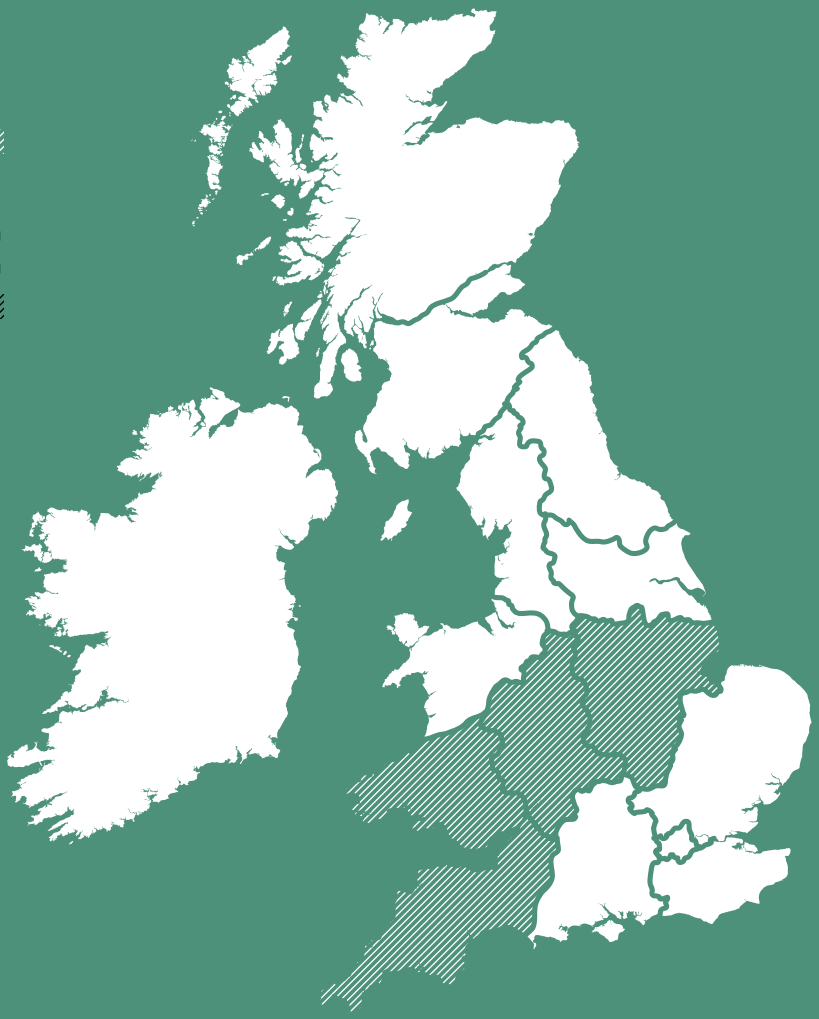
WESTERN POWER DISTRIBUTION

INNOVATION

INNOVATION FUNDING INCENTIVE

REGULATORY REPORT 2012/13



FOREWORD

Welcome to Western Power Distribution's Innovation Funding Incentive Annual Report for 2012/13.

At Western Power Distribution we recognise the challenges associated with providing affordable energy, operating a sustainable infrastructure and meeting the Government's Carbon Plan. We have a vital role to play in shaping this future and adapting our existing assets to provide reliable power to our customers. We have continued to see the increased trend of distributed generation connecting to our network at all voltage levels, including significant deployments of solar panels across our area.

We are applying our innovation strategy to deliver a robust programme of research and development that will benefit our customers and help us operate our network in more flexible and efficient ways. This report outlines some of the activities we are investing in, through IFI, to make these goals a reality.

We continue to work with a wide range of partners from universities, small and medium enterprises through to large multi-national energy companies. We are also working across the electricity industry to share our knowledge with other network operators and learn from their projects. We collaborate on shared research with other operators to reduce costs. Our projects include new equipment that will improve network flexibility and reliability through to new techniques to ensure we get the best from our existing assets. Our project portfolio has great potential to facilitate The Carbon Plan and drive improvement of the network for our customers.

Robert Symons
C.E.O. Western Power Distribution

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1. INTRODUCTION

The Innovation Funding Incentive (IFI) mechanism was introduced by Ofgem with the Distribution Price Control Review which took effect on 1 April 2005 (DPCR4) and has been continued into the current Distribution Price Control Review, which started on 1 April 2010 (DPCR5). The success of the IFI mechanism and Ofgem's continued commitment to this is welcomed by Western Power Distribution, as it has facilitated the development of a portfolio of R&D projects, which should bring significant benefits to our customers in the future.

This report contains the IFI reports for the four licensed areas of Western Power Distribution: South West, South Wales, East Midlands and West Midlands. It covers the period from 1 April 2012 to 31 March 2013, and has been produced in accordance with the Distributed Generation Regulatory Instructions and Guidance (RIGs) issued by Ofgem and the Energy Networks Association (ENA) Engineering Recommendation G85 issue 2 – IFI Good Practice Guide (GPG G85/2).

1.1 IFI

The Innovation Funding Incentive is intended to promote research and development activities within distribution network companies. It provides funding for technical development projects that deliver value to end consumers through financial, quality of supply, environmental or safety benefits. A definition of technical terms within the context of this guide is given in the glossary.

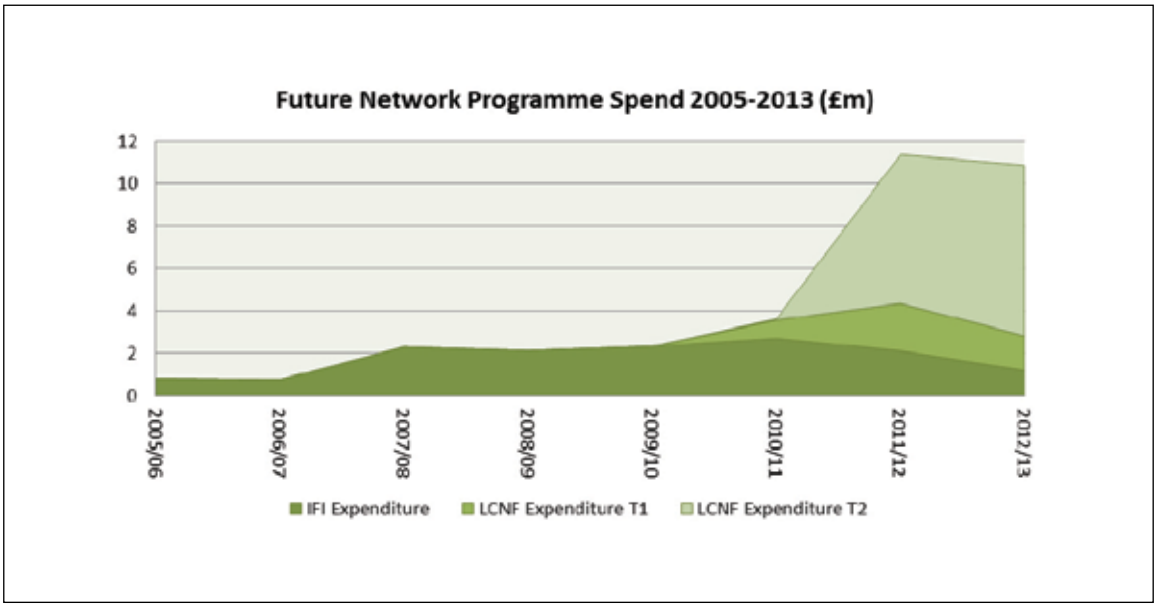
IFI projects can embrace any aspect of distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning. A DNO may spend up to 0.5% of its Combined Distribution Network Revenue on eligible IFI projects, as defined by the industry Good Practice Guide G85/2. The DNO is allowed to recover from customers a significant proportion of its IFI expenditure and in DPCR5 period the percentage of project costs passed through to customers is set at 80%.

1.2 Low Carbon Networks Fund (LCNF)

In 2010, and continuing through to 2015, Ofgem introduced the Low Carbon Networks Fund (LCNF). The LCNF is designed to support the development of low carbon technologies within the UK electricity industry and facilitate the changes brought about by the Carbon Plan. It contains three elements; large scale projects funded through a competitive process (tier 2); smaller scale projects that are self-certified (tier-1) and a discretionary reward where Ofgem will provide additional income for companies that successfully develop learning that generates benefits for the industry.

We have had a great deal of success in the Tier 2 LCNF projects with 5 of the 15 (33%) of theses larger projects being awarded to WPD up until the end of 2012. Similarly of the smaller Tier 1 projects developed up to 2012, WPD is running 28% of them.

Due to the ramping up of LCNF, there has been consequential reduction in IFI spend. Many new projects are now funded through LCNF that may have previously fallen under the remit of IFI. However, overall spend across the programme has risen significantly as the following chart demonstrates.



1.3 End of Year Report

The table below presents the End of Year Report for IFI.

Western Power Distribution. Reporting year 2012/13

INNOVATION FUNDING INCENTIVE (IFI)		SOUTH WEST	SOUTH WALES	EAST MIDLANDS	WEST MIDLANDS	TOTAL
IFI Carry Forward	£m	1.258	1.015	1.795	1.748	5.817
Eligible IFI Expenditure*	£m	0.295	0.177	0.354	0.354	1.178
Eligible IFI Internal Expenditure	£m	0.049	0.029	0.058	0.058	0.194
Increase over previous reporting year	%	-44%	-140%	-80%	-80%	-80%
Network Revenue by License Region	£m	294.9	17.9	376.2	368.6	1257.6
Number of Eligible Projects		33	33	33	33	33
Portfolio NPV of Benefits	£m	2.365	1.419	2.838	2.838	9.461

**includes internal expenditure*

2. COMPANY STRUCTURE

Western Power Distribution is the electricity distribution network operator (DNO) for the East and West Midlands, South Wales and the South West. We deliver electricity to over 7.6 million customers in a 55,300 sq. km service area, stretching from the temperate Scilly Isles to the bracing beaches at Skegness, from the port of Milford Haven to the new town of Milton Keynes, from the Pennine villages north of Leek to the heritage coast at Lyme Regis. Within our service area is England's second city and the capital of Wales.

Our network consists of 216,000km of overhead line and underground cable, and 184,000 substations. We are responsible for:

- Maintaining this electricity network on a daily basis
- Repairing this electricity network when faults occur
- Replacing assets within the network when warranted by condition
- Reinforcing this electricity network to cope with changes in the pattern of demand
- Extending this electricity network to connect new customers

Western Power Distribution does not generate electricity or buy electricity from generating stations. We do not sell electricity to end-use customers. See the map below for the area WPD covers.

3. OVERVIEW

3.1 Western Power Distribution's Innovation Objectives

It is anticipated that in the future, electricity networks will be required to operate more flexibly, efficiently and reliably. Subsequently Western Power Distribution has developed the Future Networks Programme (FNP), a targeted Research, Development and Demonstration programme to meet these challenges, delivering benefits to our customers, improve network performance and help to tackle climate change.
This focused programme is delivered through a range of funding sources including the Low Carbon Networks Fund (LCNF), along with the IFI mechanism. These two complimentary initiatives allow us to develop ideas at an early stage of realisation with IFI, through to large scale demonstration projects through LCNF. The output from these schemes influenced the development of our business plans for the ED1 RIIO price control which will run from 2015 to 2023.

Our IFI projects facilitate the integration of new technologies in the network, aide improved management of existing assets and develop knowledge to better adapt for the future. These projects are designed to further improve our performance and provide us with the ability to meet the future challenges.

3.2 Programme Delivery

The Future Network Programme is delivered through a small team of dedicated innovation engineers supported with resources from the wider business. This includes technicians, engineers and craftsmen from Network Services across the company. This structure is utilised to deliver both IFI and LCNF schemes, across all four of WPD's licence areas. The Future Networks team form part of WPD's Policy function, allowing successful projects to be transitioned to business as usual activity.

3.3 Technology Readiness

Western Power Distribution's Future Networks Programme will include projects from aspects of Research, Development and Demonstration. We do not carry out "blue sky" research. As projects are developed they progress through the technology readiness timeline until they reach the stage where they can be adopted as Business as Usual. Western Power Distribution FNP programme will deliberately maintain a mix of projects with different Technology Readiness Levels (TRL), both in quantity and financial commitment.

3.4 Collaboration

Western Power Distribution's portfolio of IFI projects attempts to balance collaborative and independent projects seeking to minimise the cost of R, D & D whilst ensuring ideas can be taken forward in a timely manner. Western Power Distribution seeks to promote collaboration and cooperation between participating DNOs and other external organisations, such as universities and research establishments. This allows an exchange of academic knowledge and practical experience. Western Power Distribution also recognises the value of collaborating with other industry expertise and has continued to develop partnerships within all these sectors throughout the 2012/13 reporting year. The encouragement of collaboration within the IFI mechanism brings with it additional benefits beyond the immediate project outcomes, such as encouraging small and medium enterprises bring new products to the market.

3.5 Leverage

Collaboration has brought the opportunity of increasing the external funding to our programme. This leverage has increased through our collaboration with funding bodies, other network operators, manufacturers and external suppliers. In many cases the external funding for projects has risen to more than 75% of the total project funding.

3.6 IFI Project Benefits

The anticipated benefits of each project within Western Power Distribution's FNP clearly show the potential value of the IFI scheme both to Western Power Distribution and to its customers. It should be noted, however, that although quantified financially, not all the projects will result in tangible financial deliverables to Western Power Distribution in terms of direct savings or deferred investments. There are significant benefits to the wider community through:

- Network performance – improved reliability and resilience
- Environmental – emissions, waste, visual impact, etc.
- Safety to employees and public
- External risk mitigation
- Knowledge transfer – acquisition and dissemination of knowledge
- Creation of a platform for debate
- Enhancing the quality and relevance of research through direct linkage with

industry, development of the available pool of expertise, greater exposure of own staff to direct engagement with research activity

While some of the new technologies and approaches that Western Power Distribution are exploring in these R, D & D projects will eventually result in the real practical benefits described in the individual reports, others will be less successful. The balanced portfolio approach reduces the risks and the G85/2 Residual Risk Rating calculation assists the selection process by quantifying risks in a structured manner. Although some R,D&D projects are unsuccessful and do not deliver the expected

benefits, they can be valuable in that they will increase knowledge both in the Collaborating Partners and the R & D Provider.

3.7 Benefit Calculation

The anticipated benefits of each project have been determined using the methodology set down in ENA ER G85/2 – IFI Good Practice Guide. This is a two stage process involving a generic assessment of the project benefits and a specific assessment of the risk associated with the project. The Generic Assessment scores a range of benefits, including: Cost, Knowledge Transfer, Safety, Environment and Network Performance. Each item is weighted in accordance with company strategy and this score can be seen on each of the individual reports. For each project pursued it is expected that the present value costs will be exceeded by the present value of the benefits that it could deliver to customers.

The Risk Assessment calculation quantifies the potential risks inherent with each project by scoring risk (innovation level and development type) and mitigation factors (average annual spend per company, leverage, likelihood of implementation). No weighting is applied to these scores and subtraction of the value of the Mitigation Ratings from the Risk Ratings produces an overall Residual Risk value for each project. A high negative figure would indicate a low-risk project. The Residual Risk value is then subtracted from the Generic Assessment Score to produce the Overall Project Score. Both the Residual Risk Value and Overall Project Score can be seen on each of the individual project reports.

In line with ENA ER G85/2 GPG, projects falling below the de-minimis level set by the Good Practice Guide (£40k per licensed DNO, £160k for WPD) may be grouped to form programmes, with costs and benefits aggregated accordingly. A number of projects within the EA Technology Ltd STP modules, the ENA R&D programme, PNRA programme and EPSRC SuperGen programmes have been reported on in this way by WPD.

3.8 Adoption

Transferring research and development projects from demonstration to adoption is essential if benefits are to be delivered to customers and this is often the hardest hurdle for any organisation to achieve. Western Power Distribution has been able to implement a number of these projects into the wider business and continues to review the output from schemes for wider application.

4. PROJECT PARTNERS

WPD has been pleased to work with many project partners in the development of its programme of work. Brief descriptions of the research establishments and industrial partners are provided on the subsequent pages (these descriptions have been provided for inclusion by the individual companies).

ADAS – is the UK's largest independent provider of environmental consultancy, rural development services and policy advice. With expertise across the environmental sector, ADAS provide consultancy and contracting services to a diverse range of organisations in the private and public sectors, throughout the UK and internationally.

Balfour Beatty Utility Solutions Ltd – the company works across the electricity, gas, wastewater and water sectors, providing a range of services to develop, design, install, replace and maintain essential utility assets.

Bartlett Tree Research – was founded in 1907 by Francis A. Bartlett and is the world's leading scientific tree and shrub care company. From its nearly 100 offices worldwide, Bartlett helps both residential and commercial customers maintain beautiful, healthy trees.

BFI Optilas – Represent many leading suppliers that offer products that cover the following product areas: Imaging & Detection, Lasers & Accessories, Optical Components, RF MicroWave & Fibre Optics, Test & Measurement, Interconnect, Passive & Electromechanical Components.

BGS – founded in 1835, the British Geological Survey (BGS) is the world's oldest national geological survey and the UK's premier centre for earth science information and expertise. With a client base drawn from the public and private sectors both in the UK and internationally, they provide expert services and impartial advice in all areas of geoscience.

CRESATECH develops and markets technology solutions that address high cost, high impact operational issues within Power Transmission & Distribution, Telecoms, Transport and other critical service environments. Their products monitor and protect critical infrastructure, reducing costs, lowering risk and improving service continuity.

E.ON New Build & Technology – is part of the E.ON group and leads the group's Research and Development activities. E.ON New Build & Technology (formally Power Technology) is also an international consultancy to the power industry with core capabilities that span the range of interests appropriate to a vertically integrated energy company.

EA Technology Ltd – originally formed as the Research & Development centre for the UK electricity industry in the 1960s, it was transformed following electricity privatisation in the 1990s. The company became fully independent in 1997 with a management and employee buy-out and is now directly owned by its staff. EA Technology is a Power Asset Management Company with a world-class reputation for

delivering innovative business solutions to companies, which supply, distribute and use energy. The company operates the internationally acclaimed Strategic Technology Programme (STP), of which all UK DNOs are members

Earthing Solutions – are involved with earthing system design and assessment, providing measurement, design, policy support, research & development and training services

Elimpus – delivers a range of radio frequency partial discharge monitoring products and services to electricity utilities, allowing them to manage high-voltage plant and equipment.

Embedded Monitoring Systems – Sub.net is the largest generation of substation monitoring systems from EMS, incorporating wide range monitoring and recording functionality for use in the electricity industry.

Engage Consulting Ltd – A consultancy organisation with extensive experience in the evolution of the GB Utilities markets.

ETI – The Energy Technologies Institute is a UK Based company formed from global industries and the UK government. It brings together projects that create affordable, reliable, clean energy for heat, power and transport. The ETI demonstrates technologies, develops knowledge, skills and supply-chains, informs the development of regulation, standards and policy, and accelerates the deployment of affordable, secure low carbon energy systems.

Isentropic is a UK-based private engineering company founded to exploit and further develop PHES technology.

Met Office – is one of the world's leading providers of environmental and weather related services. The Met Office's solutions and services meet the needs of many communities of interest…from the general public, government and schools, through broadcasters and on-line media, to civil aviation and almost every other industry sector in UK and around the world

MHA IES – a leading designer and supplier of electronic products.

Nortech Management Ltd – provide a range of telemetry products and central host software solutions for data collection systems. They design and supply remote site monitoring solutions and other specialist technology to electricity utilities, telecom network providers and others with geographically spread networks and assets

Prysmian – A leading player in the industry of high-technology cables and systems for energy and telecommunications

Rolls Royce – Power systems provider, designing, manufacturing and supporting a range of products and services for air, sea and land applications.

Schneider Electric – Schneider Electric offers integrated solutions across multiple market segments, including leadership positions in energy and infrastructure, industrial processes, building automation, and data centres/networks, as well as a broad presence in residential applications. Focused on making energy safe, reliable, and efficient.

Sibille Faeca Electric (SFE) – provide network technology that is completely focused on the safety of the people maintaining and constructing electrical structures on the low, medium and high voltage network

Sohn Associates was formed in 2003 by a group of former energy company executives. Their consultants have worked for major clients including regulators, large, medium and small energy companies, the Energy Saving Trust, Carbon Trust, carbon verification companies, metering companies, governance consultants and providers, financial institutions and renewable generation developers.

Smarter Grid Solutions (SGS) – an innovative technology company providing Smart Grid products and service to the power industry, enabling electricity network operators to cost effectively facilitate the transition to a low carbon economy.

Sterling Power – is a power engineering group composed of a number of individual companies who provide a unique range of services within the utility sector. The group has been established by personnel with a wealth of experience in the utility market.

Syngenta – a world-leading agri-business committed to sustainable agriculture through innovative research and technology.

The Transformer and Electrical Company Limited (TEC) – prides itself on providing the most efficient and flexible transformer service available

TNEI – launched in 1992, TNEI is an independent company specialising in a range of energy services. Their Power Systems and Associated Technologies group specialises in power systems modelling and analysis and works with distribution network operators, project and technology developers, and the public sector
Willow Technologies – is a specialist supplier of electrical and electronic devices focused on the niche markets of sensing, switching and specialist resistors.

Other Partners – Western Power Distribution has collaboration agreements with a number of other Academic, Industrial and Research Partners. Where possible this information is given in the individual reports, but in some cases Western Power Distribution is bound by mutual confidentiality agreements not to disclose this.

5. EXPENDITURE FROM IFI PROJECTS

The table below details the expenditure during the April 2012 – March 2013 IFI reporting period:

Internal expenditure has varied considerably between projects. The total internal expenditure is 15% of the total eligible IFI expenditure.

PROJECT TITLE	EXTERNAL	INTERNAL	TOTAL
Tree Growth Regulator	£36,185	£2,806	£38,992
Climate Change and Seasonal Variation Impacts of Electrical Earthing Installations	£126,000	£6,679	£132,679
ENA R&D Group Programme	£123,613	£11,671	£135,283
EATL STP Overhead Line Module 2 and Forum	£71,356	£10,153	£81,509
EATL STP Cable Module 3 and Forum	£82,082	£8,271	£90,353
EATL STP Plant and Protection Module 4 and Forum	£62,138	£3,294	£65,431
EATL STP Networks for Distributed Energy Resources Module 5	£57,562	£5,195	£62,757
EA Technology – Partial Discharge Project and Forum	£6,875	£3,893	£10,768
EA Technology – Protective Coatings Forum	£7,093	£1,356	£8,449
EATL – Integrated Condition Based Risk Management	£37,753	£68,995	£106,748
SuperGen HiDef	£20,000	£3,698	£23,698
Active Fault Current Management	£0	£0	£0
Transient Fault Detection from Disturbance Recorders	£10,866	£576	£11,442
Technical Assessment of Power Quality Issues	£15,523	£2,755	£18,278
Harmonic Detection and Analysis	£1,522	£3,940	£5,462
Network Unbalance Source Detection by Optimum Monitoring	£28,138	£1,980	£30,118
Power Communications Meter	£9,192	£487	£9,680

Sensor Networks (Smart Dust)	£20,297	£1,076	£21,373
Power Networks Research Academy	£27,045	£1,434	£28,479
Environmental Monitoring Fluid Filled Cables	£2,569	£136	£2,706
OLTC Tap Changer Monitor	£2,080	£110	£2,190
Voltage Optimisation – 11kV Network	£6,300	£1,578	£7,878
Investigating Balancing of LV Networks	£5,663	£1,899	£7,563
Phasor Measurement Trial	£0	£1,222	£1,222
Smart Grid – LV Link Box Monitoring	£0	£2,735	£2,735
Smart Grid Design	£18,500	£4,800	£23,300
Generating Value from Smart Electricity Meter data	£15,000	£795	£15,795
Reactive Power compensation for distribution networks	£38,000	£6,349	£44,349
Demonstration of Distribution Scale Energy Storage	£10,950	£26,215	£37,165
Carbon Tracing	£50,000	£4,818	£54,818
Identification and prioritisation of network losses	£70,528	£4,096	£74,624
CuTS LV Overhead Line Project	£21,400	£1,134	£22,534
Total Costs	**£984,230**	**£194,146**	**£1,178,346**

6. PROJECT HIGHLIGHTS

Western Power Distribution is pleased to report that R,D & D projects have continued to progress over the past year, with a number of these already proving useful to the business. Highlights include:

- The effect of Tree Growth Regulators (TGRs) is already delivering interesting results with improved tree vitality combined with a reduced rate of extension growth. Ultimately this could play a vital role in vegetation management and the influence on overhead lines.
- The integrated Condition Based Risk Management project has now completed and delivered a tool to help manage existing assets on the Western Power Distribution Network. During 2012/13 a number of engineers were trained to use the system as it has transitioned into a business as usual activity.
- The 11kV Voltage Optimisation project has also completed and been able to demonstrate wide scale voltage reduction while keeping end point customer voltages within statutory limits. This project is going to be taken further to try and identify the priority areas of the network where further voltage reductions can be applied.
- An energy storage project with Isentropic has now started. Two WPD primary substations within the East Midlands have been identified as suitable for the demonstration of energy storage. One of the substations will have the 1.4MW storage device installed.
- The Carbon tracing project has completed a proof of concept and is now working on the integration of live data from the WPD Enmac system. A customer video has also been produced.
- The Identification and Prioritisation of Network Losses project has already output an early messages report in February 2013 and continues to be delivered on time. It is envisaged that this scheme will give greatly improved visibility of the losses impact on individual network components with the aim of prioritising investment to reduce losses.

7. FUTURE INTENTIONS

During 2013/14, WPD will continue to develop projects through the Future Networks Programme guided by our Innovation Strategy. The IFI and LCNF projects will continue become more closely linked, to provide a better flow in the Research – Development – Demonstration process. New projects which will run beyond March 2015 (the start of ED1 price control period) will be evaluated in line with the Electricity Transmission Network Innovation Allowance (NIA) governance document in addition to G85. It is expected the ED1 NIA governance will be similar (or the same) as the document used in Transmission.

IFI projects will also continue to invest in academic research and the development of products and services. There will continue to be larger demonstration projects such as the fault current limiter and the energy storage project.
New LCNF projects may take some of the more successful 'smart grid' concepts developed in the IFI portfolio and will incorporate them into larger demonstration projects.

Amongst other subject areas, future projects will investigate the security of network assets, impact of electric vehicles and potential synergies between gas and electricity network operators.

8. INDIVIDUAL PROJECT REPORTS FOR PERIOD APRIL 2012 – MARCH 2013

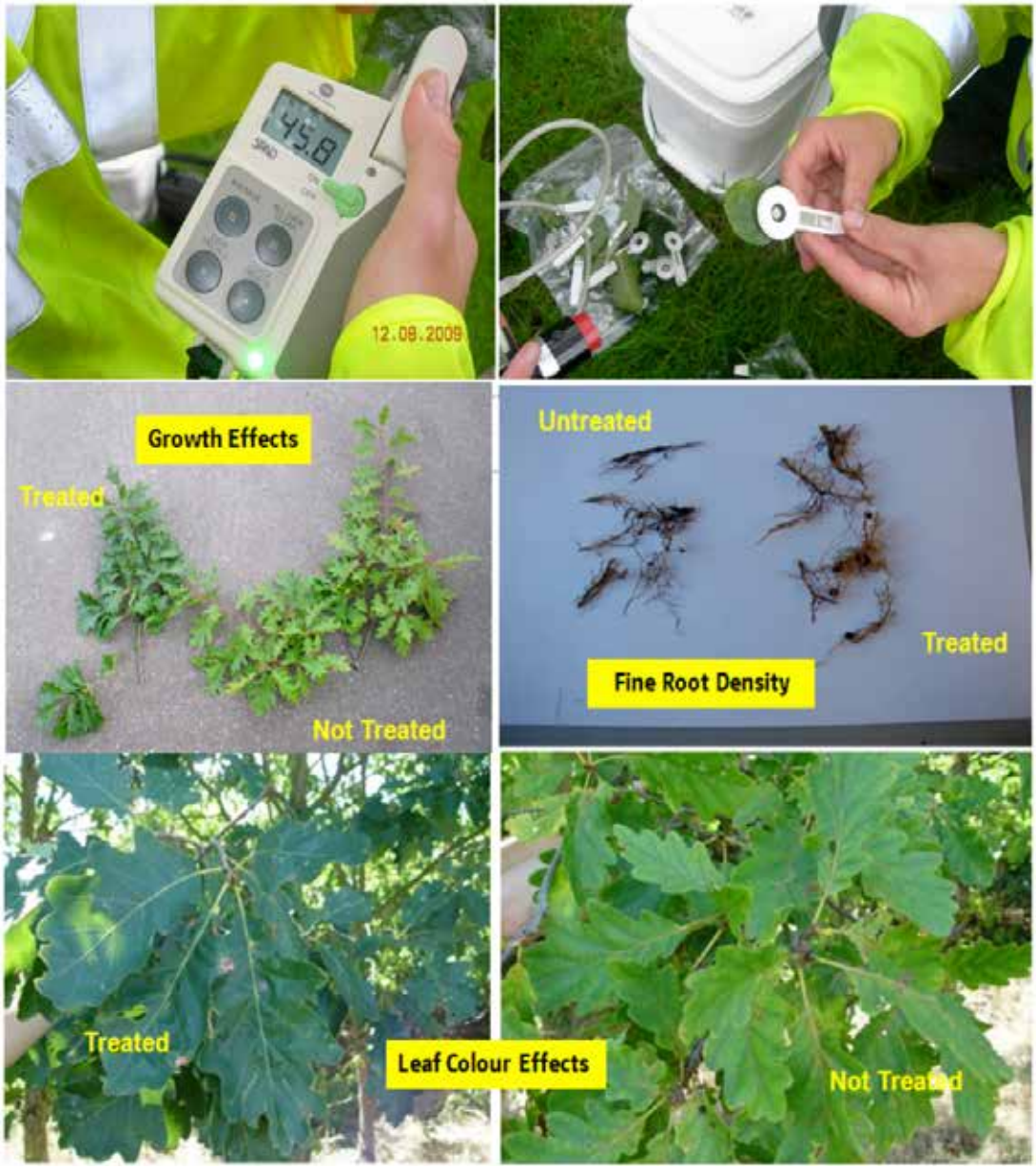
The following pages contain the Individual Project Reports for IFI projects undertaken by Western Power Distribution during the 2012/13 regulatory year.

PROJECT TITLE	TREE GROWTH REGULATOR			
Description of project	The project is investigating the effect of the plant growth regulator Paclobutrazol (PBZ) on tree vitality and growth rates of tree genera commonly found on or adjacent to overhead lines (OHL) This five year project was initiated in 2009 and finishes in 2013, with the final report due in Q1 of 2014. Six field trial sites were established throughout the UK representing a diverse range of bio-climatic zones. In addition two observational sites were established in each of the participating network operator's licence areas. Tree species selected for PBZ evaluation are those that occur commonly on or near overhead networks.			
Expenditure for financial year	Internal £2,806 External £36,185 **Total £38,991**	Expenditure in previous (IFI) financial years	**Total £210,456**	
Total Project Costs (Collaborative + external + Western Power Distribution)	**£720,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £3,000 External £36,000 **Total £39,000**	
Technological area and/or issue addressed by project	Rate of vegetation growth and use of Tree Growth Regulators to reduce maintenance costs.			
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		22	-4	**26**

Expected Benefits of Project	The expected outputs from the project will be data and information on the effect of PBZ on tree extension growth rates following pruning across a range of species and bioclimatic areas. This data will comply with ORETO experimental requirements and will be used to apply for a licence for the use of PBZ to control growth rates on amenity trees and use within utility vegetation management (UVM) programmes. PBZ could then be used as part of UVM programmes to reduce growth rates on restricted cut sites and on high value amenity trees adjacent OHPLs to reduce overall vegetation management costs. This would also minimize the disturbance to landowners as a result of repeated annual or biennial visits to maintain clearances. This would result in reduced costs as the need for annual or biennial visits would be eliminated. In effect, application of PBZ to restricted cut trees would have the effect of bringing the trees into the normal cutting cycle of 4 to 5 years dependent upon voltage.		
Expected Timescale to adoption	2013	Duration of benefit once achieved	20 Years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	>£1,000,000
Potential for achieving expected benefits	In the first year of application, 2009, no effect upon growth rates was expected because that would only become evident in the first year after pruning, 2010. However, in the year of application the possible phytotoxic effects of PBZ were assessed. No statistically significant differences were found between PBZ treated and control trees, which indicates that there were no phytotoxic effects in leaf tissue during the 2009 growing season. Likewise in both the experimental field sites and the observational sites no symptoms of phytotoxicity have been recorded on any PBZ treated tree, throughput the experimental period, 2009 to 2012).		

	A significant influence of PBZ in the reduction of extension growth and increased vitality was recorded in the majority of trees at each experimental field and observation site. These results are manifest by reduced shoot extension growth and trunk diameter and subsequent increase in fine root production and growth. Enhanced tree vitality, is manifest as increased leaf photosynthetic activity, greener leaves and plant cell wall strength. Consequently, all objectives stipulated in the IFI Research Project, The effects of Tree Growth Regulators (TGRs) on Fast Growing Trees and Application to Utility Arboriculture have, to date, been achieved. In addition, no particular factors can be foreseen which would result in delays in the achievements of any of the stated objectives in the original research proposal. Measurements continued in 2010, 2011, 2012 and will continue in 2013 to investigate the potential for reduction in utility tree growth rates.
Project Progress at March 2013	Six field sites and thirteen observational sites have been set up and PBZ applied at recommended dosage rates. Initial observations have indicated no phytotoxic effects. Following discussions with the project team, further planting of the tree species Leyland Cypress and Alder occurred on two sites in early 2010 that were treated with PBZ during summer 2010. The PSD, (now the CRD) granted an experimental licence and the work has been set up to meet ORETO research guidelines. An audit carried by ADAS compliance team has confirmed that the experiment complies with these guidelines. To date (February 2013), both the experimental field and observational site data indicate a significant positive benefit of PBZ application on tree vitality and growth. Application of PBZ has resulted in reduced shoot extension growth over three years in the majority of tree species treaded, the exceptions being Poplar, Willow and Norway Spruce However, the data seems to indicate greater growth reduction in 2010 and 2011 compared to 2012, suggesting that the effects of PBZ are starting the ‘wear off’ in some, but not all species. The effects of PBZ on shoot extension growth have been found to vary between sites, for example:

Project Progress at March 2013 (Cont)	1. Growth of English Oak was reduced by 50% at the Raglan site, and by 25% at the Reading site when averaged across three growing seasons. 2. Stem extension of Sycamore was reduced by 9% at the Boxworth site and by 44% at the Drayton site, when averaged across three seasons. 3. Differences in soil conditions may account for these differences. Based on the data for all species tested, it is possible to categorize trees as 'Sensitive'; 'Intermediate'; and 'Tolerant as follows: **Sensitive:** Lime, Evergreen Oak, Hawthorn, Apple & Alder **Intermediate:** English Oak, Beech, Silver Birch, Sycamore, Scots Pine, Ash and Leyland Cypress. **Tolerant:** Willow, Poplar and Norway Spruce In respect of tree vitality no symptoms of leaf burn or reductions in leaf photosynthetic activity caused by PBZ application have been recorded to date. Close to 2000 trees have been treated and none have shown any symptoms in the four years of the trial. A significant influence of PBZ on vitality was recorded from 2010-2012 i.e. three years after PBZ application. Analysis of individual tree species (PBZ treated Vs non-PBZ treated control) at each field site shows that the influence of PBZ was manifest by: • Increased leaf photosynthetic activity (higher CF values), • Greener leaves (higher SPAD readings as a measure of leaf chlorophyll content) • Reduced electrolyte leakage (higher plant cell wall strength). The trial concludes at the end of the 2013 growing season.
Collaborative Partners	Western Power Distribution, Scottish and Southern Energy, Northern Power Grid (formerly CE-E) and UKPN
R&D Provider	ADAS, Bartlett Tree Research at Reading University and Syngenta Crop Protection (UK)



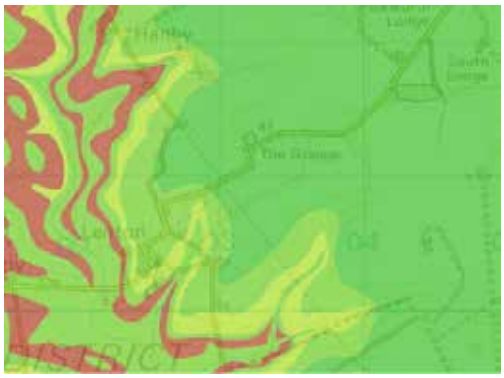
Samples being tested at Tree growth regulator (TGR) field sites and examples of typical results from previous studies.

PROJECT TITLE	CLIMATE CHANGE AND SEASONAL VARIATION IMPACTS ON ELECTRICAL EARTHING INSTALLATIONS		
Description of project	This project is developing a Graphical Information System (GIS) to assist in the prioritising of future maintenance of rural ground earthing systems, by providing a graphical presentation of ground conditions and the probability of the resistance of legacy shallow trench earthing changing significantly under future project climate change scenarios. The project will also produce seasonal variation correction factors for both deep drive and shallow trench installations to allow the existing and new GIS tools to respond to seasonal variations.		
Expenditure for financial year	Internal £6,679 External £126,000 **Total £132,679**	Expenditure in previous (IFI) financial years	**Total £530,595**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£800,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £2,000 External £35,000 **Total £37,000**
Technological area and /or issue addressed by project	The Phase 1 Electrical Earthing project – 'An Information System to assist the installation of rural ground earthing systems' was concerned with predicting the earthing requirements at sites within the network distribution areas of Western Power Distribution (Midlands) and UK Power Networks. The project assumed that the installation of vertically inserted deep drive rods was the normal method of providing earthing systems and that a horizontal trenched system would only be considered when the ground conditions prevented this normal method.		

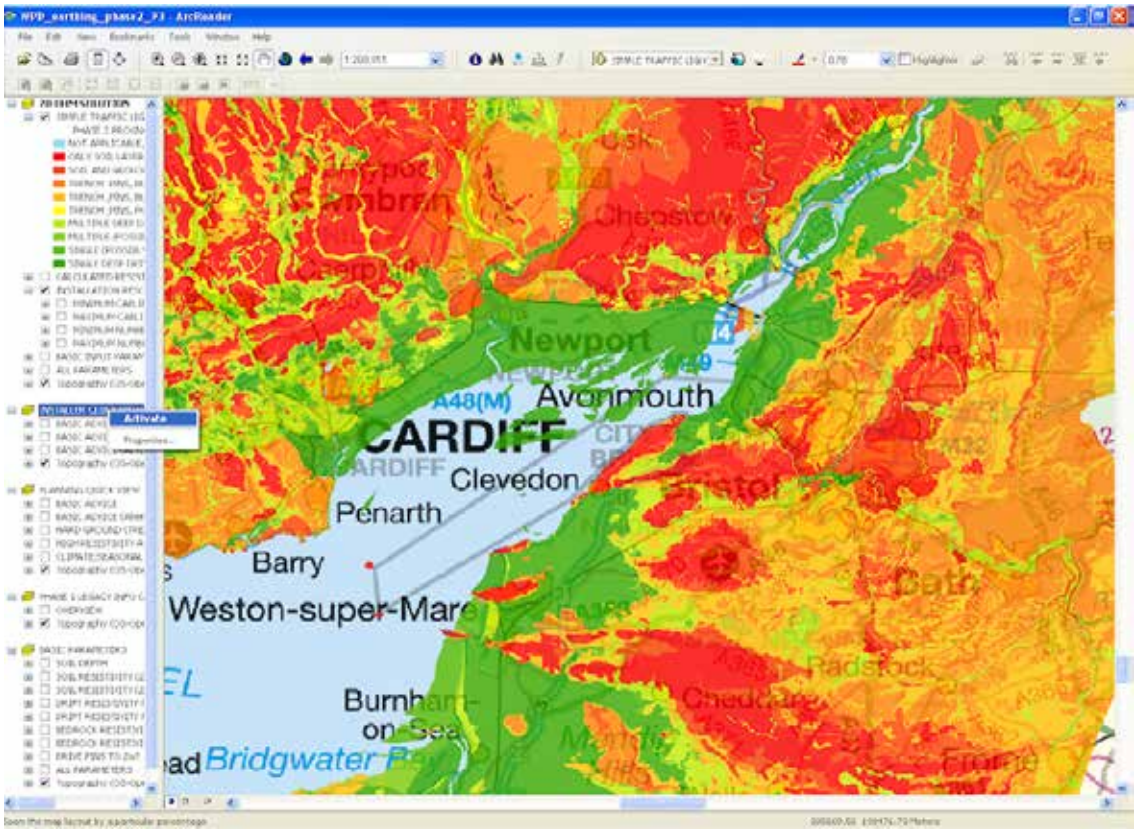
	The Phase 2 Electrical Earthing project – 'Climate change and seasonal variation impacts on electrical earthing installations' aims to investigate the temporal changes in earthing resistance. It is recognised that the earthing resistance of a system will change with time as the resistivity of the ground varies exponentially in response to changes in water content and temperature. In particular the value of legacy shallow trench earthing systems will be particularly affected. A number of climate change scenarios are available from climate modelling and these indicate that parts of the UK could experience dryer or wetter conditions and that the seasonal ranges of precipitation and temperature could be more extreme than today. This project will provide qualitative and quantitative assessments of both seasonal changes and the impact of climate change on electrical earthing installations. The results of this study will provide a tool to identify those areas where earthing installations are most likely to go out of specification in future years.

Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		9	-4	**13**
Expected Benefits of Project	The expected benefits are: • More effective earthing system inspection and maintenance regime from the prioritisation of earthing systems in susceptible areas. • Avoidance of high resistivity issues on legacy earthing systems during hot dry summers.			
Expected Timescale to adoption	2013	Duration of benefit once achieved		20 Years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success		£145,000
Potential for achieving expected benefits	The potential for achieving expected benefits is believed to be high. Many phases of the project have already been successfully implemented in all parts of Western Power Distribution.			

Project Progress at March 2013	Technical issues identified, the project plan scoped out and contractual arrangements agreed during 2010. The project will contain six main elements: 1. Update to Phase 1 2. Revised set of modelled soil resistivities 3. Development of horizontal trench preference 4. Electrical earthing vulnerability to climate change 5. Quantitative assessments of the effect of climate change 6. Electrical earthing response to seasonal variations Items 1-3 are now complete with items 4-6 being progressed for completion this year. WPD are currently adding a layer to our EMU GIS to implement item 3 throughout WPD's area. This provides information that will aid our planners in accurately planning and costing the earthing element of new distribution transformer earths. It will also include information on soil and geology sensitivity to climate and seasonal change.
Collaborative Partners	Western Power Distribution and UKPN
R&D Provider	British Geological Survey and Cranfield University



Extract from Phase 1 map showing the tool as an overlay on GIS. The colours predict the probability of installing different types of earthing systems to obtain a desired resistivity at that location.



Screen grab of the ArcReader Software

PROJECT TITLE	EATL – INTEGRATED CONDITION BASED RISK MANAGEMENT		
Description of project	Development of integration of CBRM models into asset management processes and IT systems to provide routine access to CBRM for use in future asset management and regulatory reporting		
Expenditure for financial year	Internal £68,995 External £37,753 **Total £106,748**	Expenditure in previous (IFI) financial years	**Total £478,323**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£478,323**	Projected 2013-2014 costs for Western Power Distribution	Internal £Nil External £Nil **Total £Nil**
Technological area and/or issue addressed by project	EA Technology (EATL) has previously worked with Western Power Distribution on developing Condition Based Risk Management (CBRM) models for a range of asset groups, with the exception of overhead lines. The models are however not integrated with each other, nor are they directly linked to WPD's asset databases. This results in high levels of expertise and extended durations being required to populate and subsequently refresh the CBRM models. Recent developments in Ofgem reporting requirements have resulted in a requirement for routine, consistent reporting of CBRM Health Indices and ageing. WPD invited EATL to develop a CBRM integration package that would develop a novel, new wood pole overhead line model and existing CBRM systems to a common platform, integrated with WPD's existing IT infrastructure. Due to the nature of the project it has been divided into a number of stages. 1. Integrated CBRM for Grid Transformers incl. general review to confirm risk model for all subsequent asset groups) 2. Integrated CBRM for Switchgear & Distribution Transformer 3. Integrated CBRM for cables 4. Integrated CBRM for (wood pole) Overhead Lines incl. Pole mounted transformers, pole mounted switchgear		

Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		15	-3	**18**
Expected Benefits of Project	Faster, user friendly and consistent provision of CBRM outputs for asset management and Regulatory Reporting. Reduction of risk by hard connection between systems via reduction in manual intervention and capturing existing highly skilled knowledge.			
Expected Timescale to adoption	0.5 Year	Duration of benefit once achieved		5 Years
Probability of Success	90%	Project NPV = (PV Benefits – PV Costs) x Probability of Success		£523,000
Potential for achieving expected benefits	Very High			
Project Progress at March 2013	The CBRM project has now been completed, and is fully integrated into WPD's asset management system. This has included: • delivery of the CBRM tool database; • full delivery of the CBRM asset models by EATL; • full population of the asset model data by WPD; • calibration & approval of the asset models Final costs for this reporting year have been higher than expected due to rollout of the CBRM tools and training of WPD staff to be able to utilise them.			
Collaborative Partners	Western Power Distribution (South)			
R&D Provider	EA Technology			

PROJECT TITLE	ACTIVE FAULT CURRENT MANAGEMENT		
Description of project	Development and demonstration project		
Expenditure for financial year	Internal £Nil External £Nil **Total £Nil**	Expenditure in previous (IFI) financial years	Total £256,929
Total Project Costs (Collaborative + external + Western Power Distribution)	**£9,850,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £Nil External £Nil **Total £Nil**
Technological area and/or issue addressed by project	Distribution networks have to manage ever increasing load demand and penetration of distributed generation, while having to maintain high security and reliability standards set out by the regulator. There are increasingly situations where fault current levels exceed the ratings of existing switchgear and transient current ratings of other equipment such as cables, lines and transformers. This overstressing can cause disruptive failure of switchgear or other equipment under fault conditions. The traditional method to overcome this problem is to replace relevant assets with higher rated components. An alternative to this passive approach is to install a fault current limiter. This has the effect of reducing the current during the fault, but needs to have minimal voltage drop during normal operation. There have been recent developments in active fault current management techniques by various suppliers including: 1. A fault current limiter using novel super-conducting materials 2. A fault current limiter using permanently magnetised cores 3. A fault current management using conventional L/C components This project seeks to evaluate the technical and economic viability of different active fault current management technologies and identify a preferred option that will facilitate active fault level management in a distribution network.		

	This will be followed by the construction of a prototype device, which will be demonstrated in a real application on Western Power Distribution's network to prove the fault management operation and enable knowledge of the technical performance, costs, operational and maintenance issues to be experienced in a controlled environment.			
Type(s) of innovation involved	Technological Substitution/ Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		13	0	**13**
Expected Benefits of Project	This project will investigate the various active fault current management options and will provide the following important information: • Demonstrate which fault current limiters are technically and economically viable technology for fault level management. • Determine the parameters necessary to specify and test (both type test and routine test) a fault current limiter. The practical demonstration of a fault current limiter on a distribution network will confirm the performance and allow valuable experience to be gained on the interface and interactions between the Fault Current Limiter and existing equipment. As well as providing operational experience, the demonstration should contribute to the drafting of standards (specifications, manufacturing requirements, type testing, routine testing, etc.). The demonstration should also provide an understanding of potential failure modes, degradation characteristics, reliability and determine optimal monitoring requirements for future devices. Knowledge should be gained on the whole system losses both in quiescent and operational states, allowing future improvements and with inspection, servicing and maintenance requirements, allowing these to be refined and asset management strategies to be developed.			
Expected Timescale to adoption	2018	Duration of benefit once achieved		20 Years

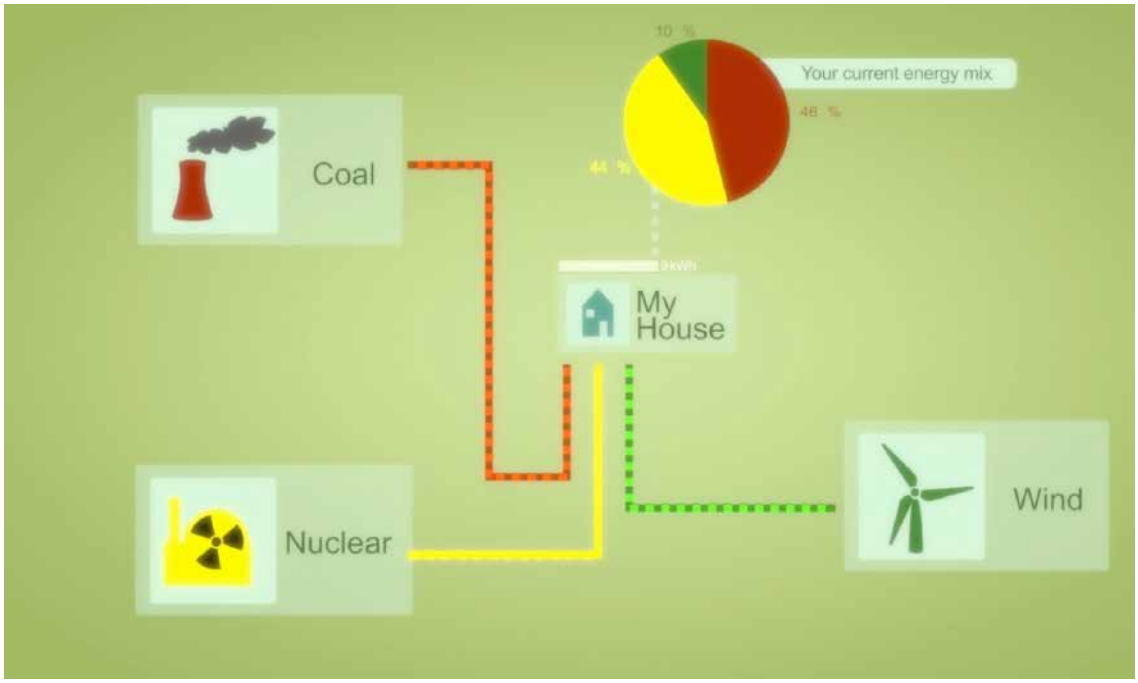
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£182,874
Potential for achieving expected benefits	After initially exploring various fault management technologies this project is now focused on superconductivity based fault current limiters and pre-saturated core type devices. These are the Active Fault Current Management technologies that are most advanced with some at early stages of commercialisation. They are novel technologies to distribution network operators and therefore will find it difficult to become established without demonstrations of the technology. An assessment of the state-of-the-art in superconducting fault current limiters determined where these Fault Current Limiters should best be deployed in the existing distribution network and a suitable location has been located within Western Power Distribution. These two types of devices will form the basis for the funding of a large scale network trial project by the Energy Technologies Institute (ETI).		
Project Progress at March 2013	Working with the ETI, Western Power Distribution commissioned a Flexible Research Programme to provide information on optimal applications and benefits of active Fault Current management. This allowed the feasibility for further development and demonstration of this technology to be considered. Following the selection of a suitable potential site, specific device specifications for a Fault Current Limiter were developed and these were issued as part of an ETI request for proposals. Two potential device providers were selected to provide a different type of Fault Current Limiters to each of the Host Distribution Network Operators. Western Power Distribution will host a resistive superconductive fault current limiter (RSFCL) type device in a bus-section position at a substation where it would allow a permanent parallel to be made between two 132/11kV transformers. A second pre-saturated core device will be demonstrated in UKPN's network and non-commercial information will be shared between projects.		

	The RSFCL device has been designed and a prototype device has been developed and is to be tested in the next reporting. The distribution equipment to enable the connection of the RSFCL device on to the 11kV network has now been ordered and over the next two reporting periods will be installed with the aim of integrating the device on to the 11kV system in February 2015.
Collaborative Partners	Western Power Distribution (Midlands), ETI and UKPN
R&D Provider	ASL, Rolls Royce, and E.ON New Build & Technology

Site for proposed Resistive Fault Current Limiter deviceproposed Resistive Fault Current Limiter device

PROJECT TITLE	CARBON TRACING			
Description of project	The project sets out to develop a methodology and algorithms for tracing the electricity flows on distribution networks based on the carbon intensity of the associated generation. The project takes grid average for a GSP in South West England together with distributed generation based on fuel type. The project will develop a prototype demonstration for real time and historic energy flows for the St Austell BSP group. In addition to the methodology the project will also research innovative ways of communicating the concept to customers.			
Expenditure for financial year	Internal £4,818 External £50,000 **Total £54,818**	Expenditure in previous (IFI) financial years	**Total £Nil**	
Total Project Costs (Collaborative + external + Western Power Distribution)	**£120,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £4,000 External £50,000 **Total £54,000**	
Technological area and/or issue addressed by project	Network Losses, Environment			
Type(s) of innovation involved	Technological Substitution/ Significant/ Radical	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		10	-1	**11**
Expected Benefits of Project	The project will identify whether it is possible to accurately measure and report carbon intensity on specific section of the distribution network. Knowing the carbon intensity would enable DNOs to consider CO_2 emissions more accurately, and discriminate between "green losses" and "carbon losses". It is expected that if successful the data will be made available to customers (initially in the trials area) possibly as part of a subsequent IFI or LCNF behavioural study.			

Expected Timescale to adoption	2014	Duration of benefit once achieved	30 Years
Probability of Success	60%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£30,164
Potential for achieving expected benefits	The modelling of the power flows uses standard IPSA tools, although some new algorithms need to be scripted. The demonstration element will require access to BSC raw data from Elexon.		
Project Progress at March 2013	The project has completed a proof of concept and is now working on the integration of live data from the WPD Enmac system. A customer video has also been produced.		
Collaborative Partners	None		
R&D Provider	Smarter Grid Solutions		



Visualisation of the generation sources feeding an individual property.

Screen shot from the customer video.

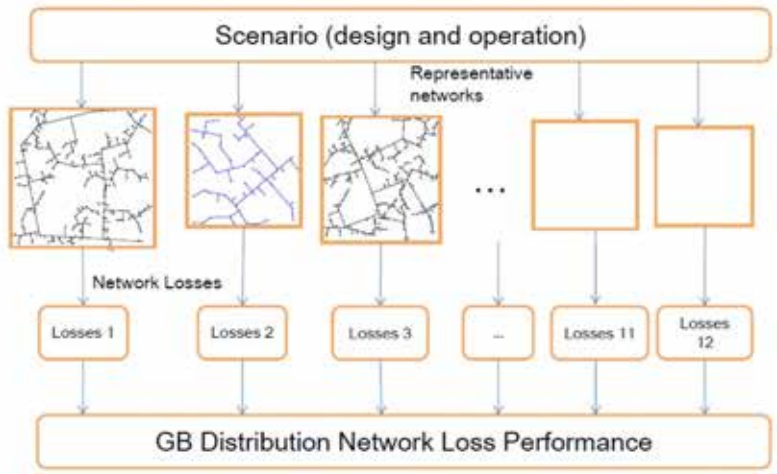
PROJECT TITLE	IDENTIFICATION AND PRIORITISATION OF NETWORK LOSSES		
Description of project	The project builds on previous IFI studies undertaken for Western Power Distribution (Central Networks) by Imperial College London. The previous project developed generic networks and calculated losses to be used as a comparison against reported data (based on settlement algorithms). This project used the same models, but set out to identify the network areas and components where losses generated (such as Transformers, voltage levels, service cables, etc.). Further this study will propose intervention measures to reduce losses and deliver a prioritised list of such initiatives.		
Expenditure for financial year	Internal £4,096 External £70,528 **Total £74,624**	Expenditure in previous (IFI) financial years	**Total £Nil**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£154,550**	Projected 2013-2014 costs for Western Power Distribution	Internal £3,000 External 73,000 **Total £76,000**
Technological area and/or issue addressed by project	Network Losses and Power System Modelling. The project also uses "smarter" intervention solutions within the power system model.		

Type(s) of innovation involved	Technological Substitution/ Significant/ Radical	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		11	0	**11**

Expected Benefits of Project	If successful, this project will give DNOs and Suppliers access not just to the large volumes of data that will be available through the smart meter roll out, but to valuable information that can be extracted from this data. It will allow DNOs to look at trends and patterns in groups of consumers, whether it is in geographic areas or by the type of consumer.		
Expected Timescale to adoption	2015	Duration of benefit once achieved	30 Years
Probability of Success	70%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£188,207

Potential for achieving expected benefits	Much of the technological risk of the project was elimination through the re-use of a previous power system losses model. It is therefore likely that the project will deliver a robust evaluation of potential loss mitigating techniques.
Project Progress at March 2013	The project delivered an early messages report in February 2013 with a review meeting in April 2013 to ensure the project was on track. The final report is due for delivery in July 2013
Collaborative Partners	UK Power Networks
R&D Provider	SOHN Associates (Project management); Imperial College London (Technical analysis)

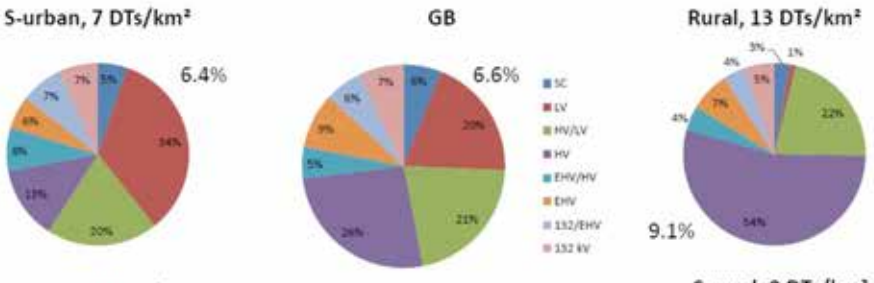
Assessing Loss Performance of LV and HV GB Distribution Networks



sohn associates

Imperial College London

Losses across different network types and assets



- Majority of distribution system losses are in LV and HV networks, 70-75%
- In urban areas losses in LV networks and DT are dominant
- In rural areas losses in HV networks are significant

sohn associates

60

Imperial College London

PROJECT TITLE	DEMONSTRATION OF DISTRIBUTION SCALE ENERGY STORAGE			
Description of project	Western Power Distribution will demonstrate an innovative 1.4MW Pumped Heat Energy Storage device that is being developed by Isentropic Ltd using funds from the Energy Technologies Institute. Isentropic are developing a 120kW prototype before developing a 1.4MW energy storage device capable of maintaining a four hour maximum output. Western Power Distribution are partnering with Isentropic to demonstrate the 1.4MW device on our network as we believe large scale storage could deliver significant benefits to distribution networks.			
Expenditure for financial year	Internal £26,215 External £10,950 **Total £37,165**	Expenditure in previous (IFI) financial years		**Total £Nil**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£15,610,000**	Projected 2013-2014 costs for Western Power Distribution		Internal £15,000 External £8,000 **Total £23,000**
Technological area and/or issue addressed by project	Networks are designed to operate with maximum demand with no contribution from Distributed Generation (DG) as well as minimum demand with maximum contribution from DG. Distribution Scale Storage is still a developing area and isn't currently a conventional network reinforcement technique due to its high capex, opex costs and asset life. Through this project WPD will be demonstrating an innovative Pumped Heat Energy Storage, the benefits of storage to the DNO and commercial models.			
Type(s) of innovation involved	Technological Substitution/ Significant/ Radical	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		12	-2	**14**
Expected Benefits of Project	The project aims to demonstrate the connection and operation of Pumped Heat Energy Storage, the benefits is successful could be; • Flexible design and operation of distribution networks • Transformer, tap changer, Overhead Line and Cable asset deferral			

Expected Benefits of Project Continued	• Quicker and potentially cheaper connection of distributed generation • Reactive power compensation, optimising the capacity of networks • Improved power quality through contribution of fault current during network transients • Potential benefits to other energy industry sectors Improved network security during asset maintenance, increased asset maintenance windows.		
Expected Timescale to adoption	2020	Duration of benefit once achieved	25 Years
Probability of Success	40%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£52,654
Potential for achieving expected benefits	It has been predicted that the UK may require up to 40GW of energy storage by 2050, this is likely to be made up of different technologies, sizes for a wide range of energy purposes. Storage may be more commercial attractive if shared by more than one party, including DNOs. Demonstrating and learning how an innovative storage technology could be used to benefit the operation of the distribution network will determine if DNOs can use storage as a smart technique		
Project Progress at March 2013	WPD and Isentropic have signed a technology contract and commenced the project. WPD and Isentropic are working together to ensure the storage device is optimised of the use of distribution networks. The design for the prototype unit has been finalised. Two WPD primary substations within the East Midlands have been identified as suitable for the demonstration of energy storage. One of the substations will have the 1.4MW storage device installed.		
Collaborative Partners	Isentropic Ltd		
R&D Provider	Isentropic Ltd		

PROJECT TITLE	POWER COMMUNICATIONS METER			
Description of project	Development and demonstration of a cost effective remote monitoring device for small embedded generation sites connected at 11kV.			
Expenditure for financial year	Internal £487 External £9,192 **Total £9,680**	Expenditure in previous (IFI) financial years		**Total £92,956**
Total Project Costs (Collaborative + external + Western Power Distribution)	**Phase 1 £77,000** **Phase 2 £112,000**	Projected 2013-2014 costs for Western Power Distribution		Internal £5,000 External £10,000 **Total £15,000**
Technological area and/or issue addressed by project	Small scale embedded generation sites connected on the 11kV Distribution Network is increasing in number, but these sites are not normally monitored. Without data from these sites, the quantity of real demand on a feeder is effectively masked by the generation and this presents difficulties for both; real time operational decision making, and for network design. A traditional SCADA RTU could be installed but this is not considered to be a cost effective solution. The larger 11kV embedded generation sites need additional monitoring facilities and this is being addressed in a second phase of this project, which will provide the following: • Tripping of switchgear controlling the generation • Close inhibit control of the switchgear • G59 Protection operation indication			
Type(s) of innovation involved	Incremental/ Technical Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		14	-4	**18**

Expected Benefits of Project	• Real time information (Voltage, current, power factor and alarms) displayed on the control System diagram will enhance network visibility when operating and will impact on network performance and safety. • This functionality will facilitate future Smart Grid development allowing the connection of more embedded generation. • Historic ½ hourly load information will improve the quality of network design and provide power quality information. • Additional control and monitoring facilities to be provided on larger embedded generation systems		
Expected Timescale to adoption	Phase 1 – 2011 Phase 2 – 2012	Duration of benefit once achieved	25 years
Probability of Success	Phase 1 – 50% Phase 2 – 75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	Phase 1 £114,606 Phase 2 £143,702
Potential for achieving expected benefits	The initial trial has proven that the equipment can remotely monitor sites and operate correctly. An alternative prototype for monitoring Maximum Demand Indicators in LV cabinets has also been developed and installed as a demonstration. Data from these sites has been displayed on the iHost Communications Hub and an interface created between this and our ENMAC control system. The second phase linking the power communications meter to distribution substation remote control equipment to demonstrate compatibility should provide the facilities to monitor and control larger embedded generation sites.		
Project Progress at March 2013	The first three trial units have continued to provide real time and ½ hourly historic information to the iHost Communications Hub. Two additional units with slightly modified functionality have been commissioned and more modified units will be installed to extend the trial to remotely monitor two large PV installations.		

	This project has provided a useful piece of equipment that can be used to provide monitoring of embedded generators. The installation of various devices is on-going and has so-far confirmed that the product works adequately.
Collaborative Partners	Western Power Distribution (Midlands)
R&D Provider	Nortech and Schneider Electric

One of the remote Communication Power Units monitoring an 11kV site with embedded generation.

PROJECT TITLE	SENSOR NETWORKS (SMART DUST)		
Description of project	"Smartdust" is a concept developed by the University of California that is based on a self-configuring wireless sensor network, capable of transmitting low bandwidth information in a series of short hops. Data acquired and transmitted from sensors is relayed through a gateway for data interpretation. Scottish Power led a feasibility study into the use of this technology for detecting the passage of fault currents on 11kV overhead line networks. Following on from this work, a collaborative project was scoped with Scottish Power to develop a product based on this principle for the remote signalling of fault passage indication on Overhead Line networks.		
Expenditure for financial year	Internal £1,076 External £20,297 **Total £21,373**	Expenditure in previous (IFI) financial years	**Total £207,367**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£462,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £2,000 External £50,000 **Total £52,000**
Technological area and/or issue addressed by project	Fault Passage Indicators (FPIs) are pole mounted sensors that detect the passage of fault current in an overhead line via disturbances in the electro-magnetic field. Presently FPIs indicate the passage of a fault current via LED or beacon on the unit itself. This is used by linesmen on patrols to identify the source of the fault. A cheap and reliable method of collection of fault passage indication data, a centralised location for Overhead Line Faults would significantly reduce the time required to resolve faults on the network and consequently reduce CML associated penalties. This technology would be especially suited to transitory fault location. Significant analysis has been undertaken on the deployment characteristics of GSM/GPRS Fault Passage Indicators Vs. Radio communicating sensors, using fault histories. The analysis is considering the relationship between sensor cost, deployment penetration and improvement to CML figures. The key conclusion is that a cheap, low power semi-mesh radio based system: • Allows a much higher percentage of locations of be monitored economically than any other option, across all price points and time savings		

<table>
<tr><td></td><td colspan="4">• Offers a much higher NPV than any other option

Owing to these factors, a significantly higher percentage of network can be monitored (from 10% for GSM devices to above 70% coverage for radio sensors), increasing the likelihood that they will be targeting faults (rather than solely focussing on worst performing circuits).</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>13</td><td>-2</td><td>15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Sensor Networks implemented as a method of fault passage indication could have an enormous effect on how faults on the overhead network are located.

Wireless Fault Passage Indication (wFPI) devices have the capability to communicate via radio frequency immediately upon detection of a fault current or loss of voltage field. Each wFPI sends a message to a dedicated gateway usually located at a substation, which in turn communicates to a centralised location the position of the fault.

This system should decrease the time required to locate a fault and should therefore reduce customer minutes lost (CML) figures. This should result in an improvement in network performance for our customers and a financial saving for the network operator.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2013</td><td colspan="2">Duration of benefit once achieved</td><td>10 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>£500,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The project is still on track to deliver the expected benefits despite a number of delays through the project history.</td></tr>
<tr><td>Project Progress at March 2013</td><td colspan="4">There have been a number of equipment related delays associated with this project. However new agreements have been established between WPD, SP, E.ON and Willow, and Willow has finalised its design of the prototype wFPI which will be rolled out Summer 2013</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">Western Power Distribution (Midlands) and Scottish Power</td></tr>
<tr><td>R&D Provider</td><td colspan="4">Willow Technologies and E.ON New Build & Technology</td></tr>
</table>

PROJECT TITLE	ENVIRONMENTAL MONITORING FLUID FILLED CABLES		
Description of project	Demonstration of how remote cable pressure monitoring equipment and Control System load information can be used to monitor the integrity of Fluid Filled Cables.		
Expenditure for financial year	Internal £136 External £2,569 **Total £2,706**	Expenditure in previous (IFI) financial years	**Total £101,102**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£105,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £Nil External £Nil **Total £Nil**
Technological area and/or issue addressed by project	The potential environmental harm caused by leaks from fluid filled cables is of concern to Western Power Distribution and methods to detect small leaks from distribution assets are necessary. Self-contained equipment for calculating the volume and pressure of a fluid filled cable system is available for transmission systems, but this is not considered to be an effective solution for distribution networks. Information about cable and ambient temperatures in addition to pressure readings and system parameters are needed to calculate the cable fluid volume. While the cable temperature depends upon a number of fixed and variable parameters (including the changes in circuit load, which is already available in our Control System). Obtaining real time pressure and temperature data from some fluid filled cable systems can be challenging due to their remote or extreme locations, which can include buried, in partially flooded roadway pits and exposed, on raised electricity tower platforms. This project attempts to integrate available monitored information to calculate changes in the cable fluid volume in a cost effective manner.		
Type(s) of innovation involved	Incremental	Project Benefits Rating 16	Project Residual Risk -3	**Overall Project Score** **19**

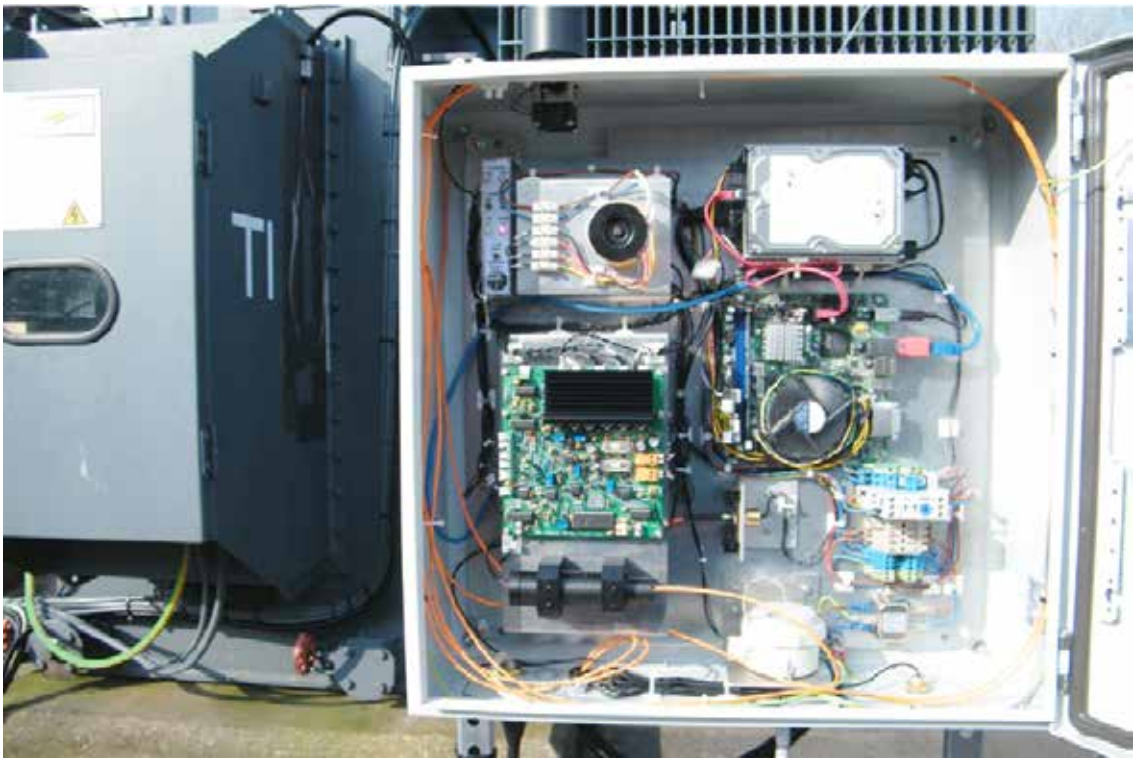
Expected Benefits of Project	Environmental • Identifying leaks sooner, so less cable fluid is leaked Financial and Safety • Remote monitoring will reduce need to visit remote or restricted gauge locations Operational • Improved condition monitoring of cable assets • Aid to identification of leak position • Monitored information could support Dynamic Ratings of Cables		
Expected Timescale to adoption	2011	Duration of benefit once achieved	25 years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£116,986
Potential for achieving expected benefits	Project is on track with remote monitoring of pressure gauges installed at over twenty locations. Analysis of the monitored parameters shows that volume calculations can be determined. Monitoring of restricted and extreme locations has continued to prove satisfactory in the majority of cases.		
Project Progress at March 2013	After completion of tests, all monitoring units have been modified to eliminate the condensation issues. At the same time a software update was applied to eliminate an extreme temperature issue. Work to determine actual volume of leakage was temporarily suspended while equipment was being modified, but data from the monitored sites continues to be collected for analysis and give early warning for leaks. After more than 30 installations, this project has been a success and is complete. It is being considered for mass roll-out in the company.		
Collaborative Partners	Western Power Distribution (Midlands)		
R&D Provider	Nortech, Balfour Beatty and Western Power Distribution		

A fluid filled cable pressure monitoring device installed in a pavement pit to prove reliability of the equipment and capability of communications in extremely challenging environments.

PROJECT TITLE	OLTC TAP CHANGER MONITOR		
Description of project	This project aims to develop the capability to non-intrusively detect incipient defects within On Load Tapchanger (OLTC) equipment using non-intrusive techniques.		
Expenditure for financial year	Internal £110 External £2,080 **Total £2,190**	Expenditure in previous (IFI) financial years	**Total £162,356**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£350,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £10,000 External £30,000 **Total £40,000**
Technological area and/or issue addressed by project	One of the most significant items of substations plant is the on-load tap changer (OLTC). It is estimated that the population on the UK distribution network is around 5000 and many different designs exist with a number of variations within the internal mechanism but all essentially provide the same function, to momentarily divert the load current being carried by a transformer to allow a physical change to made to the number of turns in the transformers winding thereby changing the output voltage. OLTCs, like many mechanical devices with stored energy mechanisms, are subjected to regular and repetitive low level mechanical stresses which over time can lead to stress and fatigue fractures that cannot easily be detected during routine maintenance and inspections. These fractures can eventually lead to catastrophic failure of the OLTC mechanism, in many instances whilst the OLTC is being switched between tap positions and is at its moment of maximum mechanical loading. It has been reliably estimated that across the UK there are up to five OLTC failures per year and at least one of these failures will lead to the loss of the transformer in addition to the OLTC. This project has taken a very early OLTC monitoring prototype developed under the SuperGen Amperes Project and made some minor modifications to facilitate data handling and retrieval and extended the monitoring to 25 OLTCs. The system will use the same type of opto acoustic unit as the initial trial for data capture but will employ an embedded PC connected to our iHost system via GPRS to remotely download the recorded data. Liverpool University will be responsible for data management and will also develop software algorithms that will interrogate the data highlighting trends of increasing vibration or acoustic energy emission that could indicate an incipient failure.		

Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		17	-4	**21**
Expected Benefits of Project	A survey of Neders data reveals that almost 60% of OLTC failures are due to mechanical failure and the same survey reveals that of these failure 90% of the original equipment manufacturers are no longer still in business. It has been apparent for many years that better OLTC management techniques are required as the population grows ever older and after other organisations have failed to deliver the industries required monitoring solution, Liverpool University and Nortech have delivered a system in less that 12 months that we can begin to use to collect data. If the monitoring system can prevent the failure of one OLTC, it will have repaid the investment many times over.			
Expected Timescale to adoption	2012	Duration of benefit once achieved	5 years	
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£684,092	
Potential for achieving expected benefits	The techniques employed in this device are well proven in a range of other applications and it is expected to deliver the required system. The benefits are based on installing over entire population of Western Power Distribution On-load Tap-changers and the statistical probability of detecting and saving the failure of a transformer.			
Project Progress at March 2013	A paper was released by Liverpool University in October 2012 based on the findings of this project, entitled “Chromatic monitoring of transformers and their on-load tap changers”. In summary it concluded that this equipment could be successfully utilised to monitor overall acoustic transformer behaviour trends as well as trends in individual tap changer events, surges, level changes, and other events			
Collaborative Partners	Western Power Distribution (Midlands) and ENW			
R&D Provider	BFI Optilas, MHA IES, Nortech and Liverpool University			

Optical fibre acoustic sensors attached to a 33/11kV transformer On-load Tap-changer



Associated monitoring and remote communications equipment sited adjacent to transformer

PROJECT TITLE	VOLTAGE OPTIMISATION – 11KV NETWORK		
Description of project	The study would see if it was still possible to operate the whole network at a reduced target voltage, but still remain within statutory limits. It would identify if there were any significant energy savings to customers by operating in this fashion. This project involved reducing the voltage by 2% and monitoring the voltage and load data at both the primary and secondary substations along the feeders.		
Expenditure for financial year	Internal £1,578 External £6,300 **Total £7,878**	Expenditure in previous (IFI) financial years	**Total £41,084**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£68,500**	Projected 2013-2014 costs for Western Power Distribution	Internal £Nil External £Nil **Total £Nil**
Technological area and/or issue addressed by project	Parts of the 11kV network in Western Power Distribution have been designed to operate at voltages significantly higher than the nominal voltage. This has the advantage of allowing long feeders and reduced network losses. However, it can also prevent the connection of embedded generation as there may be insufficient voltage headroom and may also result in a modest increase to customer consumption.		
Type(s) of innovation involved	Incremental	Project Benefits Rating: 10	Project Residual Risk: -4	**Overall Project Score: 14**
Expected Benefits of Project	The study will identify if it is still possible to operate the whole network within statutory limits if the target voltage was reduced. It will also see if there were any reductions in customers' energy usage under these operating conditions. There reduction in system voltage should also increase the voltage headroom available for connecting distributed generation. This project will balance these advantages against the statutory requirements and reduction in losses.		

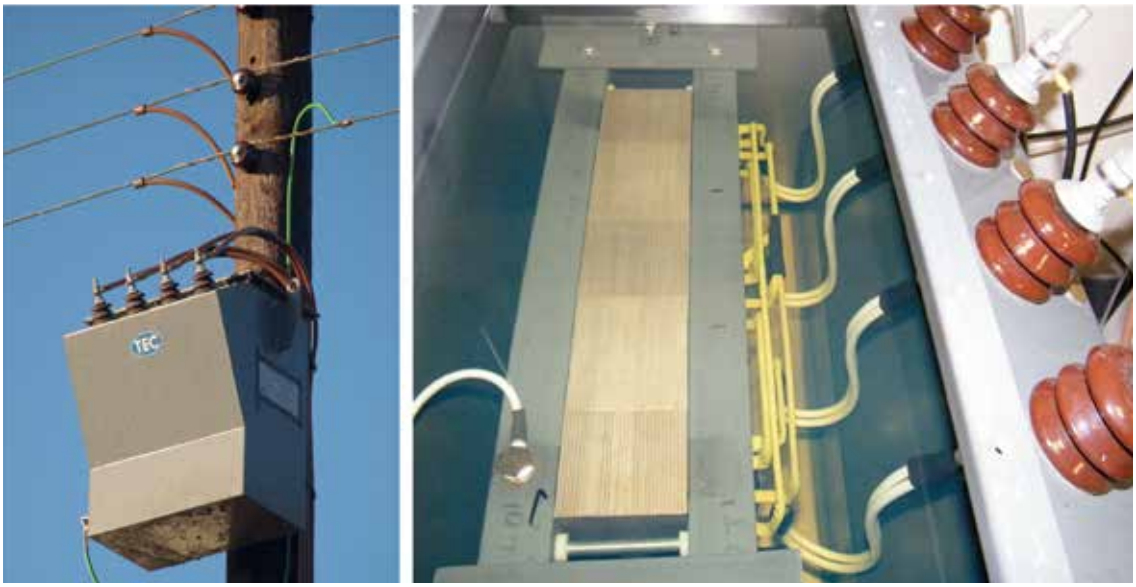
Expected Timescale to adoption	2012	Duration of benefit once achieved	20 years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	Not Known
Potential for achieving expected benefits	The initial study produced some interesting results and identified several areas where a subsequent trial could be improved. The second study confirmed many of the initial study results and being carried out at a time of higher demand gives further confidence as to the benefits accruing to the different stakeholders.		
Project Progress at March 2013	The second voltage reduction trial was applied at a rural Worcestershire 66/11kV Primary for three weeks from mid-December 2010 until January 2011. The voltage data collected from the trial was analysed to confirm that no customers on the network had voltages below statutory limits. After this assessment a voltage reduction was applied to this site in February 2011, this network continues of operate with a lower target voltage. A third voltage reduction trial was applied to primary network in Stoke during January 2013. Due to the network configuration and demand profile, only a 1.5% reduction was applied. Again the voltage data collected from the trial was analysed to confirm that no customers on the network had voltages below statutory limits. The monitored data showed the demand reduced for the duration of the trial. This network continues to operate with a lower target voltage. Further work has shown a blanket voltage reduction across all 11kV networks with significantly higher network voltages requires a system study at both 11kV and LV to ensure confidence that all customers' voltages remain within statutory limits during peak demand periods. This project is now complete; however it is proposed to raise another IFI project to conduct studies to validate the findings. In particular we are keen to ascertain the right places on the network to apply voltage reduction techniques.		
Collaborative Partners	Western Power Distribution (Midlands)		
R&D Provider	E.ON New Build & Technology		

PROJECT TITLE	INVESTIGATING BALANCING OF LV NETWORKS		
Description of project	Determine the benefits of LV balancing by development of a model to optimize inclusion of interconnected star transformers (static balancers) in to typical rural and urban network designs. Model to be derived from laboratory testing and verified by monitoring an actual installation. Model will also be used to understand operational and protection requirements.		
Expenditure for financial year	Internal £1,899 External £5,663 **Total £7,563**	Expenditure in previous (IFI) financial years	**Total £28,262**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£147,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £1,500 External £4,000 **Total £5,500**
Technological area and/or issue addressed by project	Interconnected star transformers have been available for many years, but their use has been largely limited to small devices on overhead LV networks. There is limited information to quantify their effectiveness in balancing LV networks in other situations, or understanding their operational limitations, required ratings and protection. This project aims to fill these knowledge gaps and also aims to quantify claims that these devices can reduce harmonic distortion.		

Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		11	-5	**16**

Expected Benefits of Project	Ensuring that LV networks are balanced should passively allow increased LV network utilization and reduced losses. Understanding and quantifying the benefits of LV balancing and harmonic distortion could result in the increased use of balancers on circuits where there are large quantities of non-symmetrical loads or embedded generation. The availability of a mathematical model as a design tool, should allow optimum network locations and device parameters to be identified on real networks reducing equipment cost and allowing reinforcement to be deferred.

	Understanding how interconnected star transformers perform under different operating conditions will allow protection and procedures to be designed for safe and efficient operation. Knowledge gained can be applied to the development of a device for use in more onerous urban applications.		
Expected Timescale to adoption	2014	Duration of benefit once achieved	25 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£1,138,000
Potential for achieving expected benefits	Following discussions with manufacturer, measuring instrument providers and CREST, a logical project plan has been developed and initial results are very positive.		
Project Progress at March 2013	Laboratory testing of interconnected star transformer started and initial model developed. This has been used to model worse case operational and fault scenarios to determine minimum protection requirements. It has also confirmed that there is some harmonic distortion reduction, but this has not been quantified. An interconnected star transformer has been installed on an unbalanced rural LV overhead network in the village of Much Marcle. Detailed monitoring of the unit's performance has been undertaken and passed to CREST for further analysis. This is forming part of a PHD study, which is due to complete in September 2013.		
Collaborative Partners	Western Power Distribution (Midlands) and EPSRC		
R&D Provider	Centre for Renewables and Sustainable Technology (CREST) at Loughborough University, Embedded Monitoring Solutions (EMS) Ltd, The Transformer & Electrical Co (TEC) Ltd and E.ON New Build and Technology		



Interconnected Star Transformers (Static Balancer) installed on LV overhead network (left) and under test at CREST Laboratory in Loughborough University (right)

PROJECT TITLE	PHASOR MEASUREMENT TRIAL			
Description of project	This project aims to demonstrate the use of field Phasor identification equipment on 33kV, 11kV and LV networks, to identify operational and safety issues and equipment limitations.			
Expenditure for financial year	Internal £1,222 External £Nil **Total £1,222**	Expenditure in previous (IFI) financial years		**Total £63,011**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£69,000**	Projected 2013-2014 costs for Western Power Distribution		Internal £1,500 External £Nil **Total £1,500**
Technological area and/or issue addressed by project	In future Smart Grids, it is likely to be necessary to identify the phase of connected non-symmetrical loads and embedded generation. Demonstrating equipment capabilities and understanding the expected amount of system phase shift in both a temporal and spatial context is necessary to develop reliable working practices.			
Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		11	-3	**14**
Expected Benefits of Project	Ensuring networks are balanced will maximise utilisation and reduce losses. Correct phase identification of controllable non-symmetrical loads and generation will aid network analysis. Understanding system phase shift across our extensive geographical area will determine optimum Phasor Base Station locations and working practices. Demonstrating the equipment will identify potential operational risks and training requirements that need consideration prior to adoption.			
Expected Timescale to adoption	2013	Duration of benefit once achieved		15 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success		£51,410

Potential for achieving expected benefits	The equipment has been used in Europe for similar applications.
Project Progress at March 2013	Several network vector diagrams have been confirmed and measurements taken to identify the phase connections of single phase spurs and transformers on an 11kV overhead network. Further testing will take place in 2013.
Collaborative Partners	Western Power Distribution (Midlands)
R&D Provider	Sibille Faeca Electric (SFE)

PROJECT TITLE	SMART GRID EQUIPMENT – LV LINK BOX MONITORING			
Description of project	Development of LV Link Box with remote monitoring facilities			
Expenditure for financial year	Internal £2,735 External £Nil **Total £2,735**	Expenditure in previous (IFI) financial years		**Total £51,200**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£86,000**	Projected 2013-2014 costs for Western Power Distribution		Internal £Nil External £Nil **Total £Nil**
Technological area and/or issue addressed by project	Link boxes are used to provide interconnection between LV distribution networks during maintenance or under fault conditions. They can also act as the boundary between distribution networks and independent network operators (IDNOs). Their functionality is normally limited to the manual operation of the individual phase connections. The development of Smart Grids on networks to facilitate large penetrations of micro-generation or other low carbon demand technologies will require an increased network monitoring capability. Measuring the voltage at, and current passing through, link boxes will provide some of the required information. The equipment should also be able to monitor; unbalance, power factor and harmonics. The monitoring could be used to identify the integrity of a fused interconnection in the link box and is a step towards the provision of remotely controlled LV switches in these link boxes.			
Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		14	-2	**16**
Expected Benefits of Project	The remote monitoring of link boxes in LV distribution networks will provide real time data to facilitate the active management of LV smart grids. It will also provide historic demand data which can be used for planning purposes and identify if remedial measures are required to mitigate unbalance, power factor or harmonic issues.			

	The monitoring of IDNO interfaces will confirm the presence of unmetered supplies and provide demand figures for planning purposes. The remote monitoring of fused link box interconnections can confirm the integrity of the connection and give early indication of potential network problems.		
Expected Timescale to adoption	2011	Duration of benefit once achieved	25 years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£139,475
Potential for achieving expected benefits	Working with a link box manufacturer has enabled the best use of existing specifications, standard materials and construction practices, which should ensure cost effectiveness and reliability. Use of power meters and remote communication technology proven in other projects should ensure that these are also reliable.		
Project Progress at March 2013	The link box with remote monitoring has been developed from concept through to a demonstration version. There were several iterations of the design following functionality reviews and risk assessments. The use of standard materials and proven technology has enabled rapid development and as mentioned above, should ensure reliability. The link box now has the option for one or two monitoring devices and can be provided with or without a communications module. Additional features can easily be added retrospectively or at the manufacturing stage to increase flexibility. Consideration has been given to repair and maintenance requirements and required safety labelling. It has now been decided that due to recent developments of other products that include the provision of automated switching and the potential for sectionalising. That this product will have little benefit to the Industry. The project is to be closed down, and WPD are now awaiting the results and future learning from the UKPN ‘Smart Urban Low Voltage Network’ project		
Collaborative Partners	Western Power Distribution (Midlands) and Prysmian		
R&D Provider	Schneider, Prysmiam and Nortech		

Prototype LV Link box showing the two monitoring devices and communications module in place (left) and the standard link box bell lid beneath (right).

PROJECT TITLE	SMART GRID DESIGN		
Description of project	Identify optimal network design configurations and arrangements for new and existing networks; identify potential changes in operational strategies and any required equipment characteristics.		
Expenditure for financial year	Internal £4,800 External £18,500 **Total £23,300**	Expenditure in previous (IFI) financial years	**Total £125,150**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£650,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £2,000 External £19,000 **Total £21,000**
Technological area and/or issue addressed by project	As part of the initial phase of this smart grid project, alternative network topology will be analysed to identify the advantages and limitations of different operational arrangements both under existing demand patterns and with a view to accommodating new low-carbon, distributed generation (DG) on the network. A second part to resolve issues associated with improving available network data using statistical techniques is under consideration. In particular validating estimations based on, transformer maximum demand records, demand profiles and DG intermittency. A separate phase will consider the use of a power electronic converter unit to be installed at the load end of the LV distribution network (i.e. on the distribution side of customer's meter). Development of a prototype converter unit is part of this project.		
Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating 12	Project Residual Risk 1	**Overall Project Score** **11**
Expected Benefits of Project	The initial phase evaluated the benefits of different network topologies at 11kV and LV. Currently networks at these voltage ranges are typically operated in radial configurations with normally-open points between different feeders as this allows design and operational simplicity.		

	One alternative network topology involves meshing networks permanently, to give the benefit of balancing the load between feeders and an increase in diversity. This should result in reduced conductor (I2R) losses, and may free up more network capacity to connect low carbon distributed generation (DG). Development of a converter unit which can passively provide; as a minimum 'voltage control at the point of delivery', but also has the functionality to ensure other statutory requirements of the electrical distribution network operators can be delivered, has the potential to revolutionise future LV networks.		
Expected Timescale to adoption	2015	Duration of benefit once achieved	20 years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£313,013
Potential for achieving expected benefits	The Knowledge Transfer Partnership allows close collaboration between academia and distribution network expertise, while the involvement of the Power engineering and power electronics, Computer science, and Non-linearity and complexity research groups provides access to the necessary expertise.		
Project Progress at March 2013	**Power Electronic AC/AC Converter** Extensive research has been undertaken to determine the size and space of typical enclosures in the United Kingdom in order to define an acceptable limit for the thermal dissipation of devices, as this appears to be the limiting factor. The electrical efficiency of the power electronic gates and their arrangements has been modelled and demonstrated so that their respective heat outputs can be measured. From this work, an innovative implementation of power electronic design using advanced components has been specified and will now enable a prototype to be manufactured and demonstrated. The innovative research has been presented in a number of poster sessions at power electronic events and will also feature in published conference white papers.		
Collaborative Partners	Western Power distribution (Midlands) and EPSRC (through sKTP and CASE awards)		
R&D Provider	Aston University and E.ON New Build and Technology		

PROJECT TITLE	GENERATING VALUE FROM SMART METER DATA			
Description of project	This project is investigating the potential for data mining smart meter data in order to provide useful information to DNOs and Suppliers.			
Expenditure for financial year	Internal £795 External £15,000 **Total £15,795**	Expenditure in previous (IFI) financial years		**Total £16,094**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£482,126**	Projected 2013-2014 costs for Western Power Distribution		Internal £Nil External £Nil **Total £Nil**
Technological area and/or issue addressed by project	This project is looking at two things: firstly, it is looking at the use of novel methods of data mining, by building various databases; and secondly it is looking at real-life use cases to build as queries on the database.			
Type(s) of innovation involved	Technological Substitution/ Significant/ Radical	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		12	-2	**14**
Expected Benefits of Project	If successful, this project will give DNOs and Suppliers access not just to the large volumes of data that will be available through the smart meter roll out, but to valuable information that can be extracted from this data. It will allow DNOs to look at trends and patterns in groups of consumers, whether it is in geographic areas or by the type of consumer. It tested the application of new technologies to handle “Big Data” where traditional relational databases would fail.			
Expected Timescale to adoption	2014 onwards	Duration of benefit once achieved		15 Years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success		£193,835
Potential for achieving expected benefits	The potential for this is high, as smart meter data will be available from 2014 onwards. And it could significantly change the way DNOs approach planning and customer engagement.			

Project Progress at March 2013	This project has now completed. It was able to successfully show that new data handling techniques were able to handle large Data volumes and that data mining could be used to differentiate customers groups.
Collaborative Partners	Western Power Distribution (South West), TSB, Centre for Sustainable Energy, Scottish and Southern Energy
R&D Provider	University of Bristol

PROJECT TITLE	REACTIVE POWER COMPENSATION FOR DISTRIBUTION NETWORKS		
Description of project	This project will analyse reactive power compensation as a method to increase capacity and improve voltage control on LV networks, today and with predicted future increases of Low Carbon Technologies.		
Expenditure for financial year	Internal £6,349 External £38,000 **Total £44,349**	Expenditure in previous (IFI) financial years	**Total £Nil**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£**	Projected 2013-2014 costs for Western Power Distribution	Internal £8,000 External £12,000 **Total £20,000**
Technological area and/or issue addressed by project	Predicted increases in Distributed Generation, the electrification of transport and heating may require networks to have an increased capacity and improved voltage control. New ideas are being researched as an alternative to conventional network reinforcement. This project will model the effectiveness of reactive power compensation on the LV network and the impact on the rest of the distribution network under steady state and transient conditions.		
Type(s) of innovation involved	Technological Substitution/ Significant/ Radical	Project Benefits Rating 13	Project Residual Risk -3	**Overall Project Score** **10**
Expected Benefits of Project	This project will provide an understanding of the impact when installing reactive power compensation on the Low Voltage Network: • The improvements in capacity and voltage control, • The characteristics under steady state • The characteristics under and transient conditions • The impact on the rest of the distribution system, 11kV, 33kV and 132kV if adopted on a wide scale. The outputs from this project will provide guidance as to whether Reactive Power Compensation is a technique that could be used for improving future networks.		

Expected Timescale to adoption	2015	Duration of benefit once achieved	25 years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£44,255
Potential for achieving expected benefits	The project will be run by Cardiff University and managed by WPD. The insight gained from the project will be directly applicable and relevant to all network operators preparing long term business plans.		
Project Progress at March 2013	During the last reporting period, WPD contracted with Cardiff University to conduct the analysis. The data analysis of meter readings at four distribution substations has been carried out and independent phase models of the lv networks set up in a new 'OpenDSS' software. Cardiff are now simulation the network under a range of load conditions and examining the voltage and thermal limitations.		
Collaborative Partners	Cardiff University		
R&D Provider	Cardiff University		

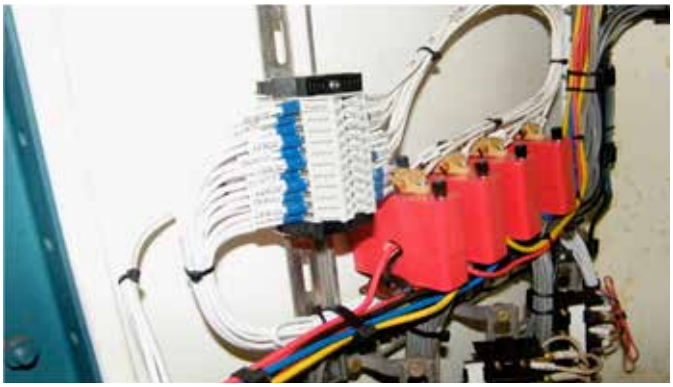
PROJECT TITLE	TRANSIENT FAULT DETECTION FROM DISTURBANCE RECORDERS		
Description of project	Use of disturbance recorder information to determine a search area for of potential faults by interpreting the waveform characteristics associated with self-healing pecking faults.		
Expenditure for financial year	Internal £576 External £10,866 **Total £11,442**	Expenditure in previous (IFI) financial years	**Total £355,867**
Total Project Costs (Collaborative + external + Western Power Distribution)	**Phase 1 £265,000** **Phase 2 £108,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £7,000 External £70,000 **Total £77,000**
Technological area and/or issue addressed by project	Pecking faults are small discharges caused by voids within the insulation of distribution cables, or surface tracking over compromised insulation on equipment. The discharges are insufficient to cause circuit protection devices to initiate a trip signal and will self-heal temporarily. As these network disturbances do not cause loss of supply and are difficult to detect, they are normally ignored, but evidence suggests that they can re-occur at irregular intervals and are often the precursor to the development of a more serious fault. If these incipient faults can be identified with equipment that can detect the small dips on the voltage waveform and short surges in current, then proactive action could be taken. If the pecking fault waveform changes are sufficient to allow the disturbances to be interpreted as an impedance value to the point of fault, then this information can be used with GIS data to determine search areas allowing these potential faults to be located and rectified before they cause a loss of supply to any customers. The project has been extended so that data collected from the monitoring of the substation battery can be used to identify the time of operation of the trip coil so that protection and switchgear operating times can be differentiated, allowing identification of any incorrect protection or circuit breaker clearance operation.		

Type(s) of innovation involved	Technological Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		13	2	**11**

Expected Benefits of Project	Detection of incipient self-healing faults will improve network performance and reduce customer interruptions by determining the location of potential faults and enabling proactive asset management. The early identification of incorrect protection or circuit breaker clearance operations will improve network performance.		
Expected Timescale to adoption	2013	Duration of benefit once achieved	20 years
Probability of Success	25%	Success	£303,600

Potential for achieving expected benefits	Initial focus has been on the design and installation of the distribution disturbance recorders at a number of 132/11kV substations and this has resulted in a cost effective, non-evasive installation arrangement which can be easily retro-fitted to existing substation sites either; using an existing relay panel; or in a dedicated wall cabinet. These disturbance recorders have the capability to provide various data reports, which include information on; substation battery operation, power quality; network stability, unbalance; harmonics and certain asset condition information. The analysis of this vast array of information is beyond the scope of this particular project and further projects using information from similar recorders have been started. One area which this project has been extended to include is the analysis of the battery waveforms at time of fault to identify if protection and switchgear clearance times are as expected. As both these projects required analysis of data collected during faults there were benefits to combining this work. The reports are sent by the instruments to a central location via a standard ADSL internet connections and this facility is providing a hub for the collection of other condition data at these sites.

Project Progress at March 2013	Installation and commissioning of multiple event recorders at 11 urban 132/11kV sites has been completed for this project. The data from any faults occurring on the networks supplied from these 11 substation sites is being collected and sent for analysis once the actual fault locations have been confirmed. Development on the fault algorithm is continuing and expected to be complete in 2013. The issues identified with obtaining accurate network cable and load data still remain to be resolved. Further work is being undertaken to upgrade the communications infrastructure for the recorders which will be completed in summer 2013
Collaborative Partners	Western Power Distribution (Midlands)
R&D Provider	Ltd, Sterling Power and E.ON New Build & Technology



Current connections made with split CTs on the secondary wiring within an existing relay cabinet. This arrangement minimises the recommissioning work needed to install disturbance recorders, when retro fitting existing sites.

PROJECT TITLE	TECHNICAL ASSESSMENT OF POWER QUALITY ISSUES		
Description of project	Confirm the extent of suspected power quality issues on an extensive sub-transmission network and consider the effect of alternative mitigation measures.		
Expenditure for financial year	Internal £2,755 External 15,523 **Total £18,278**	Expenditure in previous (IFI) financial years	**Total £138,765**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£155,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £4,000 External £25,000 **Total £29,000**
Technological area and/or issue addressed by project	Power quality issues are an increasing concern for our customers and all distribution network operators. Computer technology, automated processes and sensitive electronic equipment are in widespread use across all customer sectors. Short duration interruptions and voltage sags are the most frequent cause of loss of revenue to commercial and industrial customers as they can result in mal-operation of equipment. Installation of low loss distribution equipment and network configurations designed for optimizing the connection of low carbon devices may allow power quality issues to propagate further with single events disrupting more customers. Monitoring an extensive sub-transmission network, which is suspected to contain sources of power quality issues, will provide the opportunity to identify the extent of the propagation of power quality issues and allow alternative mitigation measures to be considered and possibly demonstrated to evaluate their effectiveness.		

Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		12	-2	**14**

Expected Benefits of Project	Deliver a better understanding of power quality issues and the cost effectiveness of potential mitigating solutions on customers. Determine the extent of propagation of power quality issues on a real network and allow the assessment of low loss distribution equipment and proposed future network configurations. Verification of previous research methods, which of assessed alternative techniques to improve power quality		
Expected Timescale to adoption	2015	Duration of benefit once achieved	8 years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£187,770
Potential for achieving expected benefits	Information from previous project on power quality explored the uncertainties posed by sag performance estimation from voltage sag monitoring and demonstrated how different methods and durations of monitoring periods affect accuracy of sag profile modelling. It also considered how to assess alternative mitigation techniques to determine optimal solutions for different customer / in various network scenarios. Assessed techniques included dynamic voltage recovery, redundant supplies and various network infrastructure improvements. This background work provides useful information, which will be incorporated into this project to increase the probability of success.		
Project Progress at March 2013	Various sources of unbalance have been modelled, looking at how this propagates across the network. Further work is being undertaken to upgrade the communications infrastructure for the recorders which will be completed in summer 2013.		
Collaborative Partners	Western Power Distribution (Midlands)		
R&D Provider	E.ON New Build and Technology		

PROJECT TITLE	HARMONIC DETECTION AND ANALYSIS		
Description of project	Use of disturbance recorder information to determine harmonic levels on a rural 33kV network with a large penetration of cable connected intermittent distributed generation.		
Expenditure for financial year	Internal £3,940 External £1,522 **Total £5,462**	Expenditure in previous (IFI) financial years	**Total £220,302**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£280,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £8,000 External £40,000 **Total £48,000**
Technological area and/or issue addressed by project	With a growing penetration of non-linear loads, distributed generators (DGs) and flexible AC transmission system (FACTS) devices that employ power electronic converters, harmonic voltage distortion on the distribution network are increasing. Harmonic voltage distortion has been recognised as a cause of: • interference to telecommunication and control systems • increased losses in circuits and equipment • overheating of rotating plant, transformers and capacitors, the latter being particularly susceptible to harmonic damage • increased voltage stress on equipment • increased vibration and noise emissions • spurious tripping of control circuits and relays, and mal-operation of any equipment using zero crossing waveform technology, including digital timers • general degradation of fuse elements Identifying the source of harmonic distortion is not always easy as the magnitude depends upon network parameters. This project aims to monitor a network which is suspected of having a high level of existing harmonic distortion. The data collected will be used to determine methodologies to identify the source of harmonics and to improve the harmonic content of the electricity supply in the future.		

Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		14	0	**14**
Expected Benefits of Project	This project will give better understanding of harmonic distortion in a rural network with large penetrations of DG. The measurement of actual network values will allow the theoretical network studies to be verified. This will enable methodologies to be developed to identify the source of harmonics distortion and the effectiveness of potential mitigation techniques tested. This knowledge will allow a potential barrier to the connection of renewable distributed generation to be removed.			
Expected Timescale to adoption	2014	Duration of benefit once achieved		20 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success		£527,630
Potential for achieving expected benefits	System studies on the 33kV network, which will be used for the data collection have identified that harmonic distortions at high even orders (between 20th-30thorders) could become close to exceeding the planning levels specified in ENA Engineering Recommendation (ER) G5/4-1. It is believed that these harmonics are caused by the power electronic technology associated with the wind generation, which is cable connected to this network. It is therefore likely that the disturbance recorders will be able to verify the high levels of harmonics and analysis should enable the objectives of this investigation to be achieved.			
Project Progress at March 2013	Thirteen disturbance recorders have been installed at six primary substations on this rural 33kV network to give complete coverage of the distribution network. Initial results indicate that the levels of harmonic distortion are as expected. Further work is being undertaken to upgrade the communications infrastructure for the recorders which will be completed in summer 2013.			
Collaborative Partners	Western Power Distribution (Midlands)			
R&D Provider	New Build and Technology			

The limited space in the primary substation control rooms and the general civil arrangements, dictated that free standing panels had to be installed at these sites instead of the more usual wall panels.

PROJECT TITLE	NETWORK UNBALANCE SOURCE DETECTION BY OPTIMUM MONITORING		
Description of project	This project aims to determine a method of identifying the source of unbalance on a 33kV mesh network using a minimal number of monitors.		
Expenditure for financial year	Internal £1,980 External £28,138 **Total £30,118**	Expenditure in previous (IFI) financial years	**Total £205,879**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£323,000**	Projected 2013 – 2014 costs for Western Power Distribution	Internal £8,000 External £15,000 **Total £23,000**
Technological area and/or issue addressed by project	Network unbalance can be an issue for customers and distribution network operators. It can cause damage to equipment, increase system losses, reduce network capacity, and prevent optimal feeding arrangements. Historically, voltage unbalance occurred due to the connection of single phase loads and conventional corrective action methods involved the permanent reconnection of specific loads to other phases. The increased in single phase distributed generation is expected to cause a rise in voltage unbalance issues, which will become more noticeable, especially as voltage unbalance on the network can prevent the connection of three phase distributed generation. As much of the future distributed generation will be intermittent (Wind, PV, etc.), detecting the source of the voltage unbalance and applying conventional corrective action is also likely to become more difficult		

Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		11	-2	**13**

Expected Benefits of Project	The objects of this project are to develop: • A methodology for the optimal placement of a limited number of monitors in a network (taking in to account any existing monitor installations) to provide full network observability. • A distribution state estimator to trace unbalance in distribution networks allowing identification of the primary source. • A real time display of network unbalance that can be used by the distribution network operator. The project aims to demonstrate how knowledge of network unbalance can be used to identify the most appropriate corrective action.		
Expected Timescale to adoption	2013	Achieved	20 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£349,486
Potential for achieving expected benefits	The design of an optimal monitor placement methodology build on previous project work carried out at Manchester University. While the data recorded from the installed network monitors will confirm the theoretical conclusions. Three-phase load flow and least square methods will be applied to achieve state estimation, which forms the basis of the methodology of detection of voltage unbalance location and source. Here the data recorded from the installed network monitors will allow the practical application of the theory. These two deliverables will be integrated to form a real-time graphical display program, indicating the health status of the network.		

Project Progress at March 2013	A methodology for probabilistic estimation of unbalance in distribution network has been developed, taking daily loading trend, varying power factor and different load types into account. With this methodology, DNOs are able to predict the status of system unbalance in the network when full monitoring is not available. Three conference papers have been accepted on this topic as well as one journal paper in preparation. Comparing one month's actual loading data with the results derived from the described method shows very good correlation. Eight disturbance recorders have been installed at three substations and configured to provide the required voltage and current monitoring facilities. Five more disturbance recorders were installed during summer 2011. Further work is being undertaken to upgrade the communications infrastructure for the recorders which will be completed in summer 2013
Collaborative Partners	Western Power Distribution (Midlands) and EPSRC
R&D Provider	Sterling Power and E.ON New Build and Technology

Disturbance recorders installed at the 132/33kV source substation to act as remote current monitors on the three 33kV feeders, which supply the unbalanced meshed network.

PROJECT TITLE	CUTS LV OVERHEAD LINE PROJECT			
Description of project	Development of an early warning/alarm system to send notification of network interference.			
Expenditure for financial year	Internal £1,134 External £21,400 **Total £22,534**	Expenditure in previous (IFI) financial years	**Total £Nil**	
Total Project Costs (Collaborative + external + Western Power Distribution)	**£120,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £2,000 External £80,000 **Total £82,000**	
Technological area and/or issue addressed by project	To detect removal of neutral and/or any one or all phases between customer premises and distribution transformer. • The unit should be sufficiently intelligent to provide information on which specific lines are down e.g. whether P1, P2, P3 or N/PE. • The unit should be able to be adapted to multiple three phase or single phase delivery formats using the main earthing type standards: TNCS, TNC etc. • The unit should be able to provide alarm functionality with or without external power present for a reasonable period. To ignore/automatic reset, upon momentary fault events. • To ensure momentary events do not cause unnecessary call outs /alarms, the unit should be able to filter out very short term events. Quick to install and set up by Craftsperson. • For most installations it is anticipated that the only connections necessary will be feeds from the supply side of the user switchgear/meter to the unit. Alarm Communications. • The alarm needs to communicate which specific fault event has occurred e.g. If a Phase failure, which Phase(s) and/or a Neutral failure. • The data output will integrate with WPD monitoring systems. • Alarm communication will need to be transmitted wirelessly. The most likely approach will be to utilise IP or SMS via GSM/GPRS on board modem.			
Type(s) of innovation involved	Technological Substitution/ Significant/ Radical	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		14	-3	**17**

Expected Benefits of Project	• Reduce Customer supply interruptions resulting from overhead metal theft. • Reduce material losses. • Potential for possible future adaptation to provide supply side smart grid information. • Low Unit cost • Quick and easy to deploy		
Expected Timescale to adoption	2015	Duration of benefit once achieved	30 Years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£12,752.27
Potential for achieving expected benefits	The project is currently in the early stages of development and looking to create a solution from a standing start. There is a high degree of confidence that a suitable product can be developed. However, the deployment strategy is going to be key to delivering the benefit for the project. Proportionally the amount of theft on out network is small compared with the size of the overall system. It is therefore vital to identify and target areas of the network that are most likely to experience theft. This will be done through identifying hot spots with the police and other interested agencies.		
Project Progress at March 2013	Phase 1/1a. Assessment of design options and Conceptual Design of CuTS® LV Overhead Line Theft Sensor by assessment of method options that were judged to be possible solutions is complete. Cresatech have submitted a Phase 1 Report that outlined the considerations and detailed a proposed technical solution for further development. Review meeting taken place to agree the findings of the report and authorise progression to Phase 2 – Proof of concept in lab/development environment and production/ test of initial prototype		
Collaborative Partners	The Service Provider has explored opportunities to work with other Organisations but is currently working alone to develop and provide the technical solution.		
R&D Provider	Cresatech LTD		

PROJECT TITLE	POWER NETWORKS RESEARCH ACADEMY		
Description of project	The Power Networks Research Academy (PNRA) has been established through a strategic partnership agreement between; the Engineering and Physical Sciences Research Council (EPSRC), electricity transmission and distribution companies, related manufacturers and consultants, that will fund and support PhD researchers in power industry related projects and help maintain and improve the research and teaching capacity in power engineering subjects. Projects are selected from a number of submissions, using a two tier process. This process comprised; an initial sift to determine the project's industrial relevance and an independent peer review to determine their academic excellence. Scholars were subsequently recruited for each of these projects.		
Expenditure for financial year	Internal £1,434 External £27,045 **Total £28,479**	Expenditure in previous (IFI) financial years	**Total £213,881**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£1,500,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £2,000 External £0,000 **Total £2,000**
Technological area and/or issue addressed by project	The projects for the first cohort of Academy scholars are: • Overhead Lines Measurement System • System Impacts and Opportunities of HVDC Upgrades • Application of Artificial Immune System Algorithm to Distribution Networks The projects for the second cohort of Academy scholars are: • Early Frequency Instability Predictor based on Synchronised Wide Area Measurements (E-FIP) • Electrical Network Fault Level Measurement for Distributed Generation and Other Applications • Protection of Converter-Dense Power Systems • Chemical Approaches Towards Intelligent Insulation • Protection Issues of Inverter-Interfaced DG • Reactive Power Dispatch Using Distributed Generation		

	The projects for the third cohort of Academy scholars are: • Influence of oil contamination on the electrical performance of power transformers • Protection of Series Compensated Transmission Lines based on Synchronised Measurement Technology • Alternatives to SF6 as an insulation medium for distribution equipment • Reducing the Risk of Sub-Synchronous Resonance in Meshed Power Networks with Increased Power Transfer Capabilities • Solid state devices for electrical power distribution			
Type(s) of innovation involved	Significant, Technological substitution and Radical innovations	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		9	-1	**10**
Expected Benefits of Project	It is expected that the Academy will: • promote a stronger, more active and robust R & D environment in power networks disciplines at UK universities; • provide capacity and capability to undertake the specialist research needed by industry and wider stakeholders; • strengthen the teaching capability at those institutions; • focus on building the health of discipline across a number of power research universities; • facilitate a resource of trained engineering staff with academic capability, who will be capable of tackling electrical power engineering challenges; • deliver research output that is industrially relevant and beneficial. See online for further information at http://www.theiet.org/about/scholarships-awards/pnra/			
Expected Timescale to adoption	2013	Duration of benefit once achieved		20 years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success		£200,000

Potential for achieving expected benefits	There are now seventeen projects and information from all the individual research projects is regularly shared amongst the members. In addition each project is also allocated to an industrial sponsor for them to provide direct support and direction This also maximises the opportunity for them to benefit from individual research projects. Six projects have now been completed. It is therefore considered that the potential for achieving excepted benefits is high.
Project Progress at March 2013	Western Power Distribution is directly involved in three projects (one from each cohort year). The potential for achieving expected benefits and progress reports for the other projects can be found in the IFI reports of their supporting companies. The information for the projects with which Western Power Distribution is directly involved can be found below: **Application of Artificial Immune System Algorithm to Distribution Networks (Manchester University)** This research project is focussed on using artificial intelligence techniques (such as artificial immune systems – AIS) to assist with the detection of weak areas within distribution networks. The artificial intelligence (AI) methodology developed will attempt to assist with the diagnosis of a series of health criterion within the power network. The expected output of the project is a methodology that will identify the worst served customers in a distribution network. The algorithms and methodologies developed in this research project are applicable to a variety of utility specific problems. It is expected that the methodologies will allow Western Power Distribution to: • Collate information from a diverse range of monitoring devices (including smart meters) and intelligently estimate the state of their power network • Identify poor performing areas of the network • Pre-emptively maintain weak areas of their network Optimally place monitors within their network to monitor power quality related issues and estimate the state of the system and feed this information into network planning, operation and optimization systems

Project Progress at March 2013 (Cont)

The benefits discussed above have been proven using generic distribution network models to detect both voltage weak buses, voltage sags and unbalance. Voltage unbalance and state estimation has been modelled on a section of distribution network belonging to Western Power Distribution (Midlands), and it is anticipated that the developed techniques will be directly applicable to the solution of this specific issue. There is therefore a near certain chance of achieving tangible direct benefits on this issue, as well as a near certainty of achieving the others at a least the research level.

Protection Issues of Inverter-Interfaced DG (Imperial College. London)

This project will look at:

1. Constant power loads in microgrids.
2. Droop controller behaviour under fault conditions
3. The stability of the distribution network feeders with DG.
4. Prime mover impacts on inverter based DG.

The benefits are tools that can be applied as part of connection studies for certain types of distributed generation (DG) and, more broadly, will aid in understanding network implications of inverter DG. This should help provide a better understanding of how feeders with high penetration of DG will behave.

The benefits described above could be implemented by the DNO to increase security of supply and understand any issues created by the feed-in tariff for domestic and commercial connections.

Currently all benefits should be achievable in three years. Due to time limitations expected benefits may not be achieved if ideas fail or experimental data does not match simulations results. In the worst case this project may only achieve some of its expected benefits.

Solid State Devices, for Power Dense, Electric Power Distribution Networks (Strathclyde University)

It is probable that a switch away from direct fossil fuel consumption to clean energy sources will drive an increased requirement for electrical energy.

Project Progress at March 2013 (Cont)

This project will focus on technologies that facilitate greater utilisation of low voltage distribution networks with the primary emphasis on high power density urban networks. In such locations the ability of power electronic based systems to achieve increased power throughput and reduced footprint can counter-balance increases in complexity and losses. Through the deployment of such devices it may be possible to increase throughput, reduce system loss and facilitate increased levels of distributed generation in locations where conventional reinforcement is impractical.

- The project will investigate techniques that allow AC distribution voltage level to be increased while regulating the consumer voltage at the point of use. This approach has the potential to increase network capacity and to buffer end user from voltage fluctuations that may result from increased levels of DG or high capacity electric vehicle charge systems.
- The project will investigate the possibility conversion of AC distribution networks low voltage DC (600 – 1kV). The use of DC has the potential to increase cable capacity. However this improvement must be balanced against the increased losses associated with power electronic energy conversion.

The project will bring benefits in the following areas,

- Understanding of the benefits and problems associated with deployment alternative LV network technologies.
- Increased power capacity of low voltage distribution networks. This will facilitate load growth, the deployment of distributed generation and high capacity electric vehicle charging.
- The project may generate technologies or control methodologies that may be exploited in collaboration with appropriate equipment manufacturers.

The project has been running for 2 months and at this stage the potential for achieving benefits can be regarded as high.

Application of Artificial Immune System Algorithm to Distribution Networks (Manchester University)

The identification of the worst served customers in the network has now been expanded to cover: voltage weak areas, voltage sags and unbalance.

Project Progress at March 2013 (Cont)	Published research on all topics include 5 conference papers and one journal paper as well as one further conference paper and two further journal papers which have been submitted, but not yet published. Methodologies have been developed for to allow Western Power Distribution and other DNO's to optimally monitor their network for voltage sags, unbalance and voltage stability and also intelligently process the gathered information using artificial intelligence techniques. The methods developed are practical and customer focussed. Recent work on voltage unbalance and state estimation has been applied to a real section of Western Power Distribution's network and it is hoped this will be used to help solve specific issues within their network. Research has been completed on collating all the developed techniques into an overall system state estimator capable of identifying the worst served and weakest areas of the network. This research has been compiled and written up as a thesis, which has been examined and passed at the University of Manchester. **Protection Issues of Inverter-Interfaced DG (Imperial College. London)** A study of the risks of islanding and LoM algorithms has been undertaken. This work concluded that islanding is not a risk while the penetration of DG is low. As DG increases however, the risk of islanding will increase and more sophisticated islanding detection algorithms will be required. A paper for UPEC 2010 was written and presented in Cardiff. The required 15-month transfer report has been submitted and examined. Solid State Devices, for Power Dense, Electric Power Distribution Networks (Strathclyde University) • Literature Review – Each of these topics were explored in depth, on their standard operation and how they would be implemented in order to increase low voltage power capacity. High frequency transformers, soft normally open points, DC networks and point of use regulation; with particular focus on low voltage distribution in the UK.

Project Progress at March 2013 (Cont)	• Viability Study – The first main segment of research of this PhD was a viability study using Powerworld simulator. The simulation was based on Sheridan Road in Bristol and has found that voltage regulation is a viable method of easing voltage congestion on a modern urban low voltage distribution system. • Converter Topologies – The second segment focused on the creation of power electronic converter topologies in Matlab Simulink. Two topologies were simulated for comparison. One circuit topology was then chosen over the other for implementation of voltage regulation. • Review Session – As part of the University of Strathclyde first year review, a detailed technical report was created and a presentation given on the progress to date. A poster was also created and presented at the University of Strathclyde annual Research Presentation Day (RPD) event. • Hardware Prototype Build – Work has begun on creating a circuit based on the earlier chosen topology. A journal paper based on material from the first year of research, which was submitted to an IET journal during summer 2012.
Collaborative Partners	EPSRC, IET, Western Power Distribution (Midlands), National Grid, Scottish and Southern Energy, UKPN and EA Technology Ltd
R&D Provider	Universities of Cardiff, Manchester, Queens (Belfast), Southampton, Strathclyde, and Imperial College London.

PROJECT TITLE	SUPERGEN HiDEF		
Description of project	The HiDEF programme, funded by the EPSRC (Engineering and Physical Sciences Research Council) researches the essential elements of a decentralised system that could be implemented over the period 2025 to 2050, to enable all end users to participate in system operation and real-time energy markets.		
Expenditure for financial year	Internal £3,698 External £20,000 **Total £23,698**	Expenditure in previous (IFI) financial years	**Total £62,856**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£4,500,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £2,000 External £20,000 **Total £22,000**
Technological area and/or issue addressed by project	The HiDef programme has five work streams: • Decentralised Energy • Decentralised Control • Decentralised Network Infrastructure • Decentralised Participation • Decentralised Policy and Macro Impact Assessment		
Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating 8	Project Residual Risk -2	**Overall Project Score** **10**
Expected Benefits of Project	Outputs from the HiDEF work streams will inform debates that are current in the industry and enable the following benefits to be realised: • Models of single and multiple DER (Distributed Energy Resource) units have been developed to assess the thermodynamic analysis, life cycle assessment and environmental cost benefit analysis, providing a quantification of performance • Development of control solutions for single units, cells containing multiple DERs, and multiple cells, with a focus on security and resilience of communications and control systems • Support and investment guidance for future decentralised network operation through the development of MV/LV architectures and planning tools		

	• Design of a distributed market place, to enable the investigation of market based response, trading contracts and products, defining the components essential to market realisation • Inform future policy decisions by reviewing current policy delivery mechanisms in the UK, comparing market structures & examining the potential for alignment with various market aggregations		
Expected Timescale to adoption	2013	Duration of benefit once achieved	20 years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£2,000,000
Potential for achieving expected benefits	Project progress over the last year has been good, and the completion of tasks and deliverables have been reported at the project management meetings. Case studies undertaken to date have demonstrated some of the benefits of wider adoption. The demand side elasticity analysis is now being supported by data from the California state pilot project. The economic implications of the highly distributed system continue to be appraised by the Decentralised Policy and Macro Impact Assessment team. An interregional analysis of the economic and environmental impact of CHP within urban environments has been completed, with particular focus to date on the economies of Glasgow and Scotland. A new computable general equilibrium model of Scotland is furthermore providing for the identification of macroeconomic impacts of technology options and recognition of their policy implications.		
Project Progress at March 2013	The Decentralised Energy Work stream has completed the realisation of open source models of energy storage, energy conversion and energy demand components. The library of domestic building models has now been complemented with commercial building models featuring hybrid and low carbon systems. These have been used by IEA (International Energy Agency) and Distribution Network Operator (DNO) partners. Further progress has been made in the realisation and testing of new cell control solutions within the team's hardware rigs and simulation environments.		

Project Progress at March 2013 (Cont)	The Decentralised Network Infrastructure Work stream has developed a number of new power and energy system analytical techniques and tools, and have applied these to the analysis of industrial case studies. Projects at Ebbw Vale, Ashton Hayes and Shetland have thus been supported, and the data sets and tools in relation to DSM, EV, HP, thermal and electrical storage refined with this experience. The Decentralised Participation team have realised stochastic optimisation techniques and novel pricing techniques that help maximise the expected portfolio of DG and DR services. Furthermore, their hardware platform showcasing frequency response functions for smart meters has now been demonstrated at a smart meter exhibition. The Decentralised Policy and Macro Impact Assessment team have continued their assessment of the effectiveness of alternative policy measures including in Glasgow, Brighton & Hove, and Milton Keynes. The ability to conduct macro-economic modelling incorporating the impact of renewables and advanced generation deployment has been enhanced through augmentation of the established CGE model to incorporate household energy demands. This will now feature in on-going economic modelling activity. The team continue to support a number of engagement and impact case studies, including a number of LCNF projects. The value of HiDEF datasets, simulation and analysis tools, and models have thus been assessed with academic partners, industrial colleagues, community groups, and agency staff. This has been complemented with significant dissemination and engagement, including 37 new publications, a HiDEF workshop in London concerning “The Future of Community Energy”, and participation in a variety of conferences and meetings.
Collaborative Partners	EPSRC and the following industrialists: Community Energy Scotland, Delta Energy & Environment, Intelligent Power Systems, National Grid, Western Power Distribution, Scottish Power Energy Networks, Scottish and Southern Energy.
R&D Provider	University of Strathclyde supported by: University of Bath, Cardiff University, University of Oxford, Loughborough University, Imperial College London.

PROJECT TITLE	ENA R&D GROUP PROGRAMME		
Description of project	The Energy Networks Association (ENA) represents all the UK network operators. Several projects have been initiated by the ENA R&D working group and have been funded through the IFI.		
Expenditure for financial year	Internal £11,671 External £123,613 **Total £135,283**	Expenditure in previous (IFI) financial years	**Total £434,705**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£598,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £15,000 External £120,000 **Total £135,000**
Technological area and/or issue addressed by project	The projects listed below address issues which have been identified by the ENA working groups as significant – requiring technical investigation and development. There are a number of projects that have been completed and reported in previous IFI years and for that reason these projects are not reported here. **Harmonic Impedance Modelling:** The project addresses the detailed modelling of cable and overhead line components, to develop cable models appropriate for distribution networks **Earthing Project –** HV/LV Earthing Transfer: The aim is to develop new techniques to assess the impact of lower voltage earth electrodes on higher voltage 'hot zones' and to measure the resistance of distribution substation earth systems **Smart Grid Forum Work stream 3 Phase 1 & 2 –** Takes the impact of Britain's future energy scenarios into key strategic directions for network development, identifying the needs for network expansion and the opportunities for smart grid techniques to drive cost-efficiency and deliver new services. It considers the enablers for change, including the necessary development of commercial and regulatory frameworks **DC Injection –** Investigation into the corrosion effects of DC on DNO networks with specific emphasis on assessing the impact of DC flows in the neutral conductors and providing evidence that a max of 20 milliamps as per British Standards is suffice		

Type(s) of innovation involved	Incremental/ Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		6.2	-10	**16.2**
Expected Benefits of Project	These projects have the potential to provide a wide range of benefits. In some cases, they will help to understand key asset-related issues and allow designs to be altered to address them. In other cases they will allow us to better understand risks to our network, whether from climate change or changes in demand. The smart metering project is already making a valuable input to the overall smart metering consultations and the development of the national Smart Metering Equipment Technical Specification (SMETS).			
Expected Timescale to adoption	Year 2012	Duration of benefit once achieved	10-20 Years	
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£100,000	
Potential for achieving expected benefits	Work on the harmonic impedance modeling (G5/4) will help DNOs understand harmonics issues on distributed networks and produce a revised revision of G5/4. The transfer potential projects will assist with understanding earthing issues in differing situations. The remaining projects are still in progress and it is hoped they will demonstrate the benefits explained. **Harmonic Impedance Modeling** The project addresses the detailed modeling of cable and overhead line components, to develop cable models appropriate for distribution networks. These will be incorporated in to a new revision of G5/4 to a new simplified Stage 3A methodology for simple and low harmonic connections. Work is ongoing to establish this simplified stage. Tests have been progressing and will be published in the new G5/4 in due course. Final document has been received from the ENA R&D Working Group (WG). The document was authorised for circulation within the ENA R&D WG in the first instance, with a view to wider circulation once approved.			

Project Progress at March 2013 (Cont)	**Earthing Project – HV/LV Earthing Transfer** This project has developed 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 up to 33kV. It is proposed this is now extended to the 132kV networks with a new calculation method being developed to accurately estimate transfer potential between EHV, HV and LV earthing system. The new calculation method will be designed with different arrangements and soil resistivity in mind. Under the previous stage of this IFI project, an MS Excel based calculation tool has been developed for analysing the earth fault current distribution for the full range of representative 11kV cables required by the member companies. This was now complete up to 11kV. A CD was provided by Earthing Solutions (ES) which included modeling calculations. The extension to the project to include voltages from 33kV up to 400kV. This new proposal is to add a representative sample of DNO 33kV, 66kV and 132kV cables into the routines. The 33kV and 66kV circuits and cables have many similarities to those previously modeled and can be added using the methods already developed. The 132kV circuits are more complex in terms of cable construction, circuit configuration, end resistance value (low) and circuit length (quite long). The work proposal includes 6 key deliverables and the price quoted by ES to complete this work is in total £25.5K. As of March 2013 further information is still being acquired for the projects potential transfer to the transmission system. **Smart Grid Forum Workstream 3 Phase 1, 2 & 3** The phase 1 report translates the impact of UK's future energy scenarios into key strategic directions for network development, identifying the needs for network expansion and the opportunities for smart grid techniques to drive cost-efficiency and deliver new services. It considers the enablers for change, including the necessary development of commercial and regulatory frameworks. It focuses on 2020 and 2030, and casts a forward look towards 2050 to consider the enablers for change, including the necessary development of commercial and regulatory frameworks.

Project Progress at March 2013 (Cont)	Phase 2 will develop a technical model and cost benefit analysis network investment tool for a range of typical network types from EHV to LV. The model will be run against synthetic networks at each voltage level under a range of low carbon uptake scenarios. As of March 2013 phase 2 is complete and can now be used for ED1 Business Plans. Work is currently commencing on WS3 Phase 3. Phase 3 deliverables agreed. Invoices have been calculated for respective DNO's. **DC Injection:** Project is underway, project objectives have been raised, project currently progressing through early stages.
Collaborative Partners	National Grid; Scottish Power Energy Networks; Scottish and Southern Energy; Electricity North West; Western Power Distribution and Northern Power Grid
R&D Provider	TNEI; Engage Consulting Limited; Imperial College London; Met Office; EA Technology Ltd (and partners); Earthing Solutions; KEMA and Redpoint Energy; Inertek; CAPCIS.

PROJECT TITLE	EA TECHNOLOGY – STRATEGIC TECHNOLOGY PROGRAMME EATL STP OVERHEAD LINE MODULE 2 AND FORUM			
Description of project	Research and development into all aspects of Distribution Overhead Lines			
Expenditure for financial year	Internal £10,153 External £71,356 **Total £81,509**	Expenditure in previous (IFI) financial years		**Total £640,298**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£325,000**	Projected 2013-2014 costs for Western Power Distribution		Internal £10,000 External £73,000 **Total £83,000**
Technological area and/or issue addressed by project	The Module 2 programme aims to optimise overhead network design, improve operational performance, maximise potential benefits, improve financial performance, and minimise risk associated with overhead networks, whilst having due regard for the environment and energy efficiency. The programme also aims to deliver continuous improvement in terms of safety and environmental performance of the overhead network to meet the individual business requirements of Member Companies. Several of the projects contribute to the industry's knowledge of variation in climate change. The projects all address real problems that have been identified by the module steering group members as significant and which require technical investigation and development.			
Type(s) of innovation involved	Incremental, Technical Transfer, Signifiant, Radical	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		16	-9	**25**
Expected Benefits of Project	Projects in this module will significantly increase the safety and reliability of the network. In certain cases the asset life may also be extended. If the projects in this module 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:			

- Improvements in network reliability by identifying root causes of faults and developing solutions;
- Safe early detection of potential defects that can then be repaired in a planned and timely fashion;
- Cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults;
- Development of tools, technology and techniques to reduce risk or cost, or to increase speed of capital deployment of Member Company programme delivery;
- A better understanding how overhead line assets perform in service which can be used to determine the overall asset management policy ;
- Reduce levels of premature failure of assets;
- Avoid redesign, reconstruction or refurbishment of overhead lines where this is driven by a perceived need to increase ratings or strengthen lines, and is required to conform with existing standards but which may be unnecessary;
- Co-operation between European countries in the development of forecasting methods of atmospheric icing and for the exchange of forecasting tools;
- Comparison of new covered conductor with known performance of older types;
- Increasing scientific understanding of processes and climatic conditions leading to icing;
- Extend the service life of poles and reduce potential levels of failures;
- Reduce lifetime costs by the appropriate use of alternative materials;
- Improved methodology for determining conductor ratings will provide greater confidence;
- Positive impact on environmental performance and many have positive impacts on safety;

Give Members a better understanding of novel conductors for new-build or re-conductoring lines that gives lower capital cost, minimum visual impact, and environmental acceptance.

Expected Timescale to adoption	Range 2012-2016 Dependent upon project	Duration of benefit once achieved	Range 3-5 years Dependent on project
Probability of Success	Range 49-95% Dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£42,652
Potential for achieving expected benefits	There are a huge variety of projects within the work programme for Module 2. A number of these projects are scientific based and will require further research and development to achieve improvements in operational performance and integration into the Network Operators business environment. Projects in these areas are mainly stages of much larger multi-stage projects and require further work to optimise network design, financial and operational performance from which the customer and stakeholders will benefit Other projects were looking at better ways of improving the operational performance, management and reliability of Overhead Networks, by minimising the impact on the environment and the safety of both the operators and the public, in a manner that could be implemented straight away. Collectively, the work programme demonstrates the development of innovative products, processes and techniques that improve the management of Overhead Networks; in terms of safety, design, environment, reliability, security and power quality. STP has also delivered a number of notable innovations since its inception.		
Project Progress at March 2013	There are many projects in this Module, each at different stages. However, the outputs of the some projects that have already identified potential benefits and opportunities for further innovative technical development work are provided below: S2126, S2174, and S2148: These three projects all relate to overhead line ratings. S2126 (temperature monitoring of conductors) has provided further insight into the probabilistic nature of overhead line ratings, and has improved our understanding of the seasonal variation of ratings compared to the original research carried out in the late 1970's and early 1980's.		

	The results from this work will feed into S2148 (ACE 104 review), with the aim of provided improved guidance for the selection and calculation of overhead line ratings. Complementing both these projects is S2174 (CIGRE participation), where STP project findings contribute to the update of one of the main, internationally recognised standards for overhead line rating calculations (CIGRE TB 207). S2164: The final outcome of this work is revised wind and ice load mapping applicable to overhead lines. Work is currently nearing completion on the development of a software tool allowing this revised mapping to be implemented by line designers. In addition, the ice mapping will now incorporated into the UK NNA of EN 50341 (the European Standard for line design above 1kV). In most cases, the loadings from the revised mapping are less onerous, with the benefit that many lines can be re-furbished/built at lower cost for the same design level of reliability. Updated information can be found at:- https://www.stp.uk.net
Collaborative Partners	Western Power Distribution, CE Electric, UKPN, Electricity North West, Northern Ireland Electricity, Scottish & Southern Energy and Scottish Power
R&D Provider	EA Technology Ltd

Effect of severe ice loads on an 11kV overhead line in winter 2010. STP Module 2 project S2164_1 is looking at designs for future ice accretion and wind loads

PROJECT TITLE	EA TECHNOLOGY – STRATEGIC TECHNOLOGY PROGRAMME EATL STP CABLE MODULE 3 AND FORUM			
Description of project	Research and development into all aspects of Distribution Cables and underground equipment			
Expenditure for financial year	Internal £8,271 External £82,082 **Total £90,353**	Expenditure in previous (IFI) financial years		**Total £739,418**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£394,000**	Projected 2013 – 2014 costs for Western Power Distribution		Internal £8,000 External £82,000 **Total £90,000**
Technological area and/or issue addressed by project	The STP Cable Networks programme aims to optimise underground cable network design, improve operational performance, maximise potential benefits, improve financial performance and minimise risk associated with underground cable networks, whilst having due regard for the environment and energy efficiency. The programme also aimed to prevent cable failure modes and to deliver continuous improvement in terms of safety and environmental performance of all aspects of the underground cable network to meet the individual business requirements of Member Companies. Several of the projects contribute to the industry's knowledge of variation in climate change.			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		14	-8	**22**
Expected Benefits of Project	Projects in this Module will significantly increase the performance and reliability of the cable network. In many cases the cable's life may also be extended. If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO Member of the programme to gain the following benefits, including: • Identifying more suitable grades of sheathing materials to prevent shrinkback of cable sheaths. • Extending the life of cables installed in contaminated ground			

	• A test to determine the remaining life of XLPE and EPR cable circuits enabling better targeting of investment. • Alternatives to current design and installation practices which offer benefits in lower lifetime cost, higher performance (e.g. increased ratings); • Reduce risk in environmentally sensitive areas; • A reduction in the number of accidents / incidents so increasing safety of staff and the public; • Reduce excavation required in locating leaks from fluid-filled cables, reduce the times and costs of leak location, and also reducing outage time; • A reduction in digging, causing less disruption to the public, reducing impact on the environment and avoiding disposal of soil to landfill; • Offset future increases in CAPEX and OPEX; • CI/CML savings per connected customer; • Reduce cable purchase costs; • Enforce Network resilience; • Implement strategies for reducing cable failures, resulting from excessive forces; • Reduction in number of cable faults; • Reduce design costs.		
Expected Timescale to adoption	Range 2012-2013 Dependent upon project	Duration of benefit once achieved	Range 3-5 years Dependent on project
Probability of Success	Range 49 – 100% Dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£42,013
Potential for achieving expected benefits	There are a huge variety of projects within the work programme for Module 3. A significant number of these projects are interlinked with previous projects. The technical development consists of numerous single projects but collectively form part of much larger suite of projects over more than one financial year which require further research and development in order to optimise the financial, operational performance and asset management from which the customer and stakeholders will benefit.		

Potential for achieving expected benefits (Cont)	Other projects were looking at better ways of improving the operational performance, management and reliability of Cable Networks, by minimising the impact on the environment and the safety of both the operators and the public, in a manner that could be implemented straight away. Collectively, the work programme demonstrates the development of innovative products, processes and techniques that improve the management of Cable Networks; in terms of safety, design, environment, reliability, security and power quality. STP has also delivered a number of notable innovations since its inception.
Project Progress at March 2013	There are many projects in this Module, each at different stages. However, the outputs of the some projects that have already identified potential benefits and opportunities for further innovative technical development work are provided below: **S3214: Research & evaluation of the effectiveness of tan delta and polarisation index for condition assessment of ageing cables (stages 1,2 and 4)** • Tests were carried out to evaluate the suitability of both tests on artificially aged XLPE and EPR 11kV cables. By correlating all the results, it shows that Tan δ tests are more suitable and could be useful in the field to predict the remaining useful life of cables in service. • These tests also showed that XLPE performed very well when subjected to accelerated aging. **S3228_1: Determination of the amounts and types of ground contamination which may affect cable sheaths** • The objective is to determine the levels and types of ground contamination which may affect the long term performance of the cable sheath, identify typical amounts of ground contamination that may be encountered in the UK and understand what mitigation options are available. • This will be used to aid design and knowledge of cables systems laid in contaminated ground, reduced cable fault levels, maintain network security and improve overall reliability.

	S3207_1 Shrink-back of Polymeric Over-sheath Materials: Study of Type and Process • The objective is to understand how significant the selection of PE grade is on retraction of the PE over-sheath used in the manufacture of MV and HV cables. This is of great importance to both manufacturers and users of MV and HV cables. • A fault on a single MV or HV circuit caused by shrink back is more costly (in comparison with a single LV circuit) in terms of repair and customer minutes lost. The cost of replacing cable and joints on a single circuit due to a failure could be at least £50k and up to £250k on a 132kV circuit **S3175_1: Bentonite grouts for ducted cable circuits** • Bentonite grouts have been used for many years to improve the thermal resistance of ducted cable circuits. Bentonite is used in differing compositions, all of which affect its thermal resistivity, thermal diffusivity, pumpability, cost, etc. • The objective of this project is to obtain relevant data on different Bentonite grouting compositions to enable cable ratings of ducted circuits to be accurately determined by calculation (CRATER) • There are potential cost reductions from increasing the rating of ducted circuits, by enabling the load to be carried without increasing the cable size. Alternatively duct filling can eliminate the need for system reinforcement. The environmental benefits include reducing digging, causing less disruption to the public and avoiding disposal of soil to landfill Updated information can be found at: https://www.stp.uk.net
Collaborative Partners	Western Power Distribution, CE Electric, UKPN, Electricity North West, Scottish & Southern Energy and Scottish Power
R&D Provider	EA Technology Ltd

PROJECT TITLE	EA TECHNOLOGY – STRATEGIC TECHNOLOGY PROGRAMME EATL STP PLANT AND PROTECTION MODULE 4 AND FORUMS			
Description of project	Research and development into all aspects of Distribution Plant and Protection equipment			
Expenditure for financial year	Internal £3,294 External £62,138 **Total £65,431**	Expenditure in previous (IFI) financial years	**Total £638,129**	
Total Project Costs (Collaborative + external + Western Power Distribution)	**£329,000**	Projected 2013-2014 costs for Western Power Distribution	Internal £5,000 External £63,000 **Total £68,000**	
Technological area and/or issue addressed by project	The STP Substations programme aims to improve operational performance, maximise potential benefits; improve financial performance and minimise risk associated with substation assets, whilst having due regard for the environment and energy efficiency. The projects aimed to provide cost effective solutions to increase reliability and deliver continuous improvement in terms of safety and environmental performance of existing and future substation assets, to meet the individual business requirements of Member Companies.			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		17	-9	**26**
Expected Benefits of Project	Projects within this Module have been cost effective and help improve reliability and safety of substations in distribution networks in line with government policy. If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO Member of the programme to gain the following benefits, including: • Increased reliability and continuous improvement in terms of safety and environmental performance of existing and future substation assets;			

	• Collaborative evaluation of battery installations and operational practice to ensure a safer and more reliable network; • CI/CML savings per connected customer; • Optimising safety and environmental requirements for management of insulating oils and SF6; • Technical liaison with International Utilities to share new technology and failure modes; • Offset future increases in CAPEX and OPEX; • Development of condition based assessments, or tests, to determine asset condition; • Preventing failures of oil-filled equipment, tap changers, earth switches will improve safety and avoid unnecessary scrapping of serviceable components, which will alleviate environmental impact; • Extend serviceable life of switchgear and transformers; • Further develop technical understanding of protection system maintenance requirements; • Understand the degradation and failure processes of substation plant and equipment, and quantify the risks associated with those processes, • Further develop technical understanding of operational staff in complex electrical issues; • Mitigate risk to environment; • Increased safety of staff and public by reducing risk of fire and the number of accidents / incidents. • Reduce lifetime costs and improve functionality by the appropriate use of new technology.		
Expected Timescale to adoption	Range 2012-2015 Dependent on project	Duration of benefit once achieved	Range 1-6 years Dependent on project
Probability of Success	Range 30 – 95% Dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£32,721

Potential for achieving expected benefits	There are a huge variety of projects within the work programme for Module 4. A significant number of these projects are scientific based, researching technical developments in degradation and understanding the failure processes of substation plant and equipment, whilst quantifying the risks associated with those processes. Projects in these areas are mainly single stages of much larger multi-stage projects which require further research and development of condition based assessments, and/or tests, asset management tools, systems and methodologies in order to optimise the financial, operational performance and design of Substation plant from which the customer and stakeholders will benefit. Other projects were looking at better ways of improving working, the performance and reliability of Substation plant, maintenance regimes, minimising the impact on the environment and the safety of both the operators and the public for Asset Managers, in a manner that could be implemented straight away. Collectively, the work programme demonstrates the development of innovative products, processes and techniques that improve the management of Substation assets; in terms of safety, design, environment, reliability, security and power quality. STP has also delivered a number of notable innovations since its inception.
Project Progress at March 2013	There are many projects in this Module, each at different stages. However, the outputs of the some projects that have already identified potential benefits and opportunities for further innovative technical development work are provided below: S4255_2: • The study has identified Tear Index (tear strength divided by paper grammage) offers an alternative to the use of degree of polymerisation values that is a cost effective and reliable method of identifying the transformer paper condition.

Project Progress at March 2013 (Cont)	S4278_1 • Technical Evaluation of Products used in the Maintenance of Electrical Plant and Equipment • Current greases and lubricants are far from ideal • Sole use of one type of lubricant is common practice in indoor substations, historical greases have not always delivered the life expectancy or performance expected S4302_1 • Researching Market Solutions for the Repair of Epoxy Based Solid State Insulation for Electrical Switchgear up to and Including 132kV • Effective repairs do not exist for damaged resin bushings ideal would be to find a process that effective and prolongs the life of the bushing S4296_1 • Power Transformer Mid Life Refurbishment • With current OFGEM drivers to increase the use of transformer refurbishment and regeneration, evaluation of services is required and the best options available to extend the life. Updated information can be found at: https://www.stp.uk.net
Collaborative Partners	Western Power Distribution, CE Electric, UKPN, Electricity North West, ESB Networks, Scottish & Southern Energy and Scottish Power
R&D Provider	EA Technology Ltd

PROJECT TITLE	EA TECHNOLOGY – STRATEGIC TECHNOLOGY PROGRAMME EATL STP NETWORKS FOR DISTRIBUTED ENERGY RESOURCES MODULE 5			
Description of project	Research and development into all aspects of Network design and management to enable an increased connection of distribution energy.			
Expenditure for financial year	Internal £5,195 External £57,562 **Total £62,757**	Expenditure in previous (IFI) financial years		**Total £526,943**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£293,000**	Projected 2013 – 2014 costs for Western Power Distribution		Internal £5,000 External £60,000 **Total £65,000**
Technological area and/or issue addressed by project	The STP Networks for Distributed Energy Resources programme aims to maximise potential benefits and reduce costs and risks associated with facilitating the design, development and operation of networks for the integration of low carbon technologies into future network designs, whilst having due regard for the environment and energy efficiency. The programme also aims to cost-effectively improve the operational efficiency and business performance of Member Companies within prevailing regulatory constraints.			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		14	-8	**22**
Expected Benefits of Project	Projects within this module have been cost effective and help improve reliability and safety of generation connection in distribution networks in line with government policy. If the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain benefits including: • Investigate distributed generation connection methods without undue reinforcement, while at the same time improving supply quality by reducing CMLs and voltage unbalance;			

	• Positive impact on environmental performance and many have positive impacts on safety; • Increased understanding between all Member Companies on technical, commercial and regulatory issues and to develop effective solutions to these issues; • Developing understanding of the implications of connecting low carbon technologies to the distribution network in terms of safety, design, reliability, security and power quality; • Where possible, try and optimise the Government's low-carbon strategy and accommodate the likely growth of DG; • Improved management of the implications of connecting distributed resources to the distribution network in terms of the statutory, regulatory and commercial frameworks; • Investigating low carbon network designs and plan transition from passive to active networks; • Improve power quality issues due to dynamic load change; • Enabling the development of strategies to manage PQ levels and customer expectations; • Reduction in losses for DNOs; • Highlight the issues and benefits of Smart Grids, Smart Meters and Active Network Management Systems, ultimately improving CMLs; • Significant benefits in terms of enhanced knowledge and awareness of overseas best practice in DG system integration, which can be applied, as appropriate in the UK; • Ensure that all participants optimise network design, financial and operational performance as the levels of storage, managed-demand and distributed generation increase on the distribution networks; Developing and emerging distributed generation, demand-side management, storage technologies.		
Expected Timescale to adoption	Range 2012-2014 Dependent on project	Duration of benefit once achieved	£28,841

Probability of Success	Range 51 – 100% Dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£28,841
Potential for achieving expected benefits	There are a huge variety of projects within the work programme for Module 5. A number of these projects are scientific based and will require further research and development to achieve improvements in operational performance and integration into the Network Operators business environment. Projects in these areas are mainly stages of much larger multi-stage projects and require further work to optimise network design, financial and operational performance from which the customer and stakeholders will benefit. Other projects are looking at better ways of improving working and productivity for network planners, in a manner that could be implemented straight away. Collectively, the work programme demonstrates the development of the technical understanding in relation to connecting and integrating low carbon technologies onto the distribution network; in terms of safety, design, reliability, security and power quality. STP has also delivered a number of notable innovations since its inception.		
Project Progress at March 2013	This year has seen a number of projects delivered that are based on a common overall theme of fault level management. These projects include work on through fault withstand of cables and overhead lines, and a sensitivity analysis on the effects that network modelling inaccuracies may have on determining the overall fault performance of the network. These projects will help to shape our future standards in this area and ensure a consistent approach amongst all DNO's. A project looking at the operation of generation in a voltage control mode will allow us to connect further generation into areas where conventional connections are not available due to voltage rise problems. A solar farm is due to be connected later this year using this technique which has resulted in a significant reduction in connection costs when compared to conventional reinforcement. Once proven and adopted this could create additional capacity for 11kV generation connections in areas which are already constrained due to existing generation.		

	Another project is looking at recommendations for future LV network design standards that will make new LV networks more capable of supporting new technologies such as the connection of generation, Heat pumps and electric vehicle charging. Projects that look at network loading including cold load pickup, standardising definitions of firm capacity, and assessing demand based on weather conditions will enable a more measured and consistent approach to our Planning Load Estimates and Load indices. Updated information can be found at: https://www.stp.uk.net
Collaborative Partners	Western Power Distribution, CE Electric, UKPN, Electricity North West, ESB Networks, Northern Ireland Electricity, Scottish & Southern Energy and Scottish Power
R&D Provider	EA Technology Ltd

PROJECT TITLE	EA TECHNOLOGY – PARTIAL DISCHARGE PROJECT AND FORUM		
Description of project	Research and development into all aspects of partial discharge in distribution equipment.		
Expenditure for financial year	Internal £3,893 External £6,875 **Total £10,768**	Expenditure in previous (IFI) financial years	**Total £416,947**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£515,146**	Projected 2013-2014 costs for Western Power Distribution	Internal £4,000 External £7,000 **Total £11,000**
Technological area and/or issue addressed by project	The projects undertaken address real problems identified by the group members as significant and which require technical investigation and development. Projects are aimed at providing: • Improved management of assets through better understanding of Partial Discharge through targeted investigative research and development work, • Reduced fault rates by early detection of insipient faults • Improvements in Safety Demonstration of cost effective permanent partial discharge condition monitoring and measurement systems using Transient Earth Voltage and Ultrasonic detection techniques.		

Type(s) of innovation involved	Technical Substitution/ Incremental	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		15	-7	**22**

Expected Benefits of Project	Partial discharge is becoming an essential technique when assessing failure probabilities in both an aging population of traditional distribution assets and certain new equipment, which has been found to have less tolerant insulation mechanisms. Early detection of faults allows controlled remedial action and provides: • Financial benefits derived from the reduction in fault repairs

Expected Benefits of Project (Cont)	• Improved network performance and operator safety • Improved quality of supply for customers In addition the PD user group allows information to be shared to; increase confidence in interpretation of results, assist in the development of operational practice, influence functionality and ergonomics of future instrument design.		
Expected Timescale to adoption	2010	Duration of benefit once achieved	10 Years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£46,829
Potential for achieving expected benefits	The demonstration installations have already been successful, with investigations at several sites where significant partial discharge was detected. This directly lead to remedial action to rectify deterioration, which if left unchecked would have caused permanent damage to the switchgear. Indications are that this project will deliver the expected benefits.		
Project Progress at March 2013	**Substation Wiki** The Substation Wiki is a Wikipedia type website of information containing useful user contributed information on PD related issues for various switchgear types. It is private to members of the PD User Group. Work has been ongoing this year and the wiki has grown to over 700 articles on various types of switchgear. The wiki also contains historic PD User Group minutes dating back over 10 years and is a valuable source of information. **Surface Tracking** This is an on-going project to gain further understanding of surface discharge activity in order to predict end of life of switchgear. Several samples of different cast resin insulation have been taken to failure whilst carrying out time lapse photography, TEV and Ultrasonic measurements in order to help members understand the correlation between the TEV and Ultrasonic readings and the physical condition of the insulation. This will aid in determining intervention strategies when dealing with surface partial discharge.		

Project Progress at March 2013 (Cont)	**Best Practice Guide** Work has been ongoing over the year to produce a 'Best Practice Guide' to carrying out partial discharge testing and using the information obtained to maximise business benefits. This guide was formed on the basis of the best practice questionnaire carried out in 2012-2011. The document is a guide that encompasses the best current practice for obtaining and verifying PD activity with suggestions and guidance for making best use of the data to minimise, costs, risk to the business and aid in condition based asset management. Significant work has been done on the guide which has been issued in draft form for review. Work is expected to continue on the guide with a final version issued within the next 12 months. The demonstration trial of the EATL Partial Discharge alarm units, which remotely monitors the partial discharge activity at eighteen 33kV and 11kV substation sites across Western Power Distribution, is continuing. The following projects have also been undertaken during 2012-2013 through the user group and forum run by EA Technology **Review of UltraTEV Detector** Through feedback from member companies it was found that a number of companies had a large number of PD "red lights" to deal with. EA Technology are working with the PD user group via to help alleviate the number of false alarms, through an UltraTEV detector training guide was issued that can be used to increase operator awareness of the correct use of the instrument, improvements in the instrument and the best practice guide. This should help member companies to focus their efforts on abnormal readings that warrant further examination.

Collaborative Partners	**IVIO Circuit Breaker Examination** An IVIO type circuit breaker removed from the field with PD activity was tested and stripped down at EA Technology's HV laboratory to help members understand the cause and severity of the PD activity. This type of work helps members understand the severity of partial discharge within common equipment types and can influence the strategy of dealing with older equipment with PD issues. **Surge Arrestor Testing** Testing and examination of surge arrestors removed from the field with high levels of partial discharge was carried out. This helped to establish the cause of partial discharge within a relatively new piece of equipment and can be used my member companies to influence purchasing and installation of surge arrestors. **PD Database** The PD database contains historical data which is of critical importance in interpreting PD results. This year it has undergone a large update and has doubled in size to over 20,000 records. Work has been on-going to move the database onto the internet and it is now available online for member companies to use.
R&D Provider	Western Power Distribution, AWE, CE Electric, CLP Hong Kong, UKPN, Energy North West, ESB Networks, Guernsey Electricity, Manx Electricity Authority, MoD, Northern Ireland Electricity, Scottish and Southern Energy, Scottish Power and Singapore Power

PROJECT TITLE	EA TECHNOLOGY – PROTECTIVE COATINGS FORUM			
Description of project	Research and development into all aspects of protective coatings on distribution equipment			
Expenditure for financial year	Internal £1,356 External £7,093 **Total £8,449**	Expenditure in previous (IFI) financial years		**Total £52,517**
Total Project Costs (Collaborative + external + Western Power Distribution)	**£42,500**	Projected 2013-2014 costs for Western Power Distribution		Internal £2,000 External £7,500 **Total £9,500**
Technological area and/or issue addressed by project	The projects undertaken address real problems that have been identified by the forum members as significant and which require technical investigation and development. Projects are aimed at providing: • Cost effective protective coatings for distribution equipment either by reducing operating costs or capital investment. • Reduction of the environmental impact of associated activities to comply with CEPE (Guide to VOC Reduction in Protective Coatings) in preparation for EC National Emissions Ceiling Directive. Improvements in safety and applications.			
Type(s) of innovation involved	Incremental/ Technological Substitution	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		12	-6	**18**
Expected Benefits of Project	Development of a Volatile Organic Compound (VOC) compliant paint system that performs at least as well as the currently used solvent based systems on towers and other structures. This will ensure a smooth transition to environmentally friendly paint systems in accordance with the anticipated legislation. The various other tests and trials will have benefits in the particular area that is being addressed.			
Expected Timescale to adoption	2010-2012 Dependent on adoption of legislation	Duration of benefit once achieved		3-10 Years

Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£25,533
Potential for achieving expected benefits	The project costs are at an early stage and the project costs not always reflect the likely full costs of implementation. These will be identified providing the outcome of the projects is positive.		
Project Progress at March 2013	EA Technology Ltd has continued to maintain paint batch testing records with on-going testing of paint samples delivered from site from members. This process in in place to ensure that quality control is maintained with the existing approved coating supplier Assessment made of two more potential paint suppliers including initial testing and factory visits. It is anticipated that further assessment of Pronto and HMG will continue in 2013-14 with a view to adding them to the approved supplier list, should they meet the approval criteria.		
Collaborative Partners	Western Power Distribution (Midlands), CE Electric, EDF Energy, Electricity North West, National Grid, Scottish & Southern Energy and Scottish Power		
R&D Provider	EA Technology Ltd		

Application of the first yellow coat, of a two coat painting system, to the de-energised side of a 132kV tower.

WESTERN POWER DISTRIBUTION

INNOVATION