded Generators (SSEG’s) the regulator could be used to maintain the local network within statutory voltage limits. There may be an eventual case where LV voltage regulators are used to maintain statutory voltages, to compensate for a less static voltage on the 11kV networks due to an increased penetration of distributed generation.

Objectives

• Short term performance, ensuring devices give an appropriate output and improve network voltages to within statutory limits.

• Long term performance, ensuring the reliability, longevity and robustness of the devices.

• Network uses, assessing the use of the units as temporary device for relieving voltage complaints vs more permanent measures.

• Alternative, previously unidentified uses for the product.</td></tr>
</table>

Type(s) of innovation involved	Technological Substitution				
Expected Benefits of Project	**Financial** Where there is a clear case for network reinforcement, which would require time to engineer the most cost-effective solution. The voltage regulator could be used to resolve the complaint whilst a reinforcement scheme is designed, wayleaves negotiated and construction undertaken and/or a permanent solution in cases of one or two customers. **Quality of Supply** Where the voltage complaint is due to disturbing loads or unidentified causes it could provide a permanent solution due to the fast response of the device to voltage dips and sags. Where voltage rise is caused by Small Scale Embedded Generators (SSEG's) the regulator could be used to maintain the local network within statutory voltage limits. There may be an eventual case where LV voltage regulators are used to maintain statutory voltages, to compensate for a less static voltage on the 11kV networks due to an increased penetration of distributed generation.				
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	£71,841	PV of Project Benefits	£247,187	NPV of project	£175,346
Commentary on project progress and potential for achieving expected benefits	United Utilities and Scottish Power have agreement to jointly trial a LV Voltage Regulator developed by SP and Micro-planet. This will involve installation of the regulators on LV poles or in GRP housings. Training of staff is planned for July/August 2006.				

Description of Project	UU26 - Super-conducting Fault Current Limiter (SFCL)				
Expenditure for financial year	Total	External	Internal	Expenditure in previous financial years	£0
	£12,114	£5,314	£6,800		
Technological area and/or issue addressed by Project.	Development in the area of fault current limiting devices has been carried out by a number of leading manufacturers and research establishments for several years in order to offer an alternative to network reconfiguration/asset replacement in tackling rising fault levels. Notably, ABB have been offering their IS – limiter as a commercial product for a number of years but this has not been adopted in the UK due to concerns over fail-safety. ASL is now offering to design, construct and undertake trials of super-conducting fault-current limiters (SFCL) in the UK. The SFCL is perceived to be a lower risk device, utilising a non-linear 'high-temperature' super-conducting ceramic rather than any electronic, electromechanical, mechanical or explosive components. When the material is operated at below its critical temperature it loses all electrical resistance, thereby allowing load current to flow with negligible losses. Either the increased current density caused by fault current, or the loss of cooling medium (liquid nitrogen) causes the temperature of the super-conducting material to rise and it reverts to a normal resistive state. This added resistance has the effect of clamping the fault current to lower/acceptable limits. Being a solid state device, the SFCL has been proven to operate in a few milliseconds, after which the impedance remains high until the fault is cleared by conventional means (protection operated circuit breakers, fuses, etc.). The SFCL's operation is sufficiently fast to ensure that the first peak of the fault current is limited. The subsequent limited current can be set to suit a specific application. It will in many cases be convenient to choose this level such that existing protection arrangements do not need to be adjusted. ASL is developing SFCLs using super-conducting material from specialist manufacturer Nexans Super-Conductors GmbH (NSC). NSC supplied the material for the successful 10MVA, 10kV, 600A CURL10 trial in RWE's network in Germany in 2004. In co-ordination with ASL difficulties like high investment costs and losses have been resolved by substantially reducing the internal thermal losses in the super-conducting material and by redesigning the super-conducting components so that a much smaller quantity of the super-conducting material is required. These latest developments will form the basis of the trial installations in the UK. The project will be carried out in a consortium comprising SP Power Systems, United Utilities, CE Electric UK and ASL. This proposal is				

	for the design, development and trial of 12kV devices, suitable for use in each of the DNO partner networks.				
Type(s) of innovation involved	Radical/Technological Substitution				
Expected Benefits of Project	Successful trials will result in the development of commercially available devices that are capable of clamping fault levels to within network design limits. This can bring a number of benefits: • If proven cost effective, SFCLs could be strategically deployed onto the network in areas either with existing high fault level issues, or experiencing a high degree of distributed generation connection activity (e.g. urban Combined Heat and Power (CHP) generation systems). This could provide a method of deferring the replacement of switchboards or reconfiguration of networks whilst ensuring fault levels are maintained within acceptable limits. • There may be operational benefits in certain areas, associated with minimising the often-complicated switching requirements needed to ensure equipment operates within its fault rating during network outages. This could reduce the risk of incurring CI and CMLs arising from either network switching or operating parts of the network temporarily on a single circuit. An improvement in staff safety may also be delivered. • If network fault currents are restricted equipment will not be subjected to increased wear or stress, potentially prolonging the asset life. • SFCLs may, subject to resolution of protection issues, allow radial circuits to be interconnected, with associated improvements to customer supply quality (both CI/CML and flicker/harmonics). This could facilitate a radical change in the way networks are designed and operated.				
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	£,000	PV of Project Benefits	£,000	NPV of project	£
Commentary on project progress and potential for achieving expected	Discussion to date has centred around the application for DTI funding, the Project Initiation Document, the Project Plan and the Collaboration Agreement. Initial investigation of possible trial sites indicates that a favourable site for the first trial installation exists at Bamber Bridge Substation, Preston, within United Utilities' Distribution Licence area.				

benefits	

<table>
<tr><td>Description of Project</td><td colspan="5">UU27 - Ihost developments</td></tr>
<tr><td rowspan="2">Expenditure for financial year</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>£4,800</td><td>£3,500</td><td>£1,300</td></tr>
<tr><td>Technological area and/or issue addressed by Project.</td><td colspan="5">Background

There are two existing projects relating to LineTracker, UU20 for the trial of LineTracker and UU21 for its development to include measurement of conductors and ambient temperatures, higher voltage and conductor applications. LineTracker data can be downloaded locally via wireless link to a laptop.

Description

Remote communications and event notification can be established via GSM/GPRS communications. Data would be held in a database for historic review (Network Planning) and interfaced with CRMS for real-time load and event notification (faults and system running). It is not thought that LineTracker would be deployed on a wide-scale basis, but at critical network points at all high voltage levels due to generation, faults and conductor rating limitations for both normal and abnormal running. LineTracker would be configured and viewed via Gridsense software over the internet (Password etc) for permanent or semi-permanent installations.

Aims

Integrate LineTracker with iHost data collection, storage and notification.

Objectives

• Identify Critical network points at all high voltage levels
• Develop Communication between LineTracker & iHost
• Develop iHost, Gridsense Software and CMRS
• Trial developments at identified critical network points</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="5">Incremental</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Financial

Reduce the capital investment of reinforcing overloaded circuits at 11/33kV/132kV

Quality of Supply</td></tr>
</table>

	Less risk under abnormal running **Environmental** Allows for reduced connection costs **Operational** Monitoring of critical network points for normal and abnormal running				
Expected Timescale to adoption	3 years		Duration of benefits once achieved	10 years	
Estimated Success probability (at start of project)	75%				
PV of Project Costs	£91,670	PV of Project Benefits	£1,019,646	NPV of project	£927,976
Commentary on project progress and potential for achieving expected benefits	Phase 1 - iHost platform functionality definition completed				

A2. SUMMARY REPORT OF IFI PROJECT ACTIVITIES

Number of active IFI projects.	25
NPV of costs and anticipated benefits from committed IFI Projects.	£6,813,265
Summary of other benefits anticipated from active IFI Projects.	Improvements in network performance by reducing the CML and CI. Effective network investment Increased safety of staff and the public. Introduction of Best Engineering practices
Total expenditure to date on IFI Projects.	£849,726
Benefits actually achieved from IFI Projects to date.	None to date

A3. REGULATORY REPORTING

Regulatory report for IFI
Reporting year 2005/06

United Utilities Plc

Innovation Funding Incentive

IFI carry forward (£m) - Combined 2004/05 & 2005/06	0.128
eligible IFI expenditure (£m)	0.849726
eligible IFI internal expenditure (£m)	0.085646
Combined distribution network revenue (£m)	234.625