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29 July 2008

Dear Gareth

ENW 07/08 IFI Annual Report

We are pleased to attach our Annual IFI Report for your consideration. 2007 was certainly a year of change for us following the formation of Electricity North West but we have maintained a focus on our IFI activities and have appointed a new research and development manager. It is intended that this will ensure that we can maximise the potential of our new organisation to both create research projects and to implement the outputs of completed projects. As we have described in our report, we feel that our new structure in fact puts in a better position than we have ever been in the past in terms of locating all our key people together.

We were extremely proud to receive the IET's Innovation Award in 2007 for our work on CBRM and believe that it reflects our commitment to innovation and research and development. It is clear to us at ENW that research and development will be vital to our continued efforts to both ensure that our customers receive the very best in terms of quality of supply and that we can continue the effective stewardship of our assets in both the short and long term.

In summary, we believe that IFI is making a significant contribution to the re-establishment of a robust distribution engineering research and development community in the UK that can only help our industry to thrive as we meet the very real challenges ahead.

Yours sincerely,

Mike Kay
Digitally signed by Mike Kay
DN: cn=Mike Kay, o, ou, email=mkay@iee.org, c=GB
Date: 2008.07.29 20:55:35 +01'00'

Mike Kay
Engineering and Planning Director

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Electricity North West Ltd

IFI Annual Report 2007/08

Table of Contents

1 Executive Summary

This report describes ENW's activities funded under the Innovation Funding Incentive scheme for 07/08. It begins with a description of the changes to our business over the last 12 months and the challenges we have faced. The report then goes on to outline our views of the recent changes to the IFI scheme and how it has encouraged the development of our research and development strategy and how the scheme has led us to be ambitious in our outlook for the future.

The report describes our partners and collaborators and how important they are to the successful delivery of research and development projects followed by details of successful projects and the required regulatory reporting figures. The report concludes with specific details of all of our current projects, analysis of the risks and benefits and two case studies describing current and recent projects.

ENW hold the IFI Scheme in high regard and we have been tremendously encouraged by the results from some of our initial projects and the willingness shown by our colleagues and partners to engage with research and development. The results from the CBRM projects have complemented our existing asset management strategy and resulted in tangible benefit, financial and risk reduction. These projects in particular have demonstrated that innovative projects that are successful can deliver substantial financial benefits and we have great expectations for projects such as the Kelman FuseRestore that will provide us with tools that should deliver direct benefits to our customers in terms of Quality of Supply. IFI has encouraged a more pro-active approach to problem recognition and solution development, Areva's 'Distribution Transformer On-Load Tap Changer' and Applied Super Conductor's 'Superconducting Fault Current Limiter' are real examples of solutions that can be developed to ensure that networks can play their role in delivering the national objectives for the future of the electricity industry.

We were disappointed to not use our full IFI allocation during 07/08 caused in part by delays to projects such as the Capenhurst Energy Innovation Centre and LV Sure but we are fully committed to using our entire allocation for this year by ensuring that any late starting projects are identified and mitigated early.

2 Introduction

A great deal has changed since the publication of United Utilities 06/07 IFI Report, not least the name of our new organisation Electricity North West Limited. ENW is now the electricity distribution licence holder for the north west of England and the owner of the electricity distribution network. The company was formerly owned by United Utilities plc, and was known as United Utilities Electricity Limited (UUE). On 19th December 2007 UUE was sold to a consortium which consists of Colonial First State Asset Management and the JP Morgan Infrastructure Investment Fund (IIF). Both parties in the Consortium have invested in ENW with the intention of delivering stable returns to their investors over the long term. The company formally changed its name to Electricity North West Limited on 20th December 2007 and United Utilities Electricity Services (UUES) is now contracted to operate and maintain the network on ENW's behalf. ENW has an eight year operating contract with UUES who are responsible for the operation and maintenance of the network, and the delivery of the capital programme, UUES remain a wholly owned subsidiary of United Utilities plc.

Although a slight delay has occurred to some of our projects as a result of the sale process, the reorganisation has resulted in all the key decision makers regarding the strategic management of our network being now located together at Birchwood in Warrington. It is believed that we have a real opportunity to both collaborate internally to a degree not possible when located in different offices and to develop reliable implementation procedures as a number of promising IFI projects approach fruition.

Research and development is not new in the electricity transmission and distribution Industry and many innovative designs and practices have been introduced since the earliest days of interconnected networks. We believe that the Innovation Funding Incentive (IFI) is providing a platform to formalise what we think of as research and development and to develop very close and productive relationships with partners who are providing real value to networks. IFI is assisting ENW in managing the future risks associated with, for example, the uncertainty regarding the likely future direction of distributed energy system penetration.

Our aim is to continue to recognise the current and most likely future challenges that we face and, through the IFI scheme, have a co-ordinated and clear sighted effort to address those challenges. Our research and development effort must be the focal point to clarify the technical issues that need to be addressed and to tap into the potential of our colleague and partners to propose and develop solutions to these challenges.

Security of our assets always remains a concern. Increasing levels of vandalism and theft are leading to a growing danger from accessibility into substations and to a greater risk of incidents involving either our employees or innocent members of the public. It is felt that there are a range of innovative security solutions available from other industries that could be utilised for distribution substations that would qualify under both technical substation and innovation level but are excluded under the IFI criteria.

3 Scope

The aim of this report is to provide an insight into the current IFI activities at ENW. It begins with a description of the IFI criteria and how this relates to ENW's research and development strategy and how it is to be delivered. It then describes our ambitions for the future followed by the required regulatory reporting and two case studies.

4 IFI

IFI is now a well established mechanism that has already created a very active and engaged community of DNOs, academics and industrial companies. Although the details of the IFI mechanism (contained in Special Licence Condition C3 and the IFI Regulatory Instructions and Guidance) have been well documented elsewhere, the underlying principals are repeated for reference.

Engineering Recommendation G85/2 states;

- An IFI Project should be well managed
- IFI reporting requirements should be met
- An IFI Project should satisfy the eligibility criteria defined as;

A project will qualify as an eligible IFI project provided that it is designed to enhance the technical development of gas transmission and electricity transmission and distribution networks. Eligible IFI projects will embrace aspects of transmission and distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning.

4.1 Engineering Recommendation G85/2

ENW believes that the revision of Engineering Recommendation G85 (issued as ER G85/2 in December 2007) has been a positive statement from Ofgem and we feel that it is a natural reflection of the evolution of IFI. The removal of the cap on internal expenditure is welcomed and the re-assurance that IFI will continue until 2015 provides encouragement to partners that longer term investments that should deliver greater rewards (in terms of technical developments) to networks are well founded.

The introduction of a "balanced-scorecard approach" to project evaluation provides a clear and consistent method to compare the relative merits of each project and allows the overall portfolio to be presented graphically. It also allows more emphasis to be placed on the risk mitigation aspect of project selection and provides an alternative method of viewing the "risk" a project may carry. Projects with a naturally higher level of risk (due to, for example, the level of technical innovation required being high) can be mitigated if they are targeted at a known problem or need. Conversely, low risk projects with a higher probability of delivering a more successful outcome may be a less attractive proposition if an identifiable need does not exist.

4.2 ENW's Research and Development Strategy

A number of well known key-issues are being described as the current challenge to electricity distribution companies upon which research and development is expected to have a positive impact. They include;

- Enhanced Customer Service
- The Development of Smart Grids or Active Networks
- Environmental Impact and Climate Change
- Connection of Distributed Energy Systems
- Management of the Ageing Asset Base
- Future Proofing

The objective when developing ENW's Research and Development Strategy was to both encompass the key issues as described and complement our wider corporate aims in the management and stewardship of our assets. To achieve this, research and development supports a number of high level objectives within ENW that can be described as follows;

- System Planning (including supporting all types of DG connection requests without resorting to reinforcement)
- Management, Inspection and Maintenance and End of Life of Assets
- System Control (including continuing the development of the 'Active' aspect of our network)
- Environmental
- Quality of Supply
- Encourage manufactures to develop 'next generation' equipment
- Integrate existing technologies from other industries onto the network

All our research and development activities that may be undertaken through discussion or project work have as their aim an attempt to deliver an innovative tool or technique that can bring a tangible benefit and enhance the technical development of our network. Our ambition is to meet our objectives in a sustainable and environmentally responsible way that reflects our wider social impact and to provide high quality network performance and services that are best value for customers.

4.3 Strategy Delivery

The procedures as described in Section 4 of last years IFI report 'United Utilities Research and Development Processes' have been revised in light of ER G85/2 but remain essentially unchanged. Following the restructuring of our business a monthly internal reporting system has been introduced to ensure that any projects that did fall behind schedule during the transition period are identified and the appropriate level of management resources can be directed to them The aim of the procedures is to record the required information in a repeatable manner and to ensure good project management but to minimise the bureaucratic load.

5 Registered Power Zones (RPZ)

ENW currently have no RPZs although a number of opportunities exist to develop an RPZ during 08/09.

6 Collaboration

ENW has a number of partner organisations and have attempted to foster an open and frank relationship with them. It is believed that the usual customer/supplier relationship of competitive tendering and price negotiation is not always appropriate for the provision of research and development services. However the usual commercial arrangements of ensuring good contractual supervision and clear deliverables are perhaps even more important.

6.1 Academic Partners

University of Manchester has provided a range of support for both individual and collaborative projects. They have particular expertise in the field of transformers and dielectrics and have substantial research and development facilities

University of Strathclyde is recognised as one of the leading Energy Research institutions in the UK and has played a role in a number of national projects, particularly the SuperGen Project

Other universities contributing to collaborative projects include the **Universities of Liverpool, Bath, Southampton, Leeds, Cardiff, Queens University and Imperial College of London**.

6.2 Industrial Partners

United Utilities Electricity Services (UUES) are actively involved in almost every aspect of our research and development activities, particularly the operational trials of equipment. The program could not be delivered without their valuable support.

Areva Technology Centre, Stafford has delivered an extremely innovative solution to the real and practical issue of voltage control with high levels of DG penetration.

Applied Super Conductors have broken new ground with the development of their Super Conducting Fault Current Limiter.

The Met Office has provided valuable insights into potential future climate scenarios and how they may impact on the networks. The Met Office has reported that the Electricity Industry is the only cross-industry group that is actively engaged with them in utilising their latest predictive models to assess the potential long-term future impact from a changing climate.

Kelman have continued to develop their range of instruments and have utilised a range of innovative design solutions. Their Fuse Restorer Project promises to deliver a tremendously innovative and useful tool to assist with the restoration of LV customers following faults.

EA Technology hosts the Strategic Technology Programme and supports our CBRM and Criticality Projects

7 Adopted Projects

A number of projects have either been fully adopted or are in the trial stage. Two examples of adopted projects are described;

Condition Based Risk Management (CBRM) – The CBRM methodology has been used to underpin our DPCR5 forecast and our capital submission for DPCR5. A great deal of data has been recorded and entered into ENW's CBRM tools to better understand the implications of ageing and asset replacement strategies. We are intending in the future to extend the CBRM methodology to asset groups that have traditionally been excluded from this approach due to the scarcity of data. We are developing new techniques to allow us to gather the required data and then to use the CBRM methodology in a similar manner. ENW were extremely proud to receive the IET Innovation Award in 2007 for our work on Asset Management and believe that the optimisation of our capital submission is direct evidence of the potential of IFI funded research and development to deliver financial benefits.

OHL Resilience Model – This project has delivered a software tool that is currently being populated with the relevant data. The model will be used to relate better the location of the OHL assets to the local weather patterns to ensure that the full implications of the forecasted weather on the OHL network can be assessed.

Two detailed case studies are included as an appendix to the report

8 Outlook for the Future

We are about to begin the formal process of examination of all aspects of our operations (for example Fault Location/Restoration both LV and HV, Vegetation Management, Planning, Equipment design) with the aim of creating an ENW 'Strategic Issues Matrix' to understand how each activity could potentially benefit from a specific research and development project. The benefits of this approach should be to reach a consensus on the specific issues to be addressed and translate these into firm project proposals with specific, measurable and deliverable objectives. We will then assess the potential benefits that could be achieved in agreed categories (typically taken from ER G85/2). Papers delivered from the SuperGen and Climate Change projects are supporting our aim of developing a widely informed opinion regarding the specific issues that we can address through co-ordinated research and development.

The IFI programme is well established within ENW we are now faced with the opportunity to implement some of the early projects that have concluded and some of the projects that are about to deliver. The Fault Current Limiter is due to be installed in the second quarter of 08/09 and it will take a substantial effort to ensure all the various issues regarding the installation and operation and control are addressed in the correct manner.

9 Conclusion

ENW remains very supportive of IFI and the original lead taken by Ofgem and others in recognising the future challenges that will face networks and the need to provide an incentive to encourage research and development.

A significant concern at present is the ever increasing issues with security of sites due to vandalism and theft. These incidents are occurring almost daily and present both technical and safety issues through the removal of earthing and busbars and damage to switchgear, transformers, earthing, etc. The accessibility of sites following vandalism and prior to ENW being aware and repairing the breach is also a major safety concern for danger to members of the public, particularly children. The ability to research modern equipment for monitoring and communication for security of sites would be a great advantage that is currently denied by the IFI scheme. It would also be useful to develop national standards through the ENA for security of sites.

10 Financial Report

Distribution Network Revenue	£282.98M
IFI Allowance	£1.415M
Unused IFI Carry Forward to 08/09	£0.5M
Number of Active IFI Projects	34
Summary of benefits anticipated from IFI projects – Σ of Project NPV	£9,537,691
External expenditure on IFI projects in 07/08	£840,689
Internal expenditure [Year] on IFI projects in 07/08	£73,700
Total expenditure 07/08 on IFI projects	£914,388
Benefits actually achieved from IFI projects to date [cost benefit plus other benefits outlined in the project benefit assessment]	£336,702*

Table 1 – 07/08 Summary Report on IFI Activities[1]

*As IFI is still a reasonably new initiative and some of our projects are on a long-term NPV payback, the specific financial benefits accrued from delivered projects are still relatively small. We are expecting this figure to increase in the future as more projects are delivered and implemented.

[1] Ref Engineering Recommendation G85/2 Table 4

11 Project Reports

<table>
<tr><td>Project Title</td><td colspan="4">Strategic Technology Programme Overhead Network Module</td></tr>
<tr><td>Description of project</td><td colspan="4">A DNO collaboration hosted by EATL</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1,195
External £43,010
Total £44,965</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £4,308
External £78,936
Total £83,244</td></tr>
<tr><td>Project Cost (Collaborative + external + [DNO])</td><td>£</td><td colspan="2">Projected 08/09 costs</td><td>Internal £1,500
External £44,400
Total £45,900</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The STP overhead network programme for budget year 2007/8 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 currently active projects within the programme include:

S2126_3 – Completion of long-term monitoring of conductor temperature by obtaining and analysing 12 months trial data.
S2126_4 – Monitoring overhead line conductor temperature at two trial sites at constant current.
S2136_3 – Continued participation in European Project COST 727: Measuring and forecasting atmospheric icing on structures.
S2140_2 – Field trials of techniques for checking the foundations of newly installed poles.
S2143_2 – Feasibility study to detect in-situ degradation of aluminium overhead line conductors.
S2146_2 – Undertake torsion testing to evaluate possible limits for composite tension insulators.
S2148_1 – Re-appraisal of ACE104 methodology
S2150_1 – Evaluation of TDR for assessment of tower foundations using actual field data.
S2151_1 – Investigate alternatives to wood poles.
S2152_1 – Evaluate performance of ice recording solution at severe weather test site.
S2154_1 – Experimental investigation of ice loading of novel conductors.
S2155_1 – Comparative performance of available pole-top shrouds.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technical Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-8</td><td>18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Due to the age profile of some identified network 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 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;</td></tr>
</table>

	• reduce levels of premature failure of assets; • provide more cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults; • confidently extend the service life of towers and reduce potential levels of tower failures; • reduce lifetime costs by the appropriate use of alternative materials.		
Expected Timescale to adoption	Range 1-5 years - dependent on project	Duration of benefit once achieved	Range 3-7 years - dependent on project
Probability of Success	Range 2-50% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£21,454
Potential for achieving expected benefits	A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it's' inception.		
Project Progress to March 08	Modules have been completed for the year 07/08		
Collaborative Partners	Other DNO's		
R&D Providers	EA Technology		

Project Title	**Strategic Technology Programme Cable Networks Module**		
Description of project	A DNO collaboration hosted by EATL		
Expenditure for financial year	Internal £5,945 External £52,117 Total £58,062	Expenditure in previous (IFI) financial years	Internal £5,196 External £76,972 Total £82,168
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs	Internal £1,500 External £53,680 Total £55,180

Technological area and / or issue addressed by project	The STP cable network programme for budget year 2007/8 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 currently active projects within the programme include: S3132_10 – Further development in cable ratings to address gas compression cables S3132_12 - Further development in cable ratings S3140_3 – Develop best practice for the installation of Ducted Cable systems. S3144_2 & 3 – Comparison of processes for the treatment of redundant fluid filled cables S3151_1, 2 & 3 – Understanding and controlling thermo-mechanical forces in cable systems S4152 – Separable connectors and cable compartments in 11kV switchgear. S3159_1 - Investigation of current ratings of triplexed cable in plastic ducts. S3157_1 – PD testing of MV cable systems to provide asset risk management data S3163_1 – On-going testing of sensors for cable fluids.			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
		10	-6	16
Expected Benefits of Project	The management and rectification of underground cable faults is always a challenge and if the projects are technically successful and the findings and recommendations are implemented the projects will potentially enable a CI/CML savings per connected customer. Further developments on the management of aged cables and fluid filled cables will have a measurable environmental and financial benefit			
Expected Timescale to adoption	Range 1-3 years - dependent on project	Duration of benefit once achieved	Range 3-5 years - dependent on project	
Probability of Success	Range 2-50% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£14,975	
Potential for achieving expected benefits	A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it's' inception.			
Project Progress to March 08	Modules have been completed for the year 07/08			
Collaborative Partners	Other DNO's			
R&D Providers	EA Technology			

Project Title	**Strategic Technology Programme Substation Module**
Description of project	A DNO collaboration hosted by EATL

<table>
<tr><td>Expenditure for financial year</td><td>Internal £11,223
External £38,081
Total £49,304</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £4,974
External £76,972
Total £81,946</td></tr>
<tr><td>Project Cost (Collaborative + external + [DNO])</td><td>£</td><td colspan="2">Projected 08/09 costs</td><td>Internal £1,500
External £39,222
Total £40,722</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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 2007/08 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 currently active projects within the programme include:

S4164_4 – On load tap changer monitor – develop and install trial systems
S4176_3 – Assessment and inspection of substation earthing systems
S4181_2 – Transformer Post Mortems.
S4185_2 – AM Forum membership.
S4212_1 – Dissemination Seminar to ensure wider appreciation of STP module outputs
S4219_1 – Management of substation batteries
S4220_1 – Management of 145kV Disconnectors
S4221_1 – Investigate Out of Phase Switching
S4222_1 – Explore Alternatives to ENATS 35-1 Transformers
S4223_1 – Review of Underground Substation design
S4225_1 – Assessment of BS148 and IEC60296 Insulating Oils
S4228_1 – Investigate Alternative Measuring Techniques for Insulation Materials
S4234_1 - Exploration of Ferroresonace Issues</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-8</td><td>18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Both new and aged substation assets continue to provide a range of management challenges and STP has assisted in many ways.

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

Financial - Offset future increases in CAPEX and OPEX
Safety - Increased safety of staff and public by reducing the number of accidents/incidents;
Environmental - Both preventing disruptive failures of oil-filled equipment to reduce land contamination and avoiding unnecessary scrapping of serviceable components will alleviate environmental impact</td></tr>
</table>

Expected Timescale to adoption	1-2 years - dependent on project	Duration of benefit once achieved	1-10 years - dependent on project
Probability of Success	5-50% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£31,805
Potential for achieving expected benefits	A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it's' inception.		
Project Progress to March 08	Modules have been completed for the year 07/08		
Collaborative Partners	Other DNO's		
R&D Providers	EA Technology		

Project Title	**Strategic Technology Programme Networks for Distributed Energy Resources Module**		
Description of project	A DNO collaboration hosted by EATL		
Expenditure for financial year	Internal £1,521 External £51,238 Total £52,759	Expenditure in previous (IFI) financial years	Internal £4,271 External £76,972 Total £81,243
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs	Internal £1,500 External £53,774 Total £55,274

<table>
<tr><td rowspan="1">Technological area and / or issue addressed by project</td><td colspan="4">The projects undertaken through budget year 2007/8 were aimed at enabling cost effective connections and ensuring techniques are in place to plan, operate and manage networks with significant amounts of dispersed generation. Most projects also had positive impacts on safety and environmental performance and all addressed real problems that had been identified by the module steering group members as significant and which required technical investigation and development.

Fifteen new project stages were approved during the year;
• S5147_4 – Monitoring of Micro generator Clusters
• S5147_5 – Analysis of Micro generator Cluster monitoring results
• S5147_7 – Reporting of Micro generator Monitoring
• S5149_5 – Explore Active Voltage Control
• S5142_4 – Generator Data and Structure for DG Connection Applications
• S5151_4 – Network Risk Modelling
• S5152_3/4 – Latest developments in the connection of distributed generation
• S5157_3 – Evaluate the Performance of Small Scale Reactive Power Compensators
• S5161_2 – Standard risk assessment approach to DNO protection
• S5167_1 – Assessment of enhanced ratings for overhead lines connecting wind farms
• S5170_1 – Explore low cost design options for connecting DG to overhead line networks
• S5171_1 - Investigate the use of inverter connected DG to alleviate fault level contribution
• S5172_1 - Optimum power factor to support a low carbon economy
• S5173_1 - Alternative techniques for temperature connected demands
• S5174_1 – Assessment of the potential for DSM from small customers
• S5176_1 – Assessing the impact of high penetrations of micro-generation on cable networks
• S5182_1 – Treatment of distribution network losses
• S5185_1 - Assessment of the potential for DSM from larger customers
• S5186_1/2 – Investigate effects on network of proposed ban on incandescent light bulbs</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-8</td><td>18</td></tr>
</table>

Expected Benefits of Project	With national energy policy driving significant increases in generation connection to distribution networks, DNO's 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: Financial - 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. Security of Supply - Reducing the probability of voltage supply limit excursions resulting from increased distributed generation. Reducing the risk of asset 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)		
Expected Timescale to adoption	1-5 years - dependent on project	Duration of benefit once achieved	1-10 years - dependent on project
Probability of Success	10-30% - dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£14,753
Potential for achieving expected benefits	A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since it's' inception.		
Project Progress to March 08	Modules have been completed for the year 07/08		
Collaborative Partners	Other DNO's		
R&D Providers	EA Technology		

Project Title	**Condition Based Risk Management**		
Description of project	Implementation of the Condition Based Risk Management Methodology		
Expenditure for financial year	Internal £4,096 External £97,809 Total £101,905	Expenditure in previous (IFI) financial years	Internal £21,895 External £63742 Total £85,637
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs	Internal £0 External £15,000 Total £15,000

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	Radical	Project Benefits Rating	Project Residual Risk	Overall Project Score
		13	-1	14
Expected Benefits of Project	Financial - Better targeting of Asset Replacement, methodology to justify reduction in Capex whilst maintaining KPI's at their historic level. Supply Quality, Environmental and Safety - Removal of assets most likely to fail			
Expected Timescale to adoption	3 years	Duration of benefit once achieved	5 years	
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£196,204	
Potential for achieving expected benefits	Condition Based Risk Management is aimed at developing a process to link an enhanced understand of the physical condition of electrical plant and it's projected ageing profile to investment decisions on plant replacement. Work during the period 07/08 has progressed the overall understanding of the company asset base to allow ranking of specific asset groups resulted in the following asset group having CBRM methodologies developed: Towers; Switchgear, Transformers, Woodpoles and LV Switchgear. Further work has been completed on determining probabilities of failure for all plant types as well as degradation rates to enable the data to be aged and hence determine capital investment needs beyond the usual 5 year planning timescales.			
Project Progress to March 08	Project is almost complete and signed off and work is well underway to use the various tools that have been produced to assist in the delivery of the DPCR5 submission			
Collaborative Partners	None			
R&D Providers	EA Technology			

Project Title	**CBRM Criticality Assessment**		
Description of project	Assisting with the implementation of the Condition Based Risk Management Methodology by better understanding the criticality of various parts of the network		
Expenditure for financial year	Internal £15,691 External £111,731 Total £127,422	Expenditure in previous (IFI) financial years	Internal £15,019 External £163,288 Total £178,307
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £ External £10,000 Total £10,000

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	Project Benefits Rating	Project Residual Risk	Overall Project Score
		12	-3	15
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 benefit once achieved	5 years	
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£194,396	
Potential for achieving expected benefits	Work on establishing asset criticality criteria and scoring factors has been completed and the scoring spreadsheets have been populated with network and asset information to enable risk scores for assets to be produced. The first batch of work concentrated on transmission assets followed by establishing criteria for distribution assets. The results of the project has successfully supported and enhanced the results from the CBRM Project			
Project Progress to March 08	This project and the previous project 'CBRM' have become indistinguishable and they are both providing a mechanism to produce part of our DPCR5 submission			
Collaborative Partners	None			
R&D Providers	EA Technology			

Project Title	**Alternative Oils for Transformers**		
Description of project	This project investigated various parameters relating to the use of Natural Ester Oils as alternative dielectric fluids for Transformers		
Expenditure for financial year	Internal £0 External £0 Total £0	Expenditure in previous (IFI) financial years	Internal £3,389 External £40,310 Total £43,699
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £0 Total £0
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	Significant	Project Benefits Rating	Project Residual Risk	Overall Project Score
		10	-2	12

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 benefit once achieved	20 years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£16,372

Potential for achieving expected benefits	The project has delivered a number of specific objectives; • The dielectric performance of ester oils as an insulation material has been quantified through experiments and tests. Dielectric performance is represented as electrical breakdown strength (EBD in kV/mm) under AC and Lightning voltages compensated for the effects of temperature, moisture contents and ageing • A statistical analysis of the experimental results to ensure that the EBD can be linked with a reliability index or probability of failure • The development of a reliable laboratory based solid insulation drying and impregnation procedure • Observation of Impregnation procedures through laboratory based experiments • A theoretical study on capillary effects and viscosity • Identification of dissolved gas fingerprints, degree of polymerisation and furfuran analysis of ester oils It is expected that natural ester oils will provide a valuable solution to assist with reducing the environmental impacts of substations in sensitive locations
Project Progress to March 08	This project is completed and we are awaiting the issue of the final PhD report
Collaborative Partners	DNO's
R&D Providers	University of Manchester

Project Title	**Reference Networks - Phase 2**
Description of project	The project used the GROND tool to develop pricing methodologies to aid with planning and technical developments

Expenditure for financial year	Internal £962 External £0 Total £962	Expenditure in previous (IFI) financial years	Internal £1,547 External £42,260 Total £43,807
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £0 Total £0

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 strategy			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
		9	-9	18
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 benefit once achieved	5 years	
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£265,621	
Potential for achieving expected benefits	The final report and software were delivered in 2007 and the project was extended through the joining of an additional DNO. Analysis of real data and the development of comparative analysis are complete			
Project Progress to March 08	The project is complete and the software tool is being evaluated for use as part of a number of Quality of Supply and Planning initiatives, part of the project completion is an implementation proposal to be completed shortly			
Collaborative Partners	Vertex			
R&D Providers	Vertex			

Project Title	**Distribution Transformer with On-Load Tap Changer**		
Description of project	This project is aiming to develop an On-Load Tap Changer for the low voltage side of a standard distribution transformer. This is to aid with voltage level issues when faced with a high level of DG penetration.		
Expenditure for financial year	Internal £0 External £65,000 Total £65,000	Expenditure in previous (IFI) financial years	Internal £3,334 External £166,572 Total £169,906
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £4,000 External £55,920 Total £59,920

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 and adverse effect on voltage regulation. This is a concern especially when a large number of DCHP units are installed in existing properties within a small geographical area on an existing LV feeder. If the feeder was designed to normal planning standards it may suffer from voltage excursions at time of peak generation			
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	Overall Project Score
		9	-6	15
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. In addition to this specific project it is envisaged that this device would have a number of applications on the LV network			
Expected Timescale to adoption	3 years	Duration of benefit once achieved	5 years	
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£199,810	
Potential for achieving expected benefits	Design phase completed and 80% of prototype components have been delivered including the transformer and tap changer tank. The low quantity requirements of the project have meant long delivery times for certain components resulting in a slippage of the project. This project uses a number of truly innovative designs and combines the most reliable aspects of standard switching devices with a novel use of power electronics. Routine and type testing of trial transformer with tap changer is planned to take place in early October 2008 at AREVA T&D Transformer factory in Turkey.			
Project Progress to March 08	The project is well advanced and prototype construction is in the final stages. The level of innovation in the designs has meant that it has been unable to define deadlines with any real certainty. However, the team at Areva have demonstrated exceptional project management skills and ENW have full confidence that the transformer will be commissioned in 2008. The current plan envisages Type Test of the entire Transformer+OLTC assembly in October.			
Collaborative Partners	None			
R&D Providers	Areva Technology Centre			

Project Title	**SuperGen V – Amperes**		
Description of project	The project comprises a collaboration of UK universities and DNO aiming to carry out fundamental research into asset management specifically for distribution networks		
Expenditure for financial year	Internal £ External £25,000 Total £25,000	Expenditure in previous (IFI) financial years	Internal £6,273 External £52,801 Total £59,074

<table>
<tr><td>Project Cost (Collaborative + external + [DNO])</td><td colspan="2">£</td><td colspan="2">Projected 08/09 costs for ENW</td><td>Internal £1,500
External £25,000
Total £26,500</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 the UK. One of the EPSRC initiatives is funding work in the area of Sustainable Power Generation and Supply and a call was put out in 2004 to a group of universities to address the issues facing the UK energy infrastructure. The SUPERGEN consortium was formed which addresses a range of issues through a number of targeted work programmes. SUPERGEN and has active collaboration with UK industry funded by IFI and has created a real cross-interest community. 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 rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Tech Transfer/ Significant</td><td colspan="2">Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td colspan="2">11</td><td>-2</td><td>13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">The consortium expects to deliver a suite of intelligent diagnostic tools for plant, integrated network planning and asset management , improved and reduced environmental impact plant and models and recommendations for network operation and management</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">12 years</td><td colspan="2">Duration of benefit once achieved</td><td>20 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£73,491</td></tr>
</table>

Potential for achieving expected benefits	The Consortium Agreement was signed in November 2006 and this led to the establishment of a Steering Group and an Executive Management group to provide engagement and effective the participation of all parties. Reports produced by the SuperGen Consortia include; • Loss of Mains Detection and Amelioration on Networks • Loss-of-Mains detection by differential ROCOF Protection using internet protocol. • Interim report on protection and control of distribution networks with synchronous islands. • Reducing the Environmental Impact of Electrical Plant - Annual report • First report on use of high temperature conductors on distribution networks. • Final report on high temperature low sag conductors. • Report on ICSD 2007 • Report on literature on non-power frequency ageing in dielectrics • Condition monitoring -State of the Art report vs 2 • 27 technical publications have been submitted or published since in the last year. A number of demonstrator projects are presently being implemented in both transmission (due to finish mid-June) and distribution substations across the UK. These will be use to prove data acquisition technology. The resulting data will be used to develop interpretation tools.
Project Progress to March 08	The project has already produced valuable outputs and has been fundamental to the continuing development of the UK R&D 'people' network and the industry and academic community
Collaborative Partners	Universities and DNO's
R&D Providers	Universities

Project Title	**Fibre Optic Based Substation Communications**		
Description of project	The project is a trial of new technology numeric line current differential relays using digital communications over ENW's SDH fibre network.		
Expenditure for financial year	Internal £1,430 External £12,588 Total £14,018	Expenditure in previous (IFI) financial years	Internal £4,813 External £15,290 Total £20,103
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £0 Total £0
Technological area and / or issue addressed by project	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 SDH network and the actual communications requirements. The trial included 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 inter-tripping. Experience gained in the trial will assist in the migration of these functions to the ENW fibre network. This is particularly important as it is becoming apparent that the BT 21st Century Network project may have an adverse effect on some protection schemes			
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	Overall Project Score
		10	-7	17
Expected Benefits of Project	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 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	
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£984,512	
Potential for achieving expected benefits	The relays on trial are Reyrolle Solkor N and Siemens 7SD61. The trial using dedicated fibre end to end has been completed and has been entirely successful. A number of other trials using the multiplexed SDH network have been carried out and the trial of the Siemens relay has been completed			
Project Progress to March 08	The project is almost complete and is in the final stages of being written up			
Collaborative Partners				
R&D Providers				

Project Title	**Lightning Protection**		
Description of project	This project was co-ordinated by the ENA and aimed to undertake a review of lightning protection measures and produce a revised technical recommendation.		
Expenditure for financial year	Internal £0 External £0 Total £0	Expenditure in previous (IFI) financial years	Internal £0 External £1,800 Total £1,800

Project Cost (Collaborative + external + [DNO])	£		Projected 08/09 costs for ENW	Internal £0 External £0 Total £0	
Technological area and / or issue addressed by project	Produce a new engineering technical recommendation on lightning protection with a scope that includes 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 and reference to peripheral issues such as earthing and protection				
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score	
		12	-9	21	
Expected Benefits of Project	Reduction in Failure/faults due to lightning, improved risk assessments and a reduction in CML's				
Expected Timescale to adoption	3 years		Duration of benefit once achieved	10 years	
Probability of Success	75%		Project NPV = (PV Benefits – PV Costs) x Probability of Success	£55,471	
Potential for achieving expected benefits	The previous guidance on lightning protection was published many years ago. This project updated industry knowledge based on the vast amount of research that has been undertaken over recent years and the various new tools and techniques that have become available				
Project Progress to March 08	The ETR has recently been published and this project is about to be closed				
Collaborative Partners	ENA member Companies				
R&D Providers	ENA				

Project Title	**Electricity Supply Fault Level Instrument**		
Description of project	This project was co-ordinated by the ENA and aimed to develop an on-line instrument that can successfully measure/estimate the fault level on a distribution network with repeatability and reliability. The instrument is to be based on the EA Technology Extended Supply Monitor		
Expenditure for financial year	Internal £0 External £0 Total £0	Expenditure in previous (IFI) financial years	Internal £1,175 External £6,066 Total £7,841
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £0 Total £0

<table>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The device will connect to the network and establish the network source impedance from small-scale disturbances or perturbations resulting from transformer tap changer operations. This impedance can accurately be correlated to a true network fault level for that location, providing near real-time information to planning engineers. This tool would also facilitate the connection of distributed generation by establishing if the proposal would exceed the fault level rating of the feeder or line</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>8</td><td>-5</td><td>13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The developed unit will allow the DNOs to accurately assess fault in-feed levels and design distribution networks appropriately. The particular benefits of this project are seen to be:
• Provide a real time and consistent estimation of fault level
• Accurately take into account all connected network elements (e.g. Motors);
• Facilitate the connection of distributed generation by providing a standardised methodology for the assessment of network fault levels
• Enable an ongoing assessment of the effects of connected distributed generation to be made;
• Provide reassurance to generator developers that decisions to upgrade networks are not subjective but based on objective measurement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 years</td><td>Duration of benefit once achieved</td><td>210 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">75%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£33,858</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">To progress to stage 2 of the project as originally defined the results obtained from stage 1 had to support a statement that it was technically feasible to develop a Fault Level Measuring Instrument capable of deriving answers within ±5% of the actual Source and Motor In-feed values. Following the work carried out it is not possible to make such a statement. The Algorithm Validation work has cast some doubt over the achievability of that goal. The good agreement of the existing Fault Level Monitor with expected values does however offer some signs that the results obtained in the algorithm validation phase are not unequivocal. The proposed testing of the existing Fault Level Monitor within a defined third party test network has not been pursued at this time since although this might provide further data supporting the instrument's capabilities it would not answer the question as to why the differences exist between the apparent capability of the existing instrument and the performance of the algorithms implemented in Matlab. As the results of Stage 1 do not support an unequivocal statement that it is technically feasible to develop a Fault Level monitor with the required degree of accuracy this project will conclude at Stage 1.

Proposals are being prepared for consideration to carry out further work to resolve questions about the apparent differences in performance of the existing Fault Level Monitor and the Fault Level Monitor Algorithms implemented in Matlab.</td></tr>
</table>

Project Progress to March 08	A number of activities have been pursued by both EA Technology and the University of Strathclyde in the progression of this project. These are summarised as: • Experiment & Laboratory Investigation – The performance of the previous Fault Level Monitor was tested against the known parameters of the University of Strathclyde's micro grid. In general a reasonable level of agreement was achieved. • Algorithm Validation – The algorithms from the Fault Level Monitor coded within Matlab were tested using a network model in Matlab/Simulink to provide the sampled data to the algorithm. The results were compared to values of source in-feed and motor in-feed calculated directly from the parameters of the disturbances used. This resulted in an assessment of the potential accuracy of the instrument under a variety of load and disturbance conditions. At the power factor and load disturbance conditions which were most likely to be experienced in a real power system the results were not within the required accuracy band. • Comparison of Real Site – In contrast to the results obtained under the algorithm validation section, comparison of measurements made on a real network with the Fault Level Monitor exhibited a much closer agreement with the results expected We are currently awaiting the issue of the final report to close this project off
Collaborative Partners	ENA Member companies
R&D Providers	University of Strathclyde, EA Technology

Project Title	**Earthing Projects**		
Description of project	This project was co-ordinated by the ENA and aimed to fundamentally investigate a number of issues relating to substation earthing including HV and LV electrode proximity effects		
Expenditure for financial year	Internal £0 External £5,691 Total £5,691	Expenditure in previous (IFI) financial years	Internal £680 External £6,800 Total £7,480
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £0 Total £0
Technological area and / or issue addressed by project	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. To 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		

<table>
<tr><td></td><td colspan="4">between HV and LV electrodes which in a PME system may be impractical to achieve and maintain.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>-5</td><td>18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 years</td><td>Duration of benefit once achieved</td><td colspan="2">40 years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£87,170</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Various measurements were are carried out at the S&S Ltd test facility to enable better understanding of transfer potential. The measurement results were compared to predictions using the CDEGS software. The initial results were encouraging and suggested that there would be benefit in proceeding with more detailed investigations at 11kV distribution substations where the HV and LV earths are known to be separate. The measurements taken at site confirmed the earlier findings and revealed that the critical factor in determining the rise of potential on the LV electrode during a HV fault was not the separation but rather the distance of the furthest part of the LV electrode from the HV electrode. This is because the LV earth electrode (in an interconnected system) assumes the average potential of every ROEP contour it lies in, the furthest point and therefore the lowest contour position reduces he average of the EPR on the entire LV electrode. A very interesting result.

Whilst the project has delivered a very valuable finding it is recognised that more work needs to be done on a larger trial sample. However, the implications for earthing design are profound</td></tr>
<tr><td>Project Progress to March 08</td><td colspan="4">The project work has completed and was discussed at the June 08 ENA R&DWG Meeting. The reports are being considered and the project will be closed in due course</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">ENA Member Companies</td></tr>
<tr><td>R&D Providers</td><td colspan="4">Strategy and Solutions</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="3">Line Tracker Trial</td></tr>
<tr><td>Description of project</td><td colspan="3">The project aimed to trial a device that can provide load and temperature data from the OHL network. The data is collected remotely and received in the network control room to assist with network management.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £0
External £0
Total £0</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £680
External £31,610
Total £32,290</td></tr>
</table>

Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £3,000 External £0 Total £0

Technological area and / or issue addressed by project	The Line Tracker is a fault and load monitor device that attached to the OHL and monitors current, line and ambient temperature that is downloaded by wireless radio link to the control room or office via GSM. The aim is to trial the Line Tracker on the OHL network to enable real load data to be monitored in areas where there is currently little visibility of the load at any point in time. The Line Tracker is one of a number of devices commercially available for this purpose but this particular device was selected based on a specific criteria, the aim of the project is not to test the device but more to collect and process data that can be used for a range of purposes including 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 There is real interest in the effect of wind cooling on OHL ratings to develop dynamic rating capabilities but the basic requirement is to be able to observe the load and ambient parameters at any instant in time. A Live Line installation procedure has been developed and a trial installation/removal of the Line Tracker by a single line team has been carried out.

Type(s) of innovation involved	Substitution	Project Benefits Rating	Project Residual Risk	Overall Project Score
		11	-6	17

Expected Benefits of Project	Financial – Deferred or part reinforcement resulting in saving of £30,000pa Security of Supply - Confirmation 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 OHL network which may be overloaded in normal running or outage. Better response to intermittent, transient and permanent faults. Confirming correct operation of GVR/protection and grading. Line Tracker senses voltage on or off and load/fault current between 5-25,000 Amps

Expected Timescale to adoption	3 years	Duration of benefit once achieved	10 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£86,397

Potential for achieving expected benefits	A great deal of work has been necessary to identify the functionality required from the device and then co-ordinating modifications to the communications and data handling aspects. It is envisaged that the eventual configuration that is being developed will allow data streams to be directly passed to control room staff from specific points on the network once the Line Tracker is installed.
Project Progress to March 08	This project has been delayed by firmware upgrades and the business re-organisation. Also, this project is being carried out in conjunction with other projects to develop capabilities in data transmission and handling. The line trackers have all now been modified, locations have been agreed and the installation procedures have been agreed with timescales for installation being finalised. Both Nortech and Gridsense have provided a high level of support

Collaborative Partners	EdF
R&D Providers	Nortech Gridsense

<table>
<tr><td>Project Title</td><td colspan="4">Line Tracker Development</td></tr>
<tr><td>Description of project</td><td colspan="4">This project implemented a technical solution to allow the Line tracker data to be received directly to the network control room via the iHost Platform.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £9,891
External £0
Total £9,891</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £2,212
External £92,431
Total £94,643</td></tr>
<tr><td>Project Cost (Collaborative + external + [DNO])</td><td>£</td><td colspan="2">Projected 08/09 costs for ENW</td><td>Internal £3,000
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The key aims are to add conductor and ambient temperature up to 132kV voltage and accommodate larger conductor applications. Present conductor ratings based on the load current and typical ambient temperature in winter, spring/autumn and summer 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. The objective is to develop Line Tracker to assist in determining dynamic conductor ratings.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>-6</td><td>17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Financial – Deferring capital investments in reinforcing overloaded circuits at 11/33/132kV. Allow the maximum load flow through conductors by recording a profile of temperatures and load currents

Security of Supply - Assist the connection of Distributed Generation</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 years</td><td colspan="2">Duration of benefit once achieved</td><td>10 years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£891,309</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Fifteen prototypes of Line Tracker LT50's have been delivered and Gridsense have provided on-site training and uploading of firmware upgrades to resolve protocols between Line Tracker and the control room iHost platform. The devices are about to be installed at a number of locations with network constraints in normal or abnormal running. Other projects are also underway to develop capabilities in data transmission and handling.

A great deal of work has been necessary to identify the functionality required from the device and then co-ordinating modifications to the communications and data handling aspects. It is envisaged that the eventual configuration that is being developed will allow data streams to be directly passed to control room staff from specific points on the network once the Line Tracker is installed</td></tr>
</table>

Project Progress to March 08	This project has been delayed by firmware upgrades and the business re-organisation. Nortech have installed the required iHost upgrade to allow communication directly to the DCMS. A DNP 3.0 link is being installed between the iHost and the DCMS to facilitate easier data transfer
Collaborative Partners	None
R&D Providers	Nortech Gridsense

Project Title	**Vista - Mapping Underground Assets**			
Description of project	This project is a collaboration of partners with an interest in street excavations. The ultimate aim is to provide tools to visualise underground assets by the use of GIS/GPS techniques before excavations are started			
Expenditure for financial year	Internal £0 External £0 Total £0	Expenditure in previous (IFI) financial years	Internal £1,180 External £2,520 Total £3,700	
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £2,520 External £2,520 Total £5,000	
Technological area and / or issue addressed by project	UKWIR successfully bid for DEBERR funding and is project managing the £2.4 million VISTA project. It is investigating 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 DEBERR funding with over 20 collaborators covering a wide range of utilities in the UK. The project is being carried out by the Universities of Leeds and Nottingham			
Type(s) of innovation involved	Radica	Project Benefits Rating	Project Residual Risk	Overall Project Score
		14	-8	22
Expected Benefits of Project	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. The recently introduced Traffic Management Act has placed even further pressure on utilities to reduce street excavations			
Expected Timescale to adoption	3 years	Duration of benefit once achieved	10 years	
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£270,093	

Potential for achieving expected benefits	The following milestones have all been delivered:- Initial exploitation & communication plan Agree location for preliminary trials Agree methodology for field trials Completion of data model and ontological specification Document protocols for field trials Identify locations for further field trials Report on preliminary field trials GIS data management GIS discrepancy resolution GPRS evaluation Techniques to deal with GPRS 'black-spots' If the project delivers its anticipated aims it could revolutionise street excavations and eliminate third party damage to other underground assets
Project Progress to March 08	The project is proceeding, the annual meeting tool place at EdF offices in London in April where currently progress was discussed
Collaborative Partners	Other DNO's and other utility companies
R&D Providers	UK Universities

Project Title	**Fault Master Developments**		
Description of project	The Kelman Re-Zap Fault Master has proved to be a very useful tool in assisting with the rapid location and restoration of LV faults. This project aimed to make several major developments to the Re-Zap in collaboration with Kelman.		
Expenditure for financial year	Internal £1,097 External £46,774 Total £47,871	Expenditure in previous (IFI) financial years	Internal £3,954 External £134,112 Total £138,066
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £40,627 Total £40,627
Technological area and / or issue addressed by project	The re-zap has been used for the last 10 years as a tool to locate intermittent LV faults and has been very successful. Kelman were engaged as a collaborative partner to develop a new re-zap with an agreed functionality and a number of additional potential beneficial features. The aims of this project; • Controlled trial and development of the re-zap Fault Master on LV Transient Faults • Develop Firmware/software interface to DCMS/CI/CML's data base • Develop additional features i.e. Mobile phone control, Auto-reset Objectives; • Develop accuracy and effectiveness of distance to fault location function • 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 re zap control software and mobile phone • Modular re zap for outdoor substations		

	The aim is to continue to develop our LV fault restoration strategy using the latest innovations			
Type(s) of innovation involved	Technical Substitution/Radical	Project Benefits Rating	Project Residual Risk	Overall Project Score
		10	-3	13
Expected Benefits of Project	Financial - Should 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 re zap 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 re zap may be re-closed remotely under certain criteria (based on an agreed risk assessment criteria) Safety - Reducing excavations and live jointing reduce the risk Environment - Reduction in joint holes saves environmental impact on landfill			
Expected Timescale to adoption	3 years	Duration of benefit once achieved	10 years	
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£295,725	
Potential for achieving expected benefits	The following developments have been completed and are now on trial; Mobile Phone Controller Trips to Lockout and Auto Reset capability Load Profiler Single Ended Location to Fault software is still under development but good results have been obtained from testing at a test facility where live faults were replicated			
Project Progress to March 08	The Fault Location Algorithms are proving more difficult to develop than envisaged, Kelman have been carrying out extensive tests and trials to complete the final stages of the project			
Collaborative Partners	Kelman			
R&D Providers	Kelman			

Project Title	**LV Voltage Regulator**		
Description of project	This project aimed to develop an alternative method of providing a temporary solution to customer voltage issues		
Expenditure for financial year	Internal £0 External £3,760 Total £3,760	Expenditure in previous (IFI) financial years	Internal £7,993 External £85,613 Total £93,606
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £0 Total £0

<table>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The Low Voltage (LV) voltage regulator is a single-phase voltage regulator which has been adapted for mounting on a wood pole and connecting to the LV feeder to the property to provide fast response voltage compensation for both over and under-voltages. Two prototype units from US manufacturer MicroPlanet have been used in a limited trial

This project aimed to undertake an extended field trial combined with detailed monitoring to ascertain both their short and medium term performance and the potential for full type approval. It is envisaged that this device will primarily used as a means of rapidly resolving voltage complaints in rural areas and 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 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.

The specific project objectives were to evaluate short term performance whilst 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. Various network uses, assessing the use of the units as temporary device for relieving voltage complaints vs more permanent measures</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>-7</td><td>18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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 in the short-term. Where other types of complaints exist the voltage regulator could be used to mitigate the problem whilst a fuller investigation is carried out to investigate the cause

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 the regulator could be used to maintain the local network within statutory voltage limits</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 years</td><td colspan="2">Duration of benefit once achieved</td><td>20 years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£175,346</td></tr>
</table>

Potential for achieving expected benefits	A number of Low-Voltage Regulators have been purchased from MicroPlanet to trial on the ENW LV network. Prior to installation the device was fully tested to determine potential failure modes and performed to specification, however, tests did identify some changes were required to the specification and design to meet basic requirements. Remote GPRS power quality monitors with web-based configuration and viewing have been used to monitor the performance of the regulators. The power quality monitors have enabled remote wireless configuration and downloading of power quality measurements to enable the data to be viewed from any location. Safety cases and installation procedures have been developed and a number of regulators are on the network at strategic locations. The initial feedback from both customers and staff has been positive
Project Progress to March 08	LV regulators have been installed and performed very well. The project is has not been closed as we are currently working with our customer liaison teams to find more locations with voltage issues to carry out extended trials
Collaborative Partners	SP
R&D Providers	MicroPlanet

Project Title	**Super-conducting Fault Current Limiter (SFCL)**		
Description of project	This project aimed to assist with the development of a Super Conducting Fault Current Limiter for use on the 11kV network. It will be the first such trial in the UK and only the second in Europe. ENW are proud to be able to host this trial on our network		
Expenditure for financial year	Internal £1,273 External £7,517 Total £8,790	Expenditure in previous (IFI) financial years	Internal £6,898 External £45,622 Total £52,520
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £5,000 External £92,500 Total £97,500

<table>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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. ASL are intending to design and construct a prototype super-conducting fault-current limiter (SFCL) and undertake trials 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 SFCLs 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) who 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, ENW, 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</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>-4</td><td>15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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:

Financial - 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.

Quality of Supply - 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 CML’s 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. 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.

Environmental - If network fault currents are restricted equipment will not be subjected to increased wear or stress, potentially prolonging the asset life.</td></tr>
</table>

Expected Timescale to adoption	3 years	Duration of benefit once achieved	20 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£1,120,000
Potential for achieving expected benefits	Bamber Bridge, Preston has been identified as the first trial site and a full specification of the SFCL has been prepared based on a detailed study of the local network impedances. Modelling of the SFCLs interaction with the network has been undertaken and no particular problems are apparent. Superconducting elements have been designed and tested and shown to provide the necessary performance. Design of the SFCL, its enclosure and associated equipment is in progress. Applied Superconductor Ltd. experienced a setback in mid 2006 when a major offer of finance from a private investor was withdrawn. The company has since secured the financial support required to ensure that the three planned pilots can be completed and the project re-commenced from the beginning of June 2007		
Project Progress to March 08	This project has been exceptionally challenging in almost every aspect and a great deal of credit is due to ASL and the original DNO sponsors. The project is nearing installation of the first prototype trial and the results are awaited with great interest.		
Collaborative Partners	SP Power Systems, CE Electric UK		
R&D Providers	Applied Super Conductors Ltd		

Project Title	**IHost developments**			
Description of project	This project is supporting a number of other projects and is aiming to provide an interface between the Line Tracker, Re-Zaps, TP-22 devices and the Control Room Management System. It is recognised that to extend the 'Active' part of our network greater visibility is needed at the lower voltage levels, IHost provides a means to achieve this			
Expenditure for financial year	Internal £0 External £19,991 Total £19,991	Expenditure in previous (IFI) financial years	Internal £4,733 External £20,495 Total £25,228	
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £0 Total £0	
Technological area and / or issue addressed by project	There are two existing projects relating to Line Tracker and its development to include measurement of conductors and ambient temperatures, higher voltage and conductor applications. Line Tracker data can be downloaded locally via wireless link to a laptop and remote communications and event notification can be established via GSM/GPRS communications. Data is to be held in a database for historic review (for Network Planning) and interfaced with CRMS for real-time load and event notification (faults and system operation). It is not thought that Line Tracker 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. The aims of the project include Integration of the Line Tracker with iHost data collection, storage and notification and the objectives include Identifying critical network points at all high voltage levels, developing communication between Line Tracker and iHost and developing iHost, Gridsense Software and CMRS interfaces			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score

		9	-9	18

Expected Benefits of Project	Financial - Reduce the capital investment of reinforcing overloaded circuits at 11/33kV/132kV Quality of Supply - less risk under abnormal running Environmental - Allows for reduced connection costs		
Expected Timescale to adoption	3 years	Duration of benefit once achieved	10 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£927,976
Potential for achieving expected benefits	This project has faced the challenging task of integrating various essentially non-compatible systems to provide a seamless interface for the control room operators. A decision has been taken to use the iHost platform to develop a number of applications as it allows a virtual link with the control room management system but does not impact on its normal operation. When successful the platform will provide access to load and fault data instantaneously		
Project Progress to March 08	Basic communications and interface software between iHost and Gridsense remote PAC units has been completed and the Line Trackers are to be installed in August 08		
Collaborative Partners	Nortech, Gridsense		
R&D Providers	Nortech		

Project Title	**Resilience and Investment Model**		
Description of project	The aim of this project was to develop a software application that could better utilise specific geographic data to predict planning needs. The tool would be primarily used to model the effects of specific extreme weather events on the OHL network to test its resilience and to identify potential reinforcement requirements.		
Expenditure for financial year	Internal £0 External £27,771 Total £27,771	Expenditure in previous (IFI) financial years	Internal £126,268 External £15,551 Total £141,819
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £0 Total £0
Technological area and / or issue addressed by project	Overhead line investment has historically been carried out on parts of the network that have a high fault rate. This has led to the identified section of network being replaced or refurbished to the current code of practice no matter what environment the line resides in. It is believed that a method to assess the performance of the overhead line against different weather patterns or storm events that it may encounter will allow better planning. A proven method of assessing the effects of more onerous weather conditions (including wind and ice-loading) would insure against any changes in local climate that may occur in the future		

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>12</td><td>-6</td><td>18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Financial – From a better targeting of asset replacement and a methodology to justify reduction in Capex whilst aiming to maintain fault rates at their current level. It has been assumed that ENW rebuilds/refurbishes 300km of HV overhead line per year. This is to cater for the worst case weather patterns seen over the entire geographical area. The consequence is that approximately 8% of all the lines rebuilt or refurbished are potentially over-designed and at present no reliable tool exists to forecast weather patterns at individual locations and to assess the impact on existing lines. In addition the ability to assess the design criterion to be utilised would allow more targeted designs</td></tr>
</table>

Expected Timescale to adoption	3 years	Duration of benefit once achieved	20 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£2,077,054
Potential for achieving expected benefits	The Resilience Model is now complete and makes use of detailed overhead line data collected either from site or from as built records to effectively reverse engineer the original line design and determine its likely performance under varying weather conditions. The model uses a geo-referenced physical representation of the network to determine span lengths, angles of deviation and any other relevant data. This information is then combined with as-built information regarding the line components including poles, stays, cross arms and conductors to allow the calculation of maximum permissible wind speeds, conductor clashing limits and conductor ultimate tensile strength limits. Three further data sets, Component Condition, Vegetation and Electrical Connectivity are then applied to the original design capability to determine the present resilience of the assets under varying weather conditions.		
Project Progress to March 08	The project is now complete and about to be signed off. The model is being populated with data and undergoing a period of evaluation and testing and early results are very promising		
Collaborative Partners	None		
R&D Providers	Poletecs		

Project Title	**TP-22 LV Fault Locator**		
Description of project	The Kehui TP-22 is used to locate the most elusive intermittent faults on the ENW LV network, this project collaborated with Kehui to introduce a number of further functional developments and also Nortech to enable the TP-22 data to be viewed over the iHost Platform		
Expenditure for financial year	Internal £0 External £2,000 Total £2,000	Expenditure in previous (IFI) financial years	Internal £4,733 External £45,206 Total £49,939

<table>
<tr><td>Project Cost (Collaborative + external + [DNO])</td><td colspan="2">£</td><td>Projected 08/09 costs for ENW</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">TP-22 units, and their predecessors the T-P20 and T-P21, have been used to locate many intermittent faults on the LV network, some of which had existed for many months and been impossible to locate with previously available fault location instruments. All of these fault locations were carried out by a small number of ‘specialists’ using the remote interrogation features of the T-P2X Master Station software. As the number of instruments in service increases it is becoming more difficult to ensure that the status of units and the integrity of the communication channels are checked regularly. If this is not done systematically it is possible for valuable ‘fault events’ to be over-written or for problems with a unit, or its communication channel, to go undetected until an interrogation is attempted after a fault has occurred. When first introduced the TP-20 operated purely as a ‘triggered’ TDR device with a limited range of functions. The TP-22 now includes the ‘Travelling Wave’ (TRS) mode of operation whilst still providing ‘triggered’ TDR, but with a wider range of functions. Alone, or in combination with TV-22, the TP-22 forms a 3 phase Voltage Gradient System (VGS) with remote control and interrogation. Depending on the situation, the 3 modes of operation can often be used simultaneously, or sequentially, to improve the chances of achieving a successful fault location or to resolve an ambiguous result on a multi-branched cable. As awareness of the usefulness of the TP-22 has grown there has been an increase in the number of non-specialist users requiring a simplified means of control and interrogation, preferably with a degree of automatic analysis and validation of the acquired data. Against the above background it is now appropriate to re-evaluate how the full potential of the T-P22 and TV-22 units can be realised through the development of a new Master Station software package which will reduce the need for manually initiated interrogation by ‘specialist’ operators. A number of T-P22 would be purchased to trial the developed firmware and software. The main features of the proposed development package are;
• Regular automatic Logging and polling of specified units
• Configuration tool to provide investigation into possible methods of automatic fault location using estimation of ‘impedance to fault’ from voltage measurements
• Conversion of ‘impedance to fault’ into ‘distance to fault’ based on Cable parameters and source transformer rating
• Estimation of ‘distance to fault’ using TRS data
• Estimation of ‘distance to fault’ using TDR data
• Create ‘automatic fault location’ log giving results of successful locations</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-10</td><td>20</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Financial - Reduction of LV joint holes and LV Cable joints would reduce the costs of an LV fault.
Quality of Supply - A reduction in joint holes and joints would save an assumed 1.5 hrs/hole on 50% of faults on 30% of the LV Feeder Network that has an average of five transient faults before a permanent fault develops. Transient fault reductions would save an assumed number of customers off supply Safety - Reducing excavations and live jointing would reduce risks
Environment - Reduction is jointing holes reduces environmental impact</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 years</td><td>Duration of benefit once achieved</td><td>5 years</td></tr>
</table>

Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£185,892
Potential for achieving expected benefits	The Kehui LV Fault Locator has been integrated with iHost and final coding and successful testing was completed last year. The trial period revealed compatibility issues with the Kehui GPRS modem and iHost but with the full support of both Kehui and Nortech the issues have been resolved. The improved functionality is being used in a variety of ways and is proving to offer a real enhancement and improved response times for fault location in even the most difficult circumstances		
Project Progress to March 08	Training of field staff is ongoing		
Collaborative Partners	EdF		
R&D Providers	Kehui/Phil Gale		

Project Title	**Delta V Developments and Trials**			
Description of project	The Delta V system has been used as an event recorder to locate difficult to find intermittent faults on underground LV feeder systems. Inherent weakness in the origin design made it difficult to use event thought it was a very useful device, this project collaborated with Kelman to improve the functionality			
Expenditure for financial year	Internal £0 External £62,410 Total £62,410		Expenditure in previous (IFI) financial years	Internal £2,212 External £0 Total £2,212
Project Cost (Collaborative + external + [DNO])	£		Projected 08/09 costs for ENW	Internal £0 External £0 Total £0
Technological area and / or issue addressed by project	Delta V is a portable system for the accurate location of intermittent and permanent faults on complex low voltage (LV) power distribution networks. The system uses a number of small transient recorders (nodes) to record the voltage drop across the network under fault conditions and a handset to gather and analyse the fault data. The fault location is calculated using a refined version of the ´transgradient´ method and the known cable topography			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
		10	-8	18
Expected Benefits of Project	Financial - The Delta V will reduce the number of jointing test positions and reduce the average fault cost of a LV fault. Quality of Supply - A reduction in jointing holes would save 1.5 hrs /hole. Assuming average of 30 customers/fault. Safety - Reducing excavations and live jointing Environment - Reduction is jointing holes reduces environmental impact			

Expected Timescale to adoption	3 years	Duration of benefit once achieved	10 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£139,577
Potential for achieving expected benefits	Functional developments carried out include: • New handset hardware with larger screen, more powerful processor, larger and more useable volatile memory, larger non-volatile memory for code and data. • Rewrite of handset software from previous handset to new handset. • Design and implementation of radio-based communications between handset, nodes and case to allow short-range data transfer from inaccessible installations. • Revision of data-structures and analysis code to permit more flexible use of data capture hardware including Rezap FM. • Revision of case to improve appearance, manufacturability, durability and to enable automatic calibration and testing of nodes. • Revision of node hardware to eliminate problems of battery failure • increase the number of records stored to 64 and to enable radio communications with the handset		
Project Progress to March 08	The Delta V system relies on installing nodes that are similar in sixe to a 13A plug into customers premises. The developments have now allowed the data to be retrieved from outside the premises wirelessly at regular intervals and does not rely o the customers being in. The Delta V is still under trial and has delivered valuable results so far		
Collaborative Partners	None		
R&D Providers	Kelman		

Project Title	**Modular Rezap Fault Master**		
Description of project	The Re-Zap has proved a real success in the restoration of supplies following transient faults but its size combined with the move to smaller outdoor LV Feeder Pillars means that it will fit into only a limited number of locations. This project collaborated with Kelman to redesign the Re-Zap to fit into all of our current and legacy design LV Feeder Pillars		
Expenditure for financial year	Internal £420 External £0 Total £420	Expenditure in previous (IFI) financial years	Internal £2,212 External £28,587 Total £30,799
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £90,137 Total £90,137

<table>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Kelman Ltd has developed a new version of the re-zap with additional beneficial features which is being trialled under separate IFI Projects. Further developments are proposed to split the electronic control/power supply and the vacuum bottle with one controller being able to control up to three separate vacuum bottles. This will allow Re-zaps to be installed in all outdoor LV cabinets and Pillars.

Aims:-
1. Develop and trial a Modular Rezap for outdoor substation (for LV Transient Faults)
2. Develop One Controller for 3 Modular Re-zaps

Objectives:-
1. Compact waterproof (IP rated) case
2. Same features are existing Rezap
3. Specifically design leads
4. Trial a number of Modular Rezap

The initial consideration is to understand the available envelope (that would fit into all our LV Pillar designs) and then to research and specify the proposed Modular REZAP by carrying out a feasibility phase</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>-9</td><td>20</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Financial - Potentially the Modular Re-zap could reduce the number of jointing test positions and reduce the average fault cost of an LV fault.
Quality of Supply -If the Re-zap could be reset remotely this would reduce the number of CI and CML's except in situation in which the fault condition changes to a permanent fault. The Re-zap can be used to turn intermittent faults into permanent faults thereby allowing a proper repair to be made and improving the quality of supply for the longer term
Safety - Reducing excavations and live jointing reduce risk
Environment - Reduction is jointing holes saves environmental impact on landfill</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 years</td><td colspan="2">Duration of benefit once achieved</td><td>10 years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£75,097</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The project has successfully developed a prototype in the required envelope which proved to be an extremely challenging task. We are confidentially expecting the modular re-zap to extend the benefits of the standard re-zap as part of our overall supply restoration strategy</td></tr>
</table>

Project Progress to March 08	Work carried out on the Modular Re-zap includes: • Research in to the physical design constraints to which the Modular Re-zap should comply • Generating a specification for the Modular Re-zap • Modelling of Switch Module assembly in Solid Works • Schematics for Switch Module • PCB Layout for Switch Module • Architecture requirements for Control Module Soft tooling has produced a number of prototypes that are undergoing a range of endurance and electrical testing, delivery of he first batch of production units is expected in August 08
Collaborative Partners	EdF
R&D Providers	Kelman

Project Title	**Climate Change**			
Description of project	In 2006 the Met Office carried out a scoping study on the impacts of climate change on the UK energy industry. The report was the result of a collaboration between E.ON UK, EDF Energy, National Grid and the Met Office Hadley Centre to better understand the impacts of climate change on the UK energy industry. This Phase 2 collaborative project between all the network operators and most energy supply businesses sets out to answer the question "What will be the effect of climate change on energy demand?"			
Expenditure for financial year	Internal £0 External £20,726 Total £20,726	Expenditure in previous (IFI) financial years	Internal £1,446 External £3,500 Total £4,946	
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £0 External £0 Total £0	
Technological area and / or issue addressed by project	Create methodology for prediction of gas and electricity demand using climate models (dealing with limitations in spatial and temporal resolution). Assess the importance of temporal resolution to the calculation of energy demand. Investigate the differences of modelling demand using: climate model output, new climate model diagnostics, and weather generated output.			
Type(s) of innovation involved	Technological substitution	Project Benefits Rating	Project Residual Risk	Overall Project Score
		9	-2	11

Expected Benefits of Project	The expected benefits of project are: • Probabilistic understanding of likely future electricity and gas demand; • Model for projecting meteorologically driven demand suitable for inclusion in climate model or for application to climate model output • Demand from 'Energy' climate model simulation • Reporting of the affect of temporal and spatial resolution on the demand calculation, and recommendations for projecting demand from UKCIP08 when available • Recommendations for improvements in demand modelling approach if necessary			
Expected Timescale to adoption	3 years	Duration of benefit once achieved	10 years	
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£256,517	
Potential for achieving expected benefits	This project provides an extremely long range view of the potential future climate in the UK and its impacts on the electricity network and it is taking some time to consider the potential impacts internally. The Met Office reported during the IFI funded project that the electricity supply industry is the only cross industry group that has commissioned such a wide ranging research programme			
Project Progress to March 08	The project is virtually completed with most of the work programmes outputs delivered in at least draft form.			
Collaborative Partners	Other DNOs, National Grid and Generators			
R&D Providers	Met Office			

Project Title	**ESR Network**			
Description of project	The Electricity Supply Network is a self-funded academic and industry network used purely for ensuring the proper visibility is given to academic research amongst potentially interested industrial companies and DNOs			
Expenditure for financial year	Internal £0 External £0 Total £0	Expenditure in previous (IFI) financial years	Internal £1,446 External £4,500 Total £5,946	
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £1,000 External £4,500 Total £5,500	
Technological area and / or issue addressed by project	The ESR Network was established in August 2000 with support from EPSRC and the major companies of the UK electricity supply industry, together with manufacturers of electrical and generating plant. The Network currently has fourteen industrial members and 49 academic members. It has a number of purposes, among which is to provide industrial members with an overview of current research, with an opportunity to become involved where appropriate, and to give academic members a chance to strengthen their links with the power industry			
Type(s) of innovation involved	Radical	Project Benefits Rating	Project Residual Risk	Overall Project Score

		7	-8	15

Expected Benefits of Project	Monitoring / data exchange of all EPSRC funded projects submitted in 'responsive mode' • Monitoring / data exchange of other UK/EU research initiatives • Network of academic contacts • Network of industrial contacts		
Expected Timescale to adoption	7 years	Duration of benefit once achieved	20 years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£4,224
Potential for achieving expected benefits	A number of very informative and stimulating research strategy papers have been published including a matrix of UK current research activities against a number of strategic issues. The ESR is a very low cost activity but more than delivers a number of tangible and intangible benefits		
Project Progress to March 08	A number of meetings have been held through the year		
Collaborative Partners	Universities, DNOs, Generators, Industrial Companies		
R&D Providers	ESR Network		

Project Title	**FuseRestore**		
Description of project	This project is aiming to develop a novel method of automatically restoring supplies following the operation of a fuse on an LV Feeder Pillar		
Expenditure for financial year	Internal £0 External £10,903 Total £10,903	Expenditure in previous (IFI) financial years	Internal £2,978 External £32,390 Total £35,368
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £1,500 External £80,400 Total £81,900

<table>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Just as with HV feeders LV feeders have rogue circuits which result in repeated faults even after a fault has been repaired therefore it is proposed to develop a device that can automatically replace a fuse that has operated. The 'FuseRestore' would be able to hold two fuses, one in circuit and the second to restore customers after 30 seconds should the first fuse operate. The units would have communication via GPRS to the iHost platform via the Kelman server in N Ireland and would be able to record any events where it has been caused to operate. This would allow for regular scheduling via the LV fault Management system for fuse replacement during normal working hours. It is envisaged that the FuseRestore could be fitted to any LV Feeder Pillar at any location.

Aims
Development of the FuseRestore to replace a standard Fuse

Objectives
1. Develop 3 FuseRestore devices as proof of concept
2. Carry out extensive testing
3. Develop proto-type units
4. Trial on the network</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>-8</td><td>17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Financial – The figures for number of fuse operations and the locations of many ‘rouge’ LV feeders are well known. If the FuseRestore was fitted to every circuit after the initial fuse operation we could potentially eliminate all subsequent fuse operations by being able to maintain the supply on the second fuse whilst the primary fuse is replaced. A successful deployment programme could have a significantly positive effect on our targets for the reduction in CML's and CI's which currently result in additional payments in IIP. 240 Installation would potential save 20% in CML's & CI's as only approximately 80% of intermittent faults will restore with one fuse replacement.

Safety – The FuseRestore will provide much more control over fault restoration and enable fuse replacement to be carried out in a scheduled manner rather than under the pressure of an outage. This should provide more time and a more planned approach for field staff</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 years</td><td colspan="2">Duration of benefit once achieved</td><td>1 years</td></tr>
<tr><td>Probability of Success</td><td>50%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£28,214</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Many iterations of design were considered for the Fuse Restore. It is now nearing the end of the design phase. A prototype switching mechanism is being manufactured for heat tests in the workshop.</td></tr>
<tr><td>Project Progress to March 08</td><td colspan="4">This is another very challenging project that has required an extremely innovative design approach. The three prototypes have been produced and are undergoing a range of endurance and electrical testing, deployment of the trial prototypes is expected in September 08</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">None</td></tr>
</table>

R&D Providers	Kelman

Project Title	**Expansion Planning**		
Description of project	This project is aiming to develop a new software module that will sit alongside the existing IPSA software suite and use the existing IPSA network model of the grid and primary distribution network		
Expenditure for financial year	Internal £12,536 External £2,350 Total £14,886	Expenditure in previous (IFI) financial years	Internal £23,591 External £12,103 Total £35,694
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £36,000 External £498,000 Total £534,000
Technological area and / or issue addressed by project	To ensure timely delivery of the load related capital investment programme, for G&P networks, it is essential to develop a forecast of network reinforcement needs. The forecast should look ahead 20 years and be reviewed annually to produce a rolling programme. Certainty of the programme of work and its associated cost will allow ENW to plan its resource requirement and negotiate its revenue stream with Ofgem on the basis of a justified Price Control submission. It is proposed to specify and develop with our partners, TNEI Services, an expansion planning tool. The new software module will sit alongside the existing IPSA software suite and using the existing IPSA network model of the G&P distribution network will apply DC load flow techniques, with a set of reinforcement rules to create an investment profile for the given time horizon. Aims To develop an Expansion Planning software tool capable of analysing the G&P network for multiple load conditions and outage scenarios. The tool shall check the network for compliance with thermal and voltage limits, fault level limits and Licence Standard ERP2/6. The output of the tool will be a record of non-compliance issues over the 20 year planning horizon. It is a further requirement of the Expansion Planning software tool that it interfaces with another IPSA related development software package which calculates nodal marginal prices for DUoS charging. Objectives 1. To specify and develop a DC load flow module for network analysis; 2. To specify and develop an expansion planning module; 3. Implement and trial the software for the creation of a forecast investment plan for a defined time horizon		

Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
		11	-3	14

Expected Benefits of Project	Financial - Although a systematic review of the network is not currently undertaken by ENW there is a clear business need to do so. It is anticipated that because there will be a greater knowledge of the status of the network it will be possible to develop engineering solutions that will utilise available Capex more efficiently. Whilst it is difficult to accurately quantify the savings it is reasonable to anticipate a 0.5% saving (available for reinvestment) over the whole load related capital programme. Based on the XD4 load related capital programme this would deliver a £250k over the five-year period, which equates to a £50k saving per annum anticipated for each year of the 20-year programme. Supply Quality - The Expansion Planning tool will enable United Utilities to plan and deliver an efficient and co-ordinated distribution network that will positively impact on the Supply Quality (CI & CML) delivered to customers. There is a further option to include a reliability element to the network analysis part of the tool, however the decisions whether to include this will be delayed until the other elements have been proven. Quality of Supply - The expansion-planning tool will assist with the efficient and co-ordinated development of the distribution network. Although the output is a first order approximation of the development of the EHV distribution network, in some cases it may provide the reinforcement solution. An output of the load related investment profile is a set of 'time to reinforcement' values for the congested elements of the EHV distribution network. These values are to be used as inputs into the creation of network prices within the Structure of Charges project to signal, through use of system charges, to existing and potential users the future cost of utilising these network assets.		
Expected Timescale to adoption	3 years	Duration of benefit once achieved	5 years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£148,000
Potential for achieving expected benefits	The main objective of the Expansion Planning Initiative is the analysis, design, development and testing of a new software tool to analyse network bottlenecks and non-compliance with the P2/6 planning standard. The tool will undertake complex analyses and calculations, taking into account a range of factors and data, to study the effects of forecast demand and generation for the company's distribution network over the next 20 years. The initial focus of the work was to investigate, analyse, design and document the initial specifications for the computational engine, and the algorithms within it, all of which form the foundation of the software tool. The computational engine specification was completed after many revision cycles between the designer and the relevant engineering specialists in ENW		
Project Progress to March 08	This project has been delayed due to the sale of the business and the resulting renegotiation of the commercial arrangements between ENW, UUES and Vertex Data Science Ltd. All agreements have now been finalised and the project has re-started		
Collaborative Partners	None		
R&D Providers	Vertex Data Science Ltd, EATL,		

Project Title	**LV Sure**
Description of project	This project aims to develop an automatic LV feeder section

Expenditure for financial year	Internal £0 External £0 Total £0		Expenditure in previous (IFI) financial years	Internal £2,212 External £3,125 Total £5,337
Project Cost (Collaborative + external + [DNO])	£		Projected 08/09 costs for ENW	Internal £0 External £31,000 Total £31,000
Technological area and / or issue addressed by project	A great deal of benefits have been realised from the many automation schemes that have been installed on the OHL network over a number of years. If the same philosophy could be applied to underground circuits it could deliver a number of benefits and offer faster customer restoration times			

Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
		7	-1	8

Expected Benefits of Project	Quality of Supply - The benefits delivered by low voltage automation are those that improve the operational performance of the low voltage electricity distribution network by a reduced number of customer interruptions (CIs). Although when deployed on a radial network actual customer interruptions will still occur, the system will reconfigure the local network and restore many customers before expiry of the 3-minute transient time limit. By automatically restoring many customers within a short period of time, only those customers within the faulted zone will remain off supply. Follow-up manual fault restoration resources can then be directed to the faulted zone for a permanent repair to be effected Quality of Supply - Fault location on low voltage networks is a time consuming activity. The system provides a means of fault localisation by isolating the faulted section, allowing fault teams to eliminate health sections of the network from their investigations		
Expected Timescale to adoption	7 years	Duration of benefit once achieved	20 years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£41,392
Potential for achieving expected benefits	Work carried out to date suggests that there may be opportunities to reduce the number of CIs and CMLs associated with transient faults by deploying this system. The preferred strategy would appear to be retrofitting 'rogue' LV circuits which have the highest number of recorded transient fault incidents. The ENW is unique in the low number of buried link boxes which are required for this proposed system		

Project Progress to March 08	The following stages have been completed Stage 1 – Applications and Benefits "Typical" radial LV network topologies have been examined. The types of faults encountered on these LV networks have been determined and specific operational practices relating to such faults have been reviewed. Stage 2 – Technical Constraints and Financial Implications A review of applicable equipment standards and specifications has been completed Stage 3 – Safety & Operational Implications A preliminary report concerning the safety and operational implications associated with the deployment of LVSure equipment on the LV network has been produced.
Collaborative Partners	SP Power Systems, EdF, SSE
R&D Providers	EATL

<table>
<tr><td>Project Title</td><td colspan="4">Pole Mounted Fault/Load monitor</td></tr>
<tr><td>Description of project</td><td colspan="4">The aim of this project was to develop and trial a reliable non-contact Fault/load remote monitor up to 33kV</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £6,499
External £
Total £6,499</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £1,446
External £0
Total £1,446</td></tr>
<tr><td>Project Cost (Collaborative + external + [DNO])</td><td>£</td><td colspan="2">Projected 08/09 costs for ENW</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">This is another project with links to other IFI funded research and development. Fault Passage Indicators have been used for many years and have evolved from simple blinking light indications to the latest devices that include an array of communications and sensor technology, The Polestar was selected for a trial with the aim of gathering data and developing communications protocols to allow the FPI to communicate with the control room management system.

The Polestar Device is non-contact and is installed 3 metres below 11kV conductors on the wooden pole. It detects the presence and magnitude of the magnetic and electrical field in the vicinity of the conductor and uses a GSM/GPRS modem to report alarms, routine events and field capture trends to a central iHost Platform

Objectives
• Trial the device
• Develop load monitoring algorithms
• Evaluate the potential replacement for power outage devices (PODs) on OHL networks
• Feed real-time fault/load data into CRMS
• Historical load data for planning network reinforcement or development</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-11</td><td>21</td></tr>
</table>

Expected Benefits of Project	Financial - From a reduction in CML and CI's Quality of supply - On-line load monitoring to assist in network management , gathering fault data and outage data, can be used with automation schemes in helping to determine which NOP to close and what load would be picked up, gathering of historical load data for planning or network development and faster restoration		
Expected Timescale to adoption	3 years	Duration of benefit once achieved	10 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£265,183
Potential for achieving expected benefits	This project stems from a strategy of developing our infrastructure to allow greater visibility of the network loads in the control room at any instant in time. The Pole Stars can be installed without any outage making them an attractive device. Once the results are calibrated they will provide another means to better manage issues such as DG connections		
Project Progress to March 08	These devices are being installed with the Line Trackers to confirm their accuracy and both projects have been delayed by issues with the devices, communications and the sale of the business. Installation is now planned for Aug/Sep 08		
Collaborative Partners	Central Networks		
R&D Providers	Nortech		

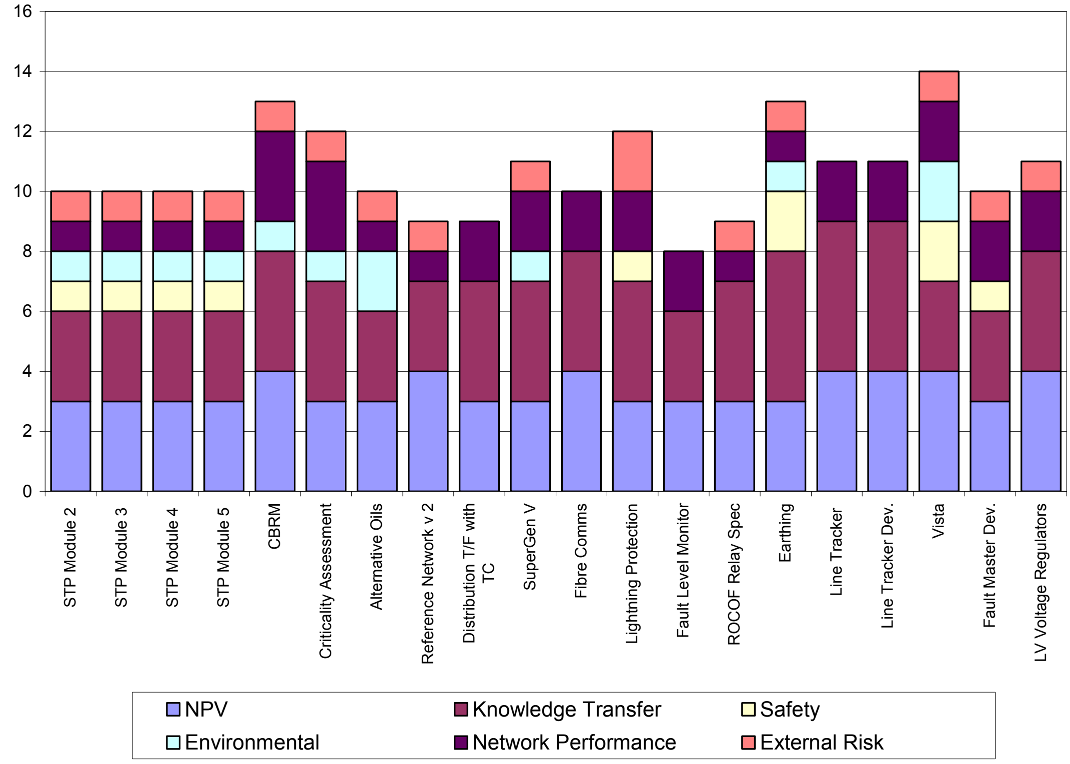
Project Title	**Vegetation Management**			
Description of project	This project proposes to Monitor vegetation growth at 2000 sites across the UK network and develop a software model which will take into account factors such as tree species, bioclimatic area, and the effect of climate variation to estimate the speed of vegetation growth at different sites			
Expenditure for financial year	Internal £0 External £131,000 Total £131,000		Expenditure in previous (IFI) financial years	Internal £0 External £0 Total £0
Project Cost (Collaborative + external + [DNO])	£		Projected 08/09 costs for ENW	Internal £0 External £41,000 Total £41,000
Technological area and / or issue addressed by project	Rate of vegetation growth and the impact on the OHL network			
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	Overall Project Score
		11	-4	15

Expected Benefits of Project	Financial - The software tool will enable an ability to predict whether areas are high growth or low growth and hence allow two-fold savings. In high-growth areas, proactive cutting can be carried out, thereby reducing the number of outages (by cutting before the vegetation enters the live zone) and cost. Simultaneously, cutting cycles in low growth areas will be extended, resulting in fewer spans being cut each year. The scale and cost of tree cutting each tear means that even a small percentage reduction in costs will be a substantial sum		
Expected Timescale to adoption	3 years	Duration of benefit once achieved	10 years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£245,230
Potential for achieving expected benefits	This project has a high probability of success as it is using well proven scientific methods combined with the ability to manipulate large amounts of data to better define vegetation management strategies		
Project Progress to March 08	Data relating to specific locations is being collected and analysed and cutting programmes are being developed		
Collaborative Partners	Other DNO's		
R&D Providers	ADAS		

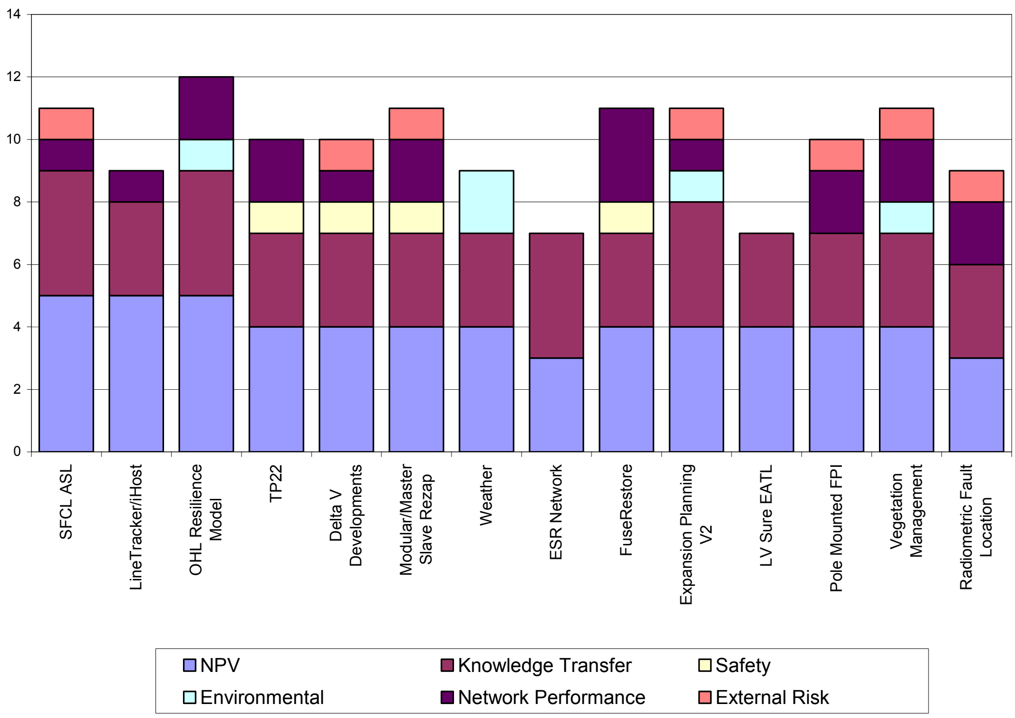
Project Title	**Radiometric fault location**			
Description of project	This project aims to develop a radiometric arc fault locator demonstrator			
Expenditure for financial year	Internal £0 External £3,220 Total £3,220	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total £	
Project Cost (Collaborative + external + [DNO])	£	Projected 08/09 costs for ENW	Internal £1,000 External £18,590 Total £19,590	
Technological area and / or issue addressed by project	Radiometric Arc Fault Location (RAFL), is a methodology to fault locate the position of arcing faults on overhead lines., this project will develop a method to use (RAFL) on OH distribution circuits			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
		9	-9	18
Expected Benefits of Project	It has been estimated that a typical DNO network could have average of 120 lightning related faults per annum affecting approximately 43000 customers giving an around 350 customers affected per fault. A faster location methodology would allow a reduction in these affected customers.			

Expected Timescale to adoption	7 years	Duration of benefit once achieved	10 years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£3,564
Potential for achieving expected benefits	The significant challenges to be faced in this project are: • Development of sub-µs timing function to measure the impulse time-of-arrival • Development of autonomous monitoring software • Development of GSM/GPRS function for remotely accessing station data Interpretation of the results It is expected that all these major challenges can be overcome and the project will deliver a successful outcome		
Project Progress to March 08	Trial sites for the initial prototype installation have been identified by taking measurements of the background radio interference and considering the geographical elevation. A number of the fundamental issues regarding the data capture and analysis including the timing issues and demonstrations are planned for later this year		
Collaborative Partners	Other DNO's		
R&D Providers	University of Strathclyde		

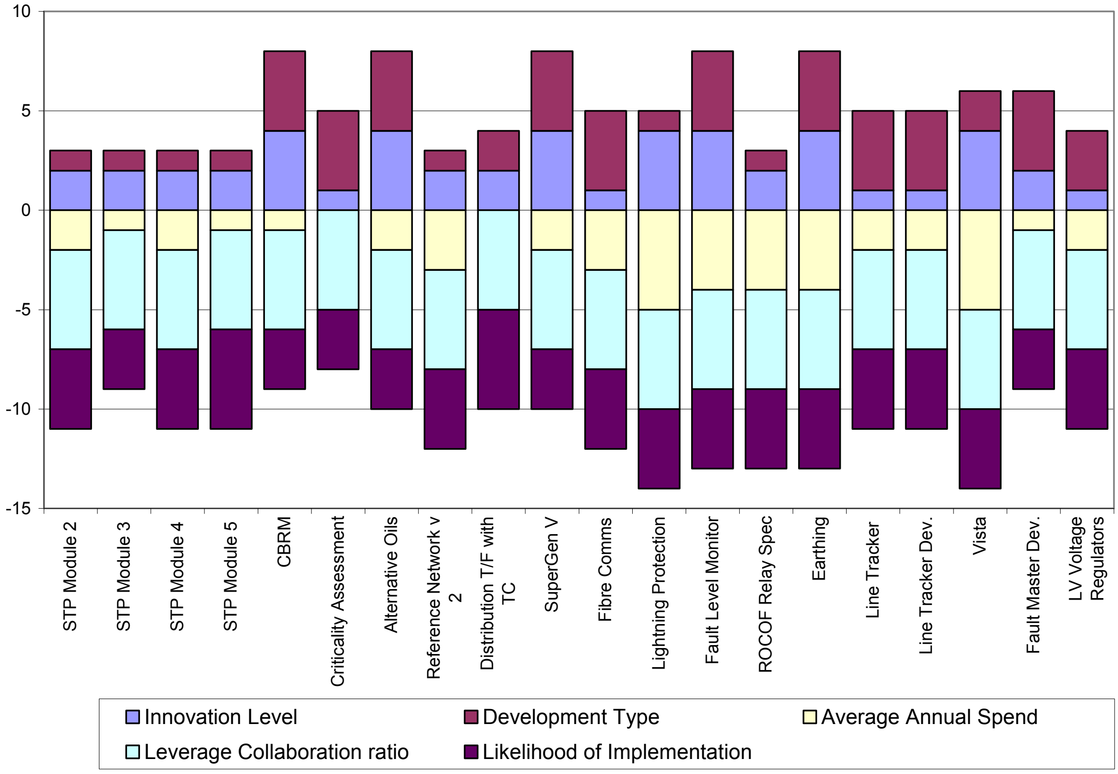
12 Summary Reports



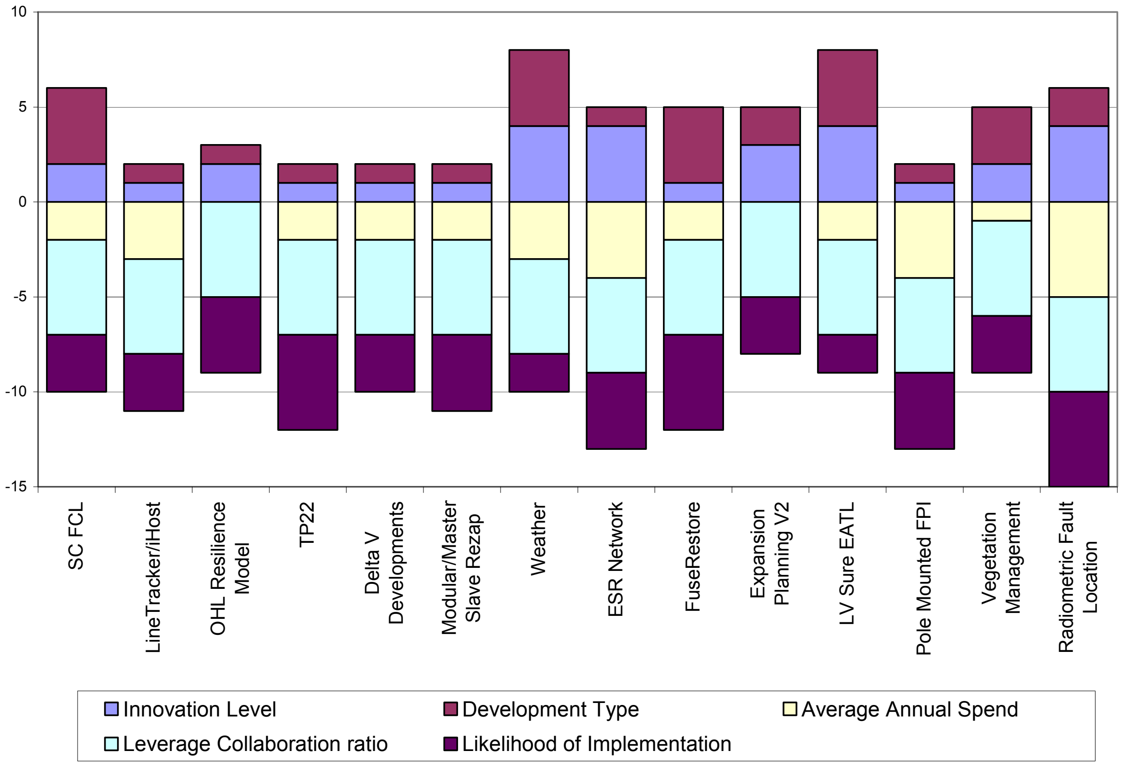
Graph 1a - The development of a benefits score for each project (ref G85/2 Figure 1)



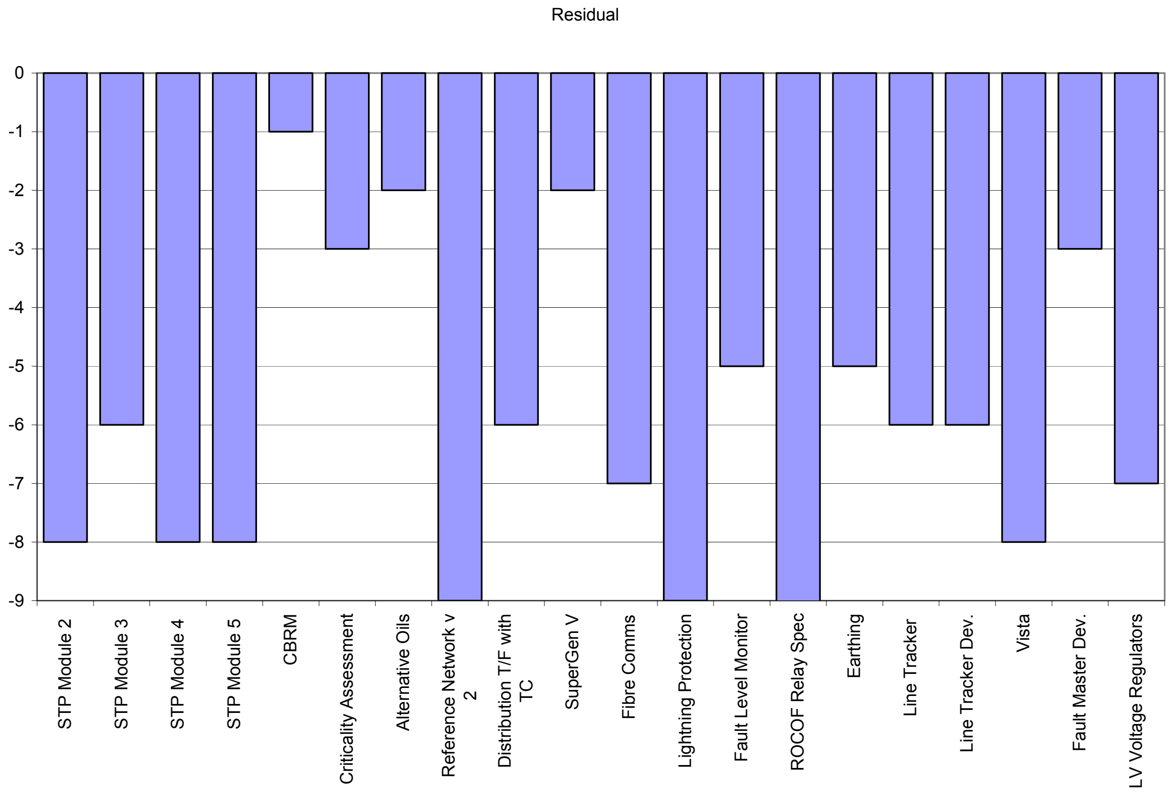
Graph 1b - The development of a benefits score for each project (ref G85/2 Figure 1)



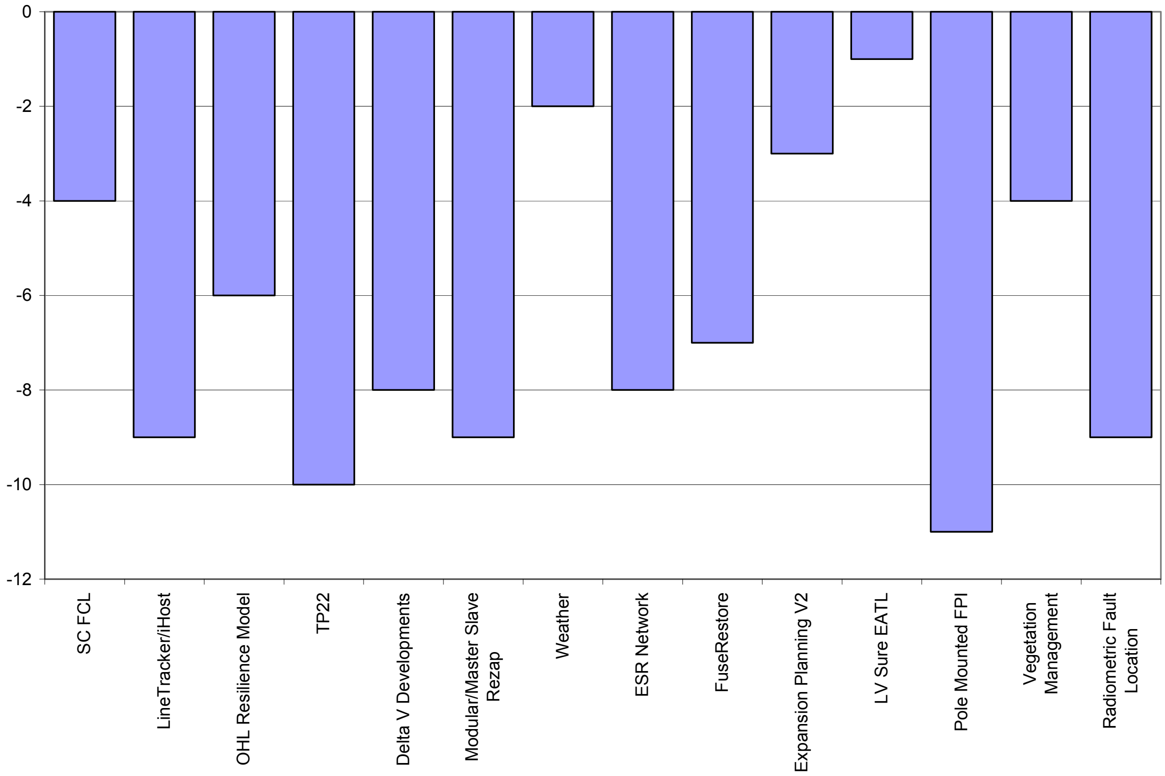
Graph 2a – Project Risk and Mitigation Measures (ref G85/2 Figure A2)



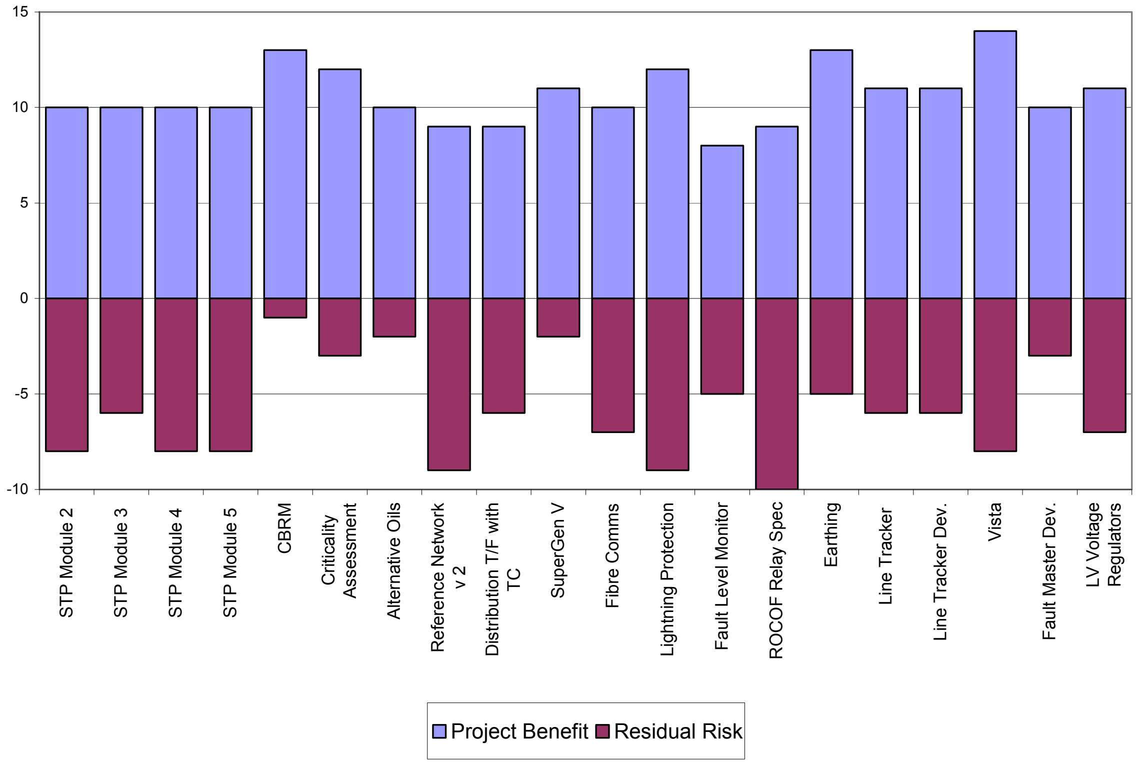
Graph 2b – Project Risk and Mitigation Measures (ref G85/2 Figure A2)



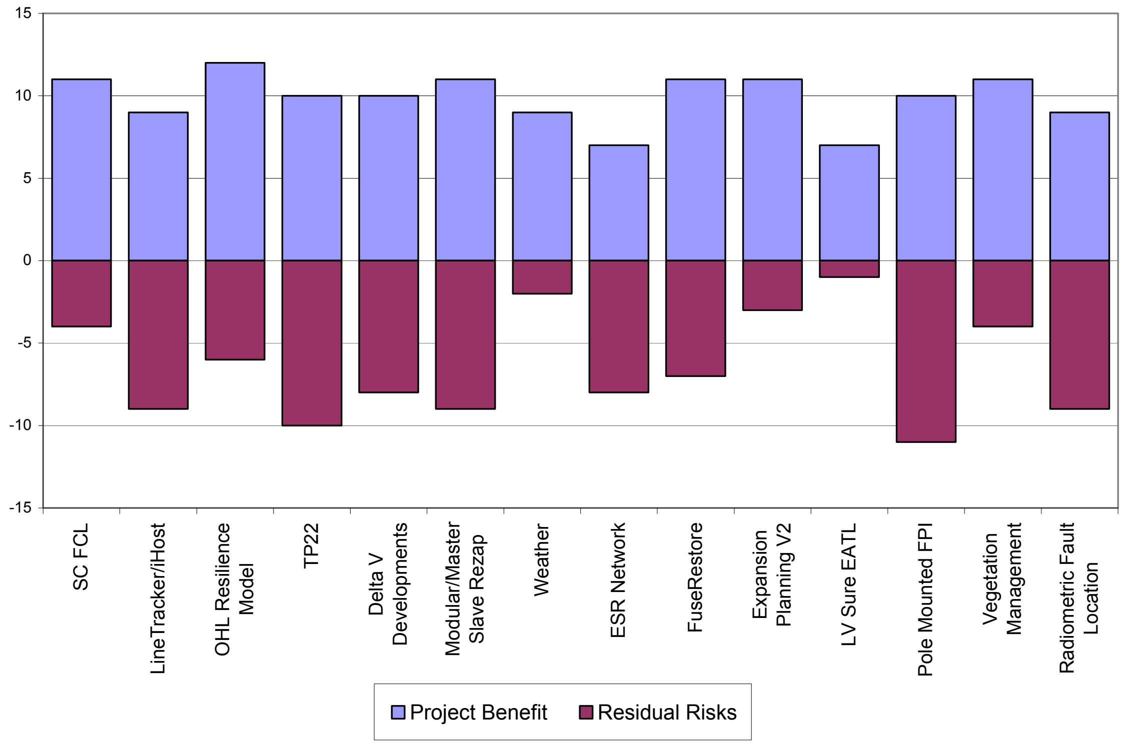
Graph 3a – Project Residual Risk (ref G85/2 Figure A3)



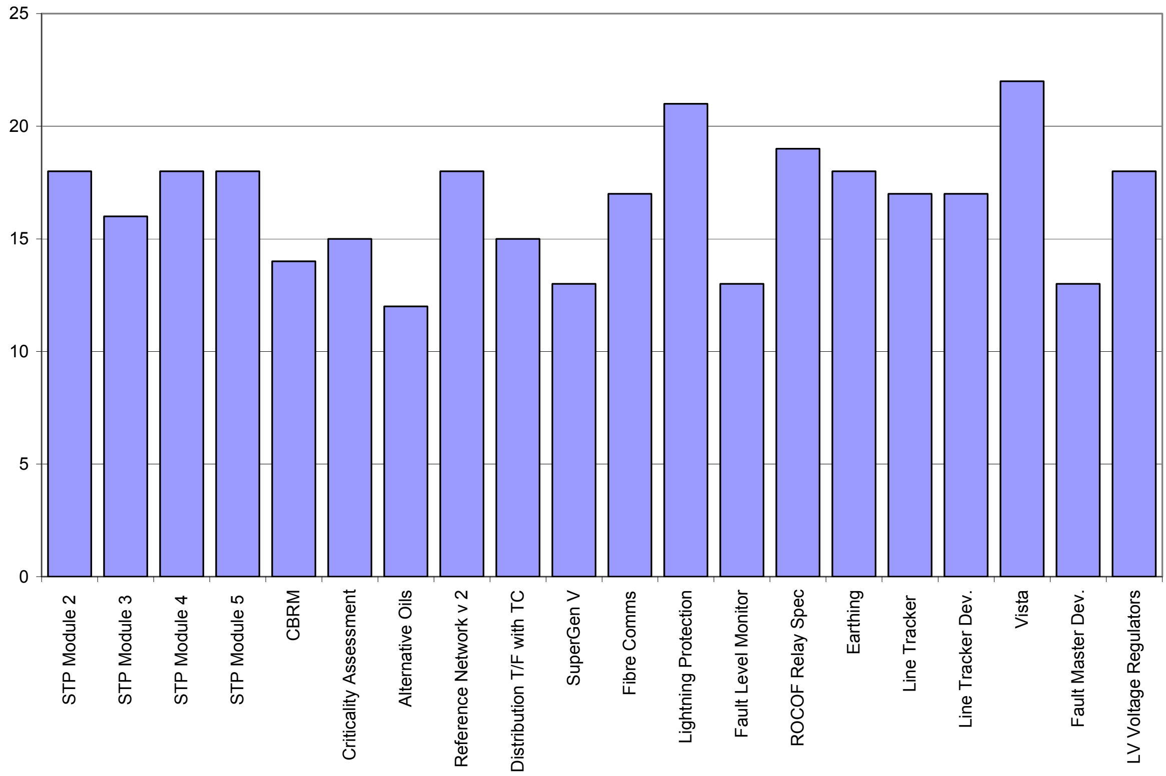
Graph 3b – Project Residual Risk (ref G85/2 Figure A3)



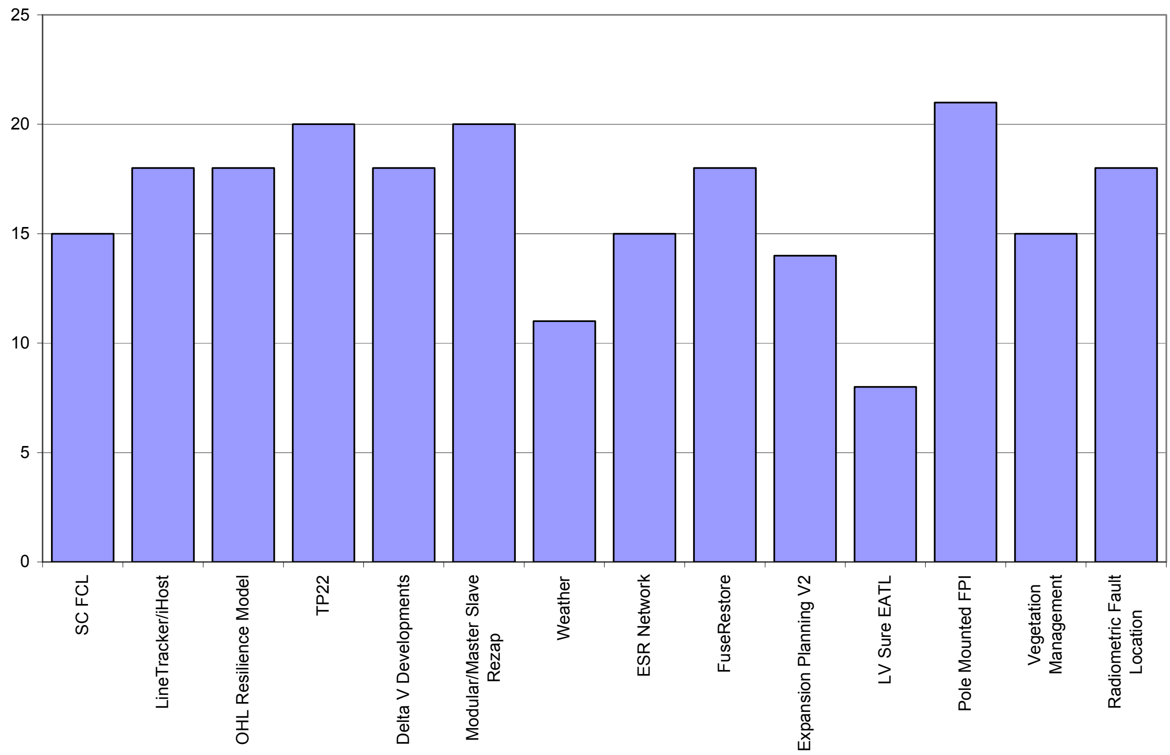
Graph 4a – Overveiw of Projects Showing Benefits and Residual Risks



Graph 4b – Overveiw of Projects Showing Benefits and Residual Risks



Graph 4a – Project Score (ref G85/2 Figure A5)



Graph 4b – Project Score (ref G85/2 Figure A5)

13 Case Studies

UU26 - Super Conducting Fault Current Limiter

David Klaus, Peter Leather, Alan Creighton, Martin Hill

Introduction
A consortium comprising Applied Superconductor Limited (ASL) and three Distribution Network Operators (DNOs) will deploy three pilot superconducting fault current limiters (SFCLs) in the UK electricity distribution system. The SFCLs are based on BSCCO superconducting elements produced by Nexans Superconductor in Hürth, Germany. The project is being undertaken by Applied Superconductor Limited with Nexans Superconductors, the New and Renewable Energy Centre in Blyth and DNO partners: CE Electric UK, Electricity North West (until recently United Utilities) and Scottish Power.

The Superconducting Fault-Current Limiter (SFCL) is perceived to be a low risk fail-safe device, utilising a non-linear 'high-temperature' super-conducting ceramic rather than electronic, electromechanical, mechanical or pyrotechnic components. When the ceramic material is operated at below its critical temperature (Tc) it loses all electrical resistance, thereby allowing normal load current to flow with negligible losses. Either the increased current density, caused by the passage of fault current, or the loss of the liquid-nitrogen cooling medium causes the temperature of the superconducting material to rise and revert to its normal resistive state. This added resistance has the effect of reducing the fault current to a lower, more acceptable, level. The SFCL has been proven to operate in a few milliseconds, after which its resistance remains high until the fault current is cleared by conventional means (e.g. protection operated circuit breakers or fuses). The SFCL's operation is sufficiently fast to ensure that the first peak of the fault current is limited; this is vitally important when considering the requirement for a circuit breaker to safely close onto a section of faulty network. The degree to which the prospective fault current is limited is set at the design stage 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 changed.

The application of a SFCL is expected to deliver a number of benefits:
SFCLs could be strategically deployed into 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). In this application SFCLs could provide a method of deferring the replacement of switchboards or reconfiguration of networks whilst ensuring that fault levels are managed within safe limits.
Where fault levels are generally high, there may be operational benefits associated with minimising the often-complicated switching required to ensure equipment operates within its fault rating during network reconfiguration and outages. This could reduce the risk of interrupting customer supplies arising from either network switching errors or operating parts of the network temporarily on single circuit security. An improvement in staff safety may also be delivered.
If the magnitude of network fault currents is restricted, equipment will not be subjected to the same level of mechanical stress arising from electromagnetic forces, potentially reducing the probability of future faults and prolonging the asset life.
SFCLs may, subject to resolution of protection issues, allow radial circuits to be interconnected, with associated improvements to customer supply security and power quality (flicker and harmonics). This could facilitate a radical change in the way networks are designed and operated.

Choice of HTS material
The term "high-temperature superconductor" (HTS) emerged in 1986 when Alex Müller and Georg Bednortz, working at the IBM Research Laboratories in Rüschlikon, Switzerland, discovered superconductivity in a ceramic compound of lanthanum, barium, copper and oxygen at, 30K. The following year they were awarded Nobel prizes for this discovery. In spite of the "high-temperature" label, this is still rather cool at -243°C, but it is significantly warmer than the highest superconducting or critical temperature (Tc) of previously known materials; an alloy of niobium and germanium with a Tc of 23K.

The discovery of superconductivity in a ceramic oxide caused great excitement in the research community and resulted in many material scientists turning their attention to these materials. In January 1987, it was discovered at Alabama-Huntsville that a ceramic oxide, Yttrium barium copper oxide, YBCO, had a critical temperature (Tc) of 92K. YBCO was the first HTS able to be cooled using liquid nitrogen, which has a boiling point of 77K at atmospheric pressure. Bi-2212, bismuth strontium calcium copper oxide (also known as BSCCO), with a Tc of 95K, was discovered by Maeda in Japan in 1988.

The numerous discoveries of materials displaying superconductivity at temperatures above 77K have increased the potential for exploitation of superconductivity in a variety of applications. Prior to these discoveries it was necessary to use helium, which liquefies at 4K, to cool the metallic superconductors sufficiently. Helium is very expensive, equipment capable of providing cooling to below 4K is expensive and difficult to manufacture and the superconducting metals themselves are also expensive. The discovery of HTS promised to reduce the costs of cooling and to deliver new applications including high-capacity power cables, more compact transformers and motors and fault-current limiters.

It has however taken longer than expected for manufacturers to develop ways to produce HTS materials suitable for use in high-power applications. Ceramics (most HTS materials belong to a family of ceramics known as perovskites) are brittle by nature, whereas engineers want conductors that are mechanically robust, don't shatter when stressed and ideally which can be made in a flexible form suitable to be made into wires and cables. Perovskite ceramics have a layered structure and the superconductivity occurs in the layers containing mainly copper and oxygen atoms. It is very difficult to manufacture large single crystals of these materials so superconducting components made from bulk material, as well as tapes and wires where the HTS material is deposited on or in a metallic strip, incorporate the HTS in a polycrystalline form. The orientation of the individual crystals with respect to each other has to be controlled so that the superconducting planes are substantially parallel and much work has been done on production methods to achieve this.

Superconducting fault-current limiter prototypes have been designed using Bi-2212 and YBCO in various guises.

Bi-2212 sheet, bonded to a metal shunt and cut into a meander to provide a low inductance superconducting element provided the basis for ABB's singe-phase demonstrator in 2000. Thin-film YBCO on a sapphire substrate was used by Siemens for a high-voltage prototype in 20??. A Bi-2212 tube, bonded to a tubular shunt and cut into a bifilar helical meander, manufactured by Nexans Superconductors (NSC), was used for the first major live network trial, known as "CURL 10", hosted by RWE at Siegen in Germany in 20??.

Consideration of the costs, availability and suitability of the various candidate materials for application in fault-current limiting leads to bulk Bi-2212, in tubular form, emerging as the most attractive material to use in a commercial SFCL. Based on the experience gained during the CURL 10 demonstrator, Nexans Superconductors was clearly in a good position to supply the superconducting components for the UK trials and with this in mind, ASL began dialogue with NSC in 2004.

Nexans Superconductors has developed a Bi-2212 component for use in the first UK pilot. The component is made from a tube of melt-cast Bi-2212 soldered to the interior of a copper-nickel tube, which provides a metallic shunt to prevent the formation of hot spots in the HTS. This arrangement is then cut into a helix giving an effective length of 3 metres for each component. The components are supported from the interior by a tube of fibre-reinforced plastic. Pairs of tubes are joined end to end and 16 of these are connected in series provide the current-limiting function for each of the three phases. The photograph below (figure 1) shows a pair of tubes designed for the first UK trial.

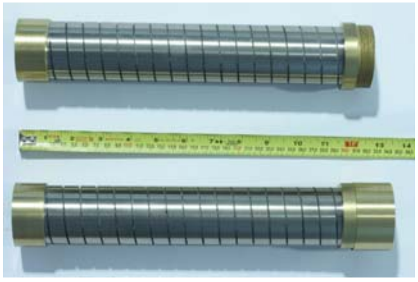


Figure 1 – Elements

Deployment of first SFCL

The site for the first pilot was selected in 2006. It is in a semi-urban location in Lancashire and was chosen for two reasons. Firstly, there is plenty of space for the installation and secondly, the site provides an example of where an SFCL might be installed in response to real need. The two 33/11kV transformers feeding the substation were recently upgraded, with the result that the fault level increased to above the making and breaking capacities of the existing circuit-breakers. It was therefore necessary to build a new substation and install a new 11kV switchboard comprising ten feeder, two incomer and one bus-section circuit breakers. Thus, while the fault level problem has been addressed in a conventional manner, the situation has allowed the design and configuration of the SFCL to be determined according to realistic criteria as though it were actually being used to provide a solution to the fault level issue.

The rating of the old switchgear was taken as the basis on which the operating characteristics of the SFCL were based. The old switchgear was rated at 11kV with a short circuit capability of 150MVA. This equates to a breaking capacity of 7.87kA and a making capacity of 19.7kA. The fault contribution of each of the two transformers is calculated to be 11kA peak, 4.2kA rms. It was decided that the SFCL should limit the fault current seen by any circuit-breaker to 95% of the old breaker rating, i.e. 7.48kA break and 18.72kA make.

The SFCL, which is deployed in a bus-section configuration, effectively in parallel with the existing bus-section circuit breaker (which will be left open during the trial), has been designed to limit the fault contribution, from one half of the busbars to the other. This contribution, together with the contribution from the transformer connected half the busbar must be no more than 95% of the rating of the old switchgear rating.

The limiting, or clamping performance of the SFCL is thus defined by the network and the rating of the available plant.

SFCL Module

The active part of the SFCL consists of 32 superconducting elements per phase, connected in series, immersed in liquid-nitrogen in a cryogenic vessel. The element

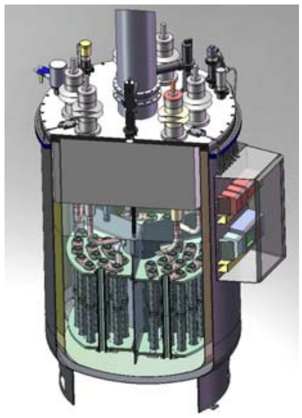


Figure 2 - Cryostat

assemblies are connected to the outside of the vessel through high-voltage bushings and current leads designed to cope with the temperature gradient between the outside and inside of the cryogenic vessel. The liquid nitrogen is cooled by an external cryocooler. A circuit breaker in series with the SFCL is tripped when the fault current has been reduced to ensure that the superconducting elements are not damaged by a prolonged period of high current. The SFCL is thoroughly instrumented to continually monitor its operation and the series circuit breaker will be tripped if abnormal conditions (e.g. cryocooler failure) occur. Communication with the DNO telecontrol systems is catered for covering operational items and ancillary information such as failure of auxiliary electricity supplies.

Project Status

At the time of writing, the design of the first SFCL to be deployed is complete and the superconducting components have been manufactured. Work on the site, to provide foundations, cabling etc. is in progress and all of the major items to be outsourced have been ordered. The device will be tested for short-circuit performance, lightning impulse and a.c. voltage withstand and to confirm its ability to carry load current continuously, prior to installation into the network.

Condition Based Risk Management (CBRM) – Maximising Value for Money from ENW's Multi-Million Pound Asset Replacement Programme

Introduction

CBRM is a new way to understand current and future investment requirements of electricity distribution assets. The projected effective end of life of assets is identified by determining the current condition, the current and future probability of failure and their criticality. The current and future risk associated with each asset is quantified in an objective and consistent manner, enabling the risk associated with different assets types and different voltage levels to be directly compared.

CBRM uses the gathering of on-site condition data, combined with engineering knowledge, practical asset experience and recent failure data to define current and future condition and probability of failure for individual assets. The consequences of failure and asset criticality are then combined with the probability of failure to quantify current and future risk. This data is then used to determine the levels of Opex and Capex expenditure required by our business to achieve acceptable levels of future risk and inputs to the five-yearly regulatory review with Ofgem.

The Condition Based Risk Management (CBRM) project covers the vast majority of fixed assets in ENW's distribution business, including transformers, switchgear, overhead circuits and some cable types, at all voltage levels.

Development of the CBRM Process

In the mid 1990's Distribution Network Operator's (DNO's) began to look into the issue of changing from an age-driven asset replacement strategy to one based on condition. The drivers were associated with the need to reduce overall capital requirements, as the five-yearly funding-round by Ofgem was unlikely to permit the policy of automatically replacing assets regardless of their condition (and remaining life) in the face of a national requirement for increased investment. This quickly established the need to rank asset condition, usually on a 1 – 5 basis.

The new approach permitted assets to be managed on pure condition, on an 'as found' basis. However, it did not always support a full submission for regulatory funding, so it was identified that there was a need to correlate condition data with actual failure rates, as described by 'bath tub' curves, hence permitting forward prediction of the time to failure of assets.

Improvements to the model have been facilitated by using company and national statistics to predict general levels of failure, informed by post mortem examination of failed plant and equipment, so that individual and common modes failures can be determined. ENW (as United Utilities) first used this as part of its price control submission in 2003. Working on that foundation, we are now able to model individual assets for 132 and 33kV Transformers and Switchgear 11 kV Switchgear, LV Pillars and link boxes as well as fluid filled cables.

Additionally within the model, ENW has devised an operability system which helps the asset manager to factor in other issues, such as operator safety and availability of spares and support.

The ultimate CBRM model now in place is one built on a risk assessment of each asset, or grouped assets, so that the business can manage risk, rather than condition alone.

Implementation of CBRM at ENW

For the first time within our company, a criticality model for each asset has been established, based on its place in the network and customers served, safety for operators and the public, and environmental issues, together with Capex and Opex cost implications.

Compared with the CBRM methodology, using conventional management techniques to factor in these risk areas would have made the model extremely complex and difficult to progress beyond an early version.

In addition to the obvious economic impact of this methodology it has fundamentally changed the organisation's behaviour. Recognised by Ofgem as world leading, it is novel in approach and has been the subject of papers at international asset management conferences.

ENW and United Utilities have co-developed and implemented CBRM because the business is committed to setting new world standards in asset management. We therefore established:

1. A new method for meeting stakeholders' expectations of a move away from traditional, age related, Capex-driven expenditure to a programme based on risk and asset life maximisation. Also being able to demonstrate to a regulator the adequacy of funding granted and the potential impact on future regulatory settlements.
2. A way of expressing asset deterioration now and in future years, as a risk quantity, thus demonstrating the need for continued funding by the regulator of asset replacement.
3. A system which is driven by reliable data and not engineering judgement, based on current knowledge of asset management techniques i.e. prediction of failure.
4. Ranked lists of assets, either individually or grouped into "maintenance units", on which asset managers can identify and initiate intervention.

CBRM has been implemented with great success at ENW and has delivered the following measurable benefits:

1. High levels of asset inclusion (over 90% of fixed assets).
2. Simple data collection at minimum cost (20% saving on existing overhead inspection strategy).
3. Scenario modelling of future failure levels dependent on different future expenditure levels (achieved and demonstrated in results tables).
4. Ability to determine risk levels pre and post intervention (achieved).
5. Demonstration of impacts of suspension of maintenance regimes on future expenditure (achieved).
6. Life extension expectation, where limited interventions are planned (the CBRM model enables this to occur in a consistent manner, within a model under change control).
7. Reduction in capital expenditure for the DPCR4 submission of 19% compared to traditional age based replacement strategies.
8. Regulatory acceptance (Ofgem accepts the principles of CBRM and has changed its annual reporting requirements as a result of our enhanced ability to provide data.)
9. High correlation of model results to field staff expectation (achieved).
10. Increased training of asset managers in sophisticated asset management techniques.

CBRM represents a major innovation in asset management methodologies. As a result of its successful development and implementation at ENW and United Utilities, in collaboration with asset management consultancy EA Technology, it has gone on to be adopted by a growing number of large electricity asset owners, from China and the Middle East, to mainland Europe.

UU28 - Network Resilience Modelling

Introduction

The autumn of 2000, was the wettest since records began in 1766, and delivered a deluge of 251mm of rain above average levels. In addition, many other examples of floods having devastating effects on local communities and the infrastructure which serves them exist and have been experienced in areas such as:

Carlisle in 2006
Hull and the Humber Region in 2007
Gloucester in 2007

The majority of power to outlying rural and semi-rural communities in the UK is delivered on Overhead Lines primarily supported on wooden poles and these OHL networks form a substantial part of a DNO's asset base. Extreme weather events and increased levels of local floodwater have on occasion led to both wood poles and steel lattice pylon structures having foundations in standing water. For wood poles this provides the ideal environment for bacterial rot at the ground interface level and for pylons, accelerated levels of corrosion activity and weakening of the soil infrastructure that supports their foundations can occur.

Figure 1 – A Failed 33kV Steel Tower - The result of high corrosion levels and a high mean wind speed!

As a result of the constant drive to improve the management of network assets a specific requirement was identified for a tool that could better utilise specific geographic data to predict planning needs. The tool would be primarily used to model the effects of specific extreme weather events on the OHL network to test its resilience and to identify potential reinforcement requirements.

In addition to the basic weather event, a number of other factors need to be considered including;

- The condition of the network and its components
- Proximity of vegetation including tall trees and associated branches
- Seasonal tree and leaf density variations
- Local land topology and the ground profile.

Each of these factors would have differing impacts on the overall model

The Resilience Model

Over a period of three years ENW worked with Poletecs Ltd to develop a predictive modelling tool that would enable prescribed field data to be collected and used to determine the resilience of specific assets.

The Resilience Model makes use of detailed overhead line data collected either from site or from 'as built' records to effectively 'reverse engineer' the original line design and determine its likely performance under varying weather conditions.

Data Requirements

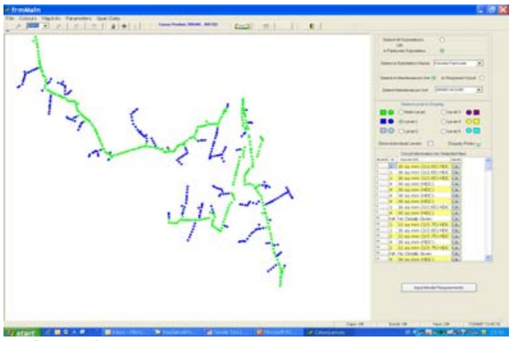
The model uses a geo-referenced physical representation of the network to determine span lengths, angles of deviation and any other relevant data. This information is then combined with as-built information regarding the line components including poles, stays, cross arms and conductors to allow the calculation of maximum permissible wind speeds, conductor clashing limits and conductor ultimate tensile strength limits.

Three further data sets are then applied to the original design capability to determine the present resilience of the assets under varying weather conditions.

Component Condition – the model incorporates all condition factors that will impact on the resilience of the line such as pole strength, conductor condition and certain conductor fittings. These condition factors are applied to the original design capabilities to determine their impact on current day resilience.

Vegetation – one of the most significant factors affecting overhead line resilience is vegetation in the vicinity of overhead lines. The model factors in the type and proximity of trees to the overhead line to determine their effect on overall resilience.

Electrical Connectivity – Whilst the resilience model operates on entirely physical parameters, the results are conveyed in electrical terms representing which sections of which circuits are affected. The electrical diagram is overlaid onto the physical layout to better



visualise the results.

Once the model is populated with sufficient data it is possible to reproduce the effects of different variables including wind speed and Ice accretion and then choose from a menu of standard conductor and pole configurations. This allows an understanding of not just what the effect of the weather event would be, but more importantly what needs to be done to reinforce precise sections of the network to bring its reliance up to the required standard. Once different reinforcement strategies have been applied to the model, the weather event is re-run and the proposed solution can be tested.

Benefits of Modelling

The OHL Resilience Model has successfully provided a means to cost-effectively predict and plan for the worst effects of severe weather conditions. The resilience modelling allows targeted investments to be proposed and facilitates a much more pro-active approach to extreme weather events. The model is being continually updated with field data regarding the present condition of the network and will continue to deliver benefits for a number of years.

