WESTERN POWER DISTRIBUTION

INNOVATION

INNOVATION FUNDING INCENTIVE

REGULATORY REPORT 2014/15

Foreword

Welcome to Western Power Distribution's Innovation Funding Incentive Annual Report for 2014/15.

At Western Power Distribution we always seek to find better ways of working and our track record of innovation and change has helped us continually improve the way we deliver our services to customers. The challenge of operating a robust, sustainable network whilst meeting the increasing demands from Low Carbon Technologies and Distributed Generation will call for Network Operators to become more creative and develop a new sophisticated and responsive network.

The uncertainty of the predicted uptake of these technologies will require a flexible approach which can accommodate these changes when they arise. By carrying out a wide portfolio of innovative projects which build upon what we have already learnt and incorporating successful developments from other DNOs, we can ensure the network will meet all future needs and we will maintain our position as the leading performer in network availability and customer service.

The IFI programme has funded a significant number of successful developments over the past decade, which have steadily been embedded into our core business, providing direct customer benefits such as increased network performance and reduced connection times. Further innovation mechanisms under RIIO-ED1, will allow innovation to remain a fundamental foundation in how we adopt new technology and develop our operational practices.

We continue to work together with a wide range of partners across the industry, ranging from small and medium enterprises, universities through to large multi-national companies to develop our knowledge and drive innovation forwards. By sharing research and transferring technology from adjacent industry sectors, we can reduce costs for all our customers whilst delivering an improved network for the future.

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) was continued throughout the last Distribution Price Control Review, which ended on 31st March 2015 (DPCR5). The success of the IFI mechanism and Ofgem's continued commitment to innovation 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 2014 to 31 March 2015, 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 was intended to promote research and development activities within distribution network companies. It provided funding for technical development projects that would 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 could embrace any aspect of distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning. As defined by the industry Good Practice Guide G85/2, a DNO could spend up to 0.5% of its Combined Distribution Network Revenue on eligible IFI projects. The DNO was 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 was set at 80%.

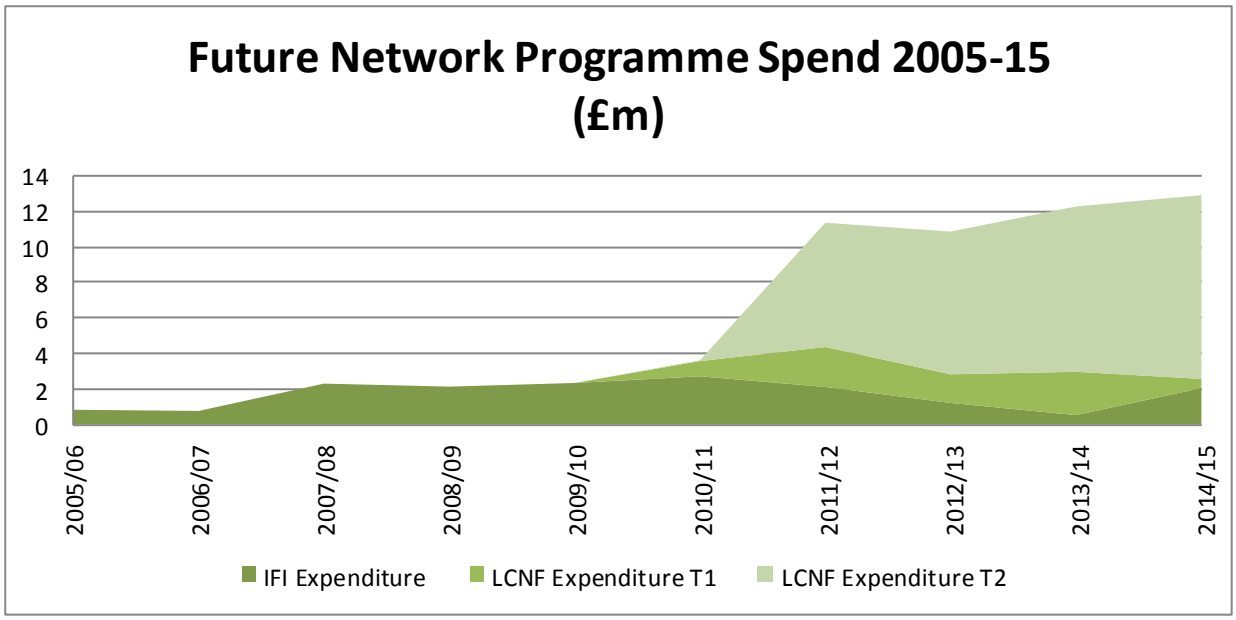
The IFI mechanism was formally closed on 31st March 2015 at the end of DPCR5.

1.2 Low Carbon Networks Fund (LCNF)

From 2010, and through to early 2015, Ofgem established the Low Carbon Networks Fund (LCNF) which was 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 contained three elements; large scale projects funded through a competitive process (tier 2); smaller scale projects that were self-certified (tier-1) and a discretionary reward where Ofgem would 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 6 of the 24 (25%) of these larger projects being awarded to WPD. Similarly of the smaller Tier 1 projects developed under LCNF, WPD is running 29% of them.

Due to the increased focus of LCNF, from 2011 there was a consequential reduction in IFI spend and many projects were funded through LCNF that would have previously fallen under the remit of IFI. With the transition into the new RIIO-ED1 price control review period, the LCNF allowances have been closed and the NIA and NIC elements introduced. There has been an increased spend under IFI during 2014/15 in line with the accelerated completion of a number of projects to avoid the need to transition and also some low TRL projects have had development brought forward to ensure their eligibility under the future NIA mechanism. In line with previous years, the overall spend across the innovation programme has steadily grown year on year, as the following chart demonstrates.



1.3 End of Year Report

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

Regulatory report for IFI
Reporting year 2014/15

Western Power Distribution
Innovation Funding Incentive (IFI)

		South West	South Wales	East Mids	West Mids	Total
IFI Carry Forward	£m	0	0	0	0	0
Eligible IFI Expenditure*	£m	0.496	0.277	0.555	0.554	1.883
Eligible IFI Internal Expenditure	£m	0.039	0.023	0.046	0.046	0.155
increase over previous reporting year	%	285%	255%	258%	258%	264%
Network Revenue by License Region	£m	271.65	352.16	450.14	461.36	1535.3
Number of Eligible Projects		31	31	31	31	31
Portfolio NPV of Benefits	£m	16.910	9.443	18.924	18.892	64.169

**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 7.8 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 largest 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 has been delivered through a range of funding sources including the Low Carbon Networks Fund (LCNF), along with the IFI mechanism and will continue to deliver innovation through the NIA and NIC mechanisms in the future. These targeted initiatives allow us to develop ideas at an early stage of realisation, through to large scale demonstration projects and allow us the mechanism to embed successful innovation into the main business. The output from these schemes influenced the development of our business plans for the ED1 RIIO price control.

Our IFI projects have facilitated the integration of new technologies in the network, aided improved management of existing assets and developed 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 has balanced 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 2014/15 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).

ABB - is the largest supplier of industrial motors, drives and power grids worldwide, supplying around £1bn of power and automation solutions, products and services annually in the UK to a wide range of sectors.

Alpha Construction Ltd - is a civil engineering and building contractor, formed in 1982, focused on providing safe, sustainable, cost effective solutions to clients across the UK.

AND Technology Research - is an independent privately owned company founded in 1980, comprising of multidisciplinary engineers experienced in electronics, embedded systems application software, user interface and product design.

CGI - is a global business with 68,000 professionals in 40 countries across the Americas, Asia-Pacific and Europe who provide end-to-end IT and business process services.

Converter Technology Ltd - is a Reading-based design consultancy of experienced electronics engineers founded in 2006 with the purpose of enabling companies to rapidly integrate modern, energy efficient, switched-mode power conversion into their products.

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.

DNV GL - is a world-leading consulting, testing and certification company that provides a number of services to the global energy sector.

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 - was 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

EDF Energy - is one of the largest energy companies in the Uk, supplying around 6 million residential and business accounts with electricity or gas and producing around 20% of the nation's electricity.

Element Energy - is a dynamic and growing strategic energy consultancy, specialising in the intelligent analysis of low-carbon energy for clients in the transport, power generation and building sectors.

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 - supplies substation monitoring systems, such as the sub.net range, which incorporates wide range monitoring and recording functionality for use in the electricity industry.

EPSRC - (Engineering and Physical Sciences Research Council) is the UK's main agency for funding research in engineering and the physical sciences, investing around £800 million a year in research and post-graduate training, to help the nation handle the next generation of technological change.

ETI - (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.

FTS - (Future Transport Systems) has delivered some of Europe's leading EV related projects including major EV fleet trials, infrastructure strategies, business case and technology development and deployment.

Haysys - is an electronic design company that focuses on a wide variety of commercial, industrial and defence applications. They provide turnkey solutions for a wide range of developments – from the concept/specification stage right through to final production and on-going support.

IET - (Institute of Engineering and Technology) is one of the world's largest engineering institutions with 160,000 members in 127 countries.

Locamation - created the SASensor platform, a grid management system which helps to improve information and network visibility on distribution assets.

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

NPL - (National Physical Laboratory) is the UK's National Measurement Institute, and is a world-leading centre of excellence in developing and applying the most accurate measurement standards, science and technology available.

Portastor - is a market leader in the supply of integrated factory-built equipment housings. For more than 40 years, it has been manufacturing bespoke E-Houses for a range of Industries including Oil and Gas, Rail, Power, Nuclear, Communications and Data Centres.

Psymetrix - is a leading provider of synchrophasor-based wide area management systems, services and support for the energy industry.

Regen SW - is an independent not for profit that uses its expertise to work with industry, communities and the public sector to revolutionise the way we generate, supply and use energy.

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.

Selex - an international leader in electronic and information technologies for defence systems, aerospace, data, infrastructures, land security and protection and sustainable solutions.

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.

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.

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.

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.

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

Toshiba - Toshiba's Energy & Infrastructure Group is a leading supplier of power transmission and distribution systems that deliver electricity to homes commercial facilities and other users; rechargeable batteries for the efficient storage of energy; and smart grids, next-generation energy distribution systems combining power infrastructure with communications infrastructure.

TTP - (The Technology Partnership) a world-leading technology and development organisation.

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 following table details the expenditure during the April 2014 - March 2015 IFI reporting period. Internal expenditure has varied considerably between projects. The total internal expenditure is 8% of the total eligible IFI expenditure.

Project Title	External Costs	Internal Costs
Identification and Prioritisation of Network Losses	£50,000	£1,410
Sensor Networks (Smart Dust)	£7,699	£217
WPD South West Distribution Network Strategy Development	£155,000	£5,774
Network Finger Printing	£18,500	£1,049
Project Galaxy - Network Analytics	£65,250	£3,290
Domestic Demand Response Network Study	£60,000	£2,192
Phasor Measurement Trial	£0	£8,178
Smart Grid Design	£19,528	£551
Reactive Power compensation for distribution network	£13,700	£862
Technical assessment of Power Quality issues	£71,201	£5,283
CuTS LV Overhead Line Project	£0	£2,168
Power Networks Research Academy	£6,788	£1,128
Active Fault Current Management	£92,144	£2,599
Islanding Identification using Phasor Measurement	£65,067	£1,835
Distributed Intelligence Proof of Concept	£225,324	£20,565
PSR Scout	£73,334	£2,069
Half Hourly Metered Customer Archetypes	£60,165	£16,937
Phase ID Tool	£223,337	£15,139
South Wales Voltage Reduction Analysis	£33,740	£952
Willenhall Energy Park	£75,042	£7,700
Offset Connection Feasibility	£35,101	£990
Aerial Fault Detection Technology Review	£17,038	£5,176
Vehicle to Grid Phase 1 - Laboratory Trial	£203,386	£7,781
Improved Condition Assessment of Primary/Grid Substations	£14,000	£395
ENA R&D Group Programme	£16,907	£2,794
EATL STP Overhead Line Module 2 and Forum	£50,629	£6,199
EATL STP Cable Module 3 and Forum	£90,508	£6,890
EATL STP Plant and Protection Module 4 and Forums	£109,196	£5,249
EATL STP Networks for Distributed Energy Resources Module 5	£16,417	£15,857
EA Technology - Partial Discharge Project and Forum	£6,650	£2,356
EA Technology - Protective Coatings Forum	£7,295	£1,073
Total Costs Shared	**£1,882,944**	**£154,657**

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 proving useful to the business. Highlights include:

- The Network Finger Printing project has given recommendations into how a template approach can be applied to harmonic analysis for distribution networks.
- The Identification and Prioritisation of Network Losses project has now completed. 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. It also forms a fundamental part out WPDs losses strategy and will inform both design and operational practices.
- A study into the potential of demand response in areas of high solar generation conducted by Smarter Grid Solutions has compounded learning from earlier IFI projects and further evaluated the cost benefits achieved through various demand response mechanisms. This learning will in turn be fed into future NIA projects, such as Sunshine Tariffs
- The PSR Scout has been developed to enable immediate identification of interruptions at a customer's property. This will help us to provide support for customers on the Priority Service Register.
- The Distributed Intelligence Proof of Concept has trialled an advanced prototype of substation monitoring, which can be updated remotely to undertake configurable analysis directly on the monitored data at source. This will reduce the required data flows and communications bandwidth, whilst still obtaining meaningful observations from the electrical network. This could aid the detection and locating of network excursions, harmonic distortions and non-technical losses.

7. Future Intentions

Under the RIIO (Revenue = Incentives + Innovation + Outputs) model for price controls, Ofgem has introduced an innovation stimulus consisting of three measures: Network Innovation Allowance (NIA), Network Innovation Competition (NIC) and Innovation Roll-Out Mechanism (IRM).

The NIA and NIC are successors to the Low Carbon Networks (LCN) Fund and broadly replicate the structure of the LCN Fund. The scope of the NIC is broader than the Second Tier Funding of the LCN Fund as it also includes Development as well as Demonstration Projects, whilst the NIA also builds upon elements of the Innovation Funding Incentive (IFI) that was in place under previous price controls.

With the transition into the new RIIO-ED1 price control review period, the IFI and LCNF allowances have been closed and the NIA and NIC elements introduced. In line with previous years, the overall spend across the innovation programme will be steadily grown, year on year.

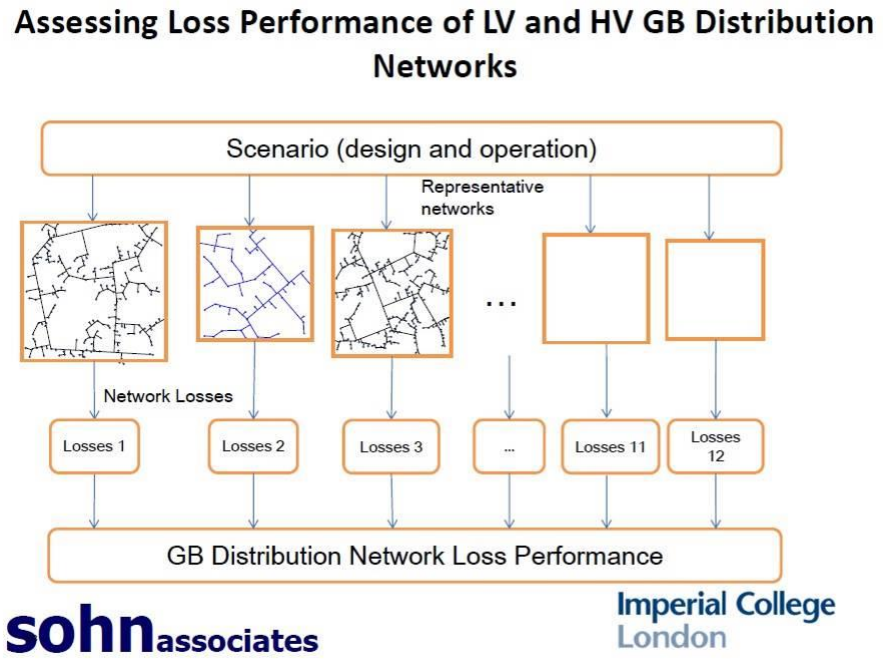
During 2015/16, WPD will continue to develop projects through the Future Networks Programme guided by our Innovation Strategy.

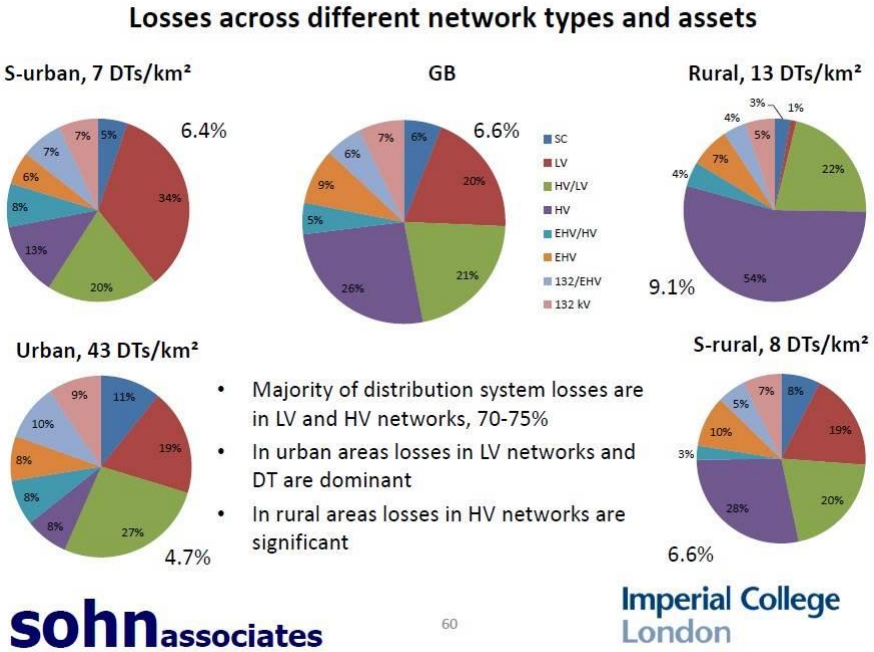
8. Individual Project Reports for Period April 2014 - March 2015

The following pages contain the Individual Project Reports for IFI projects undertaken by Western Power Distribution during the 2014/15 regulatory year.

<table>
<tr><td>Project Title</td><td colspan="4">Identification and Prioritisation of Network Losses</td></tr>
<tr><td>Description of project</td><td colspan="4">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.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,410
External £ 50,000
Total £ 51,410</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 128,777</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 289,387</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ 150,000
External £ 750,000
Total £ 900,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Network Losses and Power System Modelling. The project also uses “smarter” intervention solutions within the power system model.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution / Significant / Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>0</td><td>11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2015</td><td colspan="2">Duration of benefit once achieved</td><td>30 Years</td></tr>
<tr><td>Probability of Success</td><td>70%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£188,207</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">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.</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="4">The final project written report was issued in mid-2014 and has identified a number of key findings which have enabled a number of recommendations to be made for the reduction of losses during the ED1 period. Many of the identified recommendations have been developed into WPD’s losses strategy.</td></tr>
</table>

Collaborative Partners	UK Power Networks
R&D Provider	SOHN Associates (Project management); Imperial College London (Technical analysis)





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 £ 217 External £ 7,699 Total **£ 7,916**	Expenditure in previous (IFI) financial years	Total **£ 230,099**	
Total Project Costs (Collaborative + external + Western Power Distribution)	**£ 617,637**	Projected 2015 - 2016 costs for Western Power Distribution	Internal £ Nil External £ Nil Total **£ Nil**	
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 • 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).			
Type(s) of innovation involved	radical	Project Benefits Rating	Project Residual Risk	**Overall Project Score**

		13	-2	**15**
Expected Benefits of Project	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.			
Expected Timescale to adoption	2013	Duration of benefit once achieved		10 years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success		£ 500,000
Potential for achieving expected benefits	The project theory is sound and should achieve the expected benefits if the technological and manufacturing obstacles can be overcome.			
Project Progress at March 2015	Following extensive testing and development, manufacturing difficulties have been overcome and equipment has been supplied from the R&D provider. This equipment has been tested on the distribution overhead network to assess the effectiveness of the product and kept in-situ to monitor for overhead conductor faults. Whilst the concept for this product is sound, various manufacturing difficulties and technological challenges have slowed the development of the device. Further work will be required on this device before it can be deployed widely across the network and achieve the full range of benefits envisaged in the initial concept. This product will be reviewed along with other similar technologies to decide on future development to reach a TRL required for DNO deployment.			
Collaborative Partners	Scottish Power			
R&D Provider	Willow Technologies and E.ON New Build & Technology			

<table>
<tr><td>Project Title</td><td colspan="4">WPD South West Distribution Network Strategy Development</td></tr>
<tr><td>Description of project</td><td colspan="4">The electrical distribution network in the South West of England has been increasingly challenged in recent years with both reducing demand and significant step-changes in the level of embedded generation at all voltage levels from LV to 132kV. This generation ranges from diesel, biomass, and waste power plants on standard connection or short-term reserve contracts, to a large number of onshore wind farms and significant levels of green-field and domestic PV installations.

WPD South West is seeking the development of an innovative network master plan using a whole-network approach in order to accommodate the large level of PV generation into its distribution network in the coming years. This will take learning from transmission systems and emergent technology and commercial solutions to inform network development, taking into account short-term tactical solutions, as well as appropriate long-term strategic options with minimal stranding risk.

A two-phase system study detailed below will be delivered in order to meet the requirements:

• Phase 1 - Distribution System Performance Review
• Phase 2 – Network Strategy Reinforcement Options Development</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 5,774
External £155,000
Total £ 160,774</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 48,738</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 209,512</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Whole-network analysis approach in order to develop strategies to accommodate large levels of PV generation</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>12</td><td>-4</td><td>16</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Creation of up to date network model including generation connections
• Provide adequate headroom for future distribution network development
• Assessment of new technology applications
• Network Reinforcement Options Study</td></tr>
</table>

Expected Timescale to adoption	2015	Duration of benefit once achieved	30 Years
Probability of Success	60%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£817,171
Potential for achieving expected benefits	Potential for developing outputs is high. The project is mostly around network studies so the technical risk is low.		
Project Progress at March 2015	The completed analysis on this project has identified the potential benefits of employing various innovative techniques across the South West distribution network to unlock further capacity and quantified the possible capacity available. Using these desktop study results, further detailed analysis is now being undertaken by WPD planning teams to assess the viability of deploying Quadrature boosters, Static compensators, extra grid supply points and other innovative solutions where highlighted in the report.		
Collaborative Partners	None		
R&D Provider	TNEI		

Project Title	**Network Finger Printing**		
Description of project	Electricity distribution networks may sometimes be required to absorb harmonic current emissions from equipment that is connected to it. As these current emissions travel through the electricity distribution network they will distort the shape of the voltage waveform that is supplied to network customers. The amount of distortion inflicted upon the voltage waveform by the harmonic current emissions is a function of both the magnitude of the current harmonics but also the frequency response of the distribution network. The frequency response of the distribution network can have a particularly large influence upon this problem as it is possible for resonant conditions to exist within the network which will serve to amplify distortion across a wide area of the distribution network. By understanding the frequency response of their network a network owner will be able to make more informed decisions during the planning process of new connections to the system. Western Power Distribution will work with DNV GL to develop a process that allows calculation of changes in Harmonic Distortion on their 33 kV network using fixed tables.		
Expenditure for financial year	Internal £ 1,049 External £ 18,500 **Total £ 19,549**	Expenditure in previous (IFI) financial years	**Total £ 16,322**
Total Project Costs (Collaborative + external + Western Power Distribution)	£ 35,871	Projected 2015 - 2016 costs for Western Power Distribution	Internal £ Nil External £ Nil **Total £ Nil**
Technological area and / or issue addressed by project	Harmonic currents flowing through a distribution system will create harmonic distortion by virtue of the fact that they will flow through network impedance. The magnitude of this network impedance will be influenced by the series and parallel combinations of inductive or capacitive reactance presented by the wider network. Because these values of individual reactance will differ over the range of harmonic frequencies the magnitude of overall network impedance will vary across the harmonic frequency range. This is because these different combinations of reactance move in and out of resonance across the harmonic frequency range. It will therefore be understood that the use of a frequency sweep methodology allows the network owner to understand the likely frequency response of their network to the injection of harmonics. Furthermore by making suitable allowances for the natural damping of these resonances inherent in the overhead lines and transformers of the distribution network then a more accurate estimate of the magnitude of the harmonic impedances can be obtained. These harmonic impedances can be then used to calculate the resultant voltage distortion at the point of current injection.		

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>9</td><td>-2</td><td>11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">This project will clearly detail the network's characteristics. Generation Developers will then have a much better understanding on how their development will impact the network, the amount of studies they will need to undertake and a understanding if harmonic filtering may be required.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 Year</td><td colspan="2">Duration of benefit once achieved</td><td>5 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>£18,877</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The project has a 60% change of achieving its expected project benefits.</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="4">This project has identified the key factors in understanding the frequency response of their network, allowing a network owner to make a more informed decision during the planning process of new connections to the system.

Recommendations from this project on the use of linear versus non-linear models for harmonic analysis will be taken forward and developed further to provide a template approach for studying particular networks.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">None</td></tr>
<tr><td>R&D Provider</td><td colspan="4">DNV GL</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5">Project Galaxy - Network Analytics</td></tr>
<tr><td>Description of project</td><td colspan="5">As substation monitoring increases on the network, so does the amount of data being gathered. However, it is often difficult to identify the significant information from the data using manual analysis techniques.

This project is a feasibility study to determine if specific consumer electrical load profiles can be identified in an overall load profile of a suburban environment such that the specific profiles can be identified to a specific feeder and phase.

There are two phases of the project, the first to create a profile of the specific load and the second to electronically embed that into some real data collected from a typical substation installation and to determine if the specific load profile can be located.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 3,290
External £ 65,250
Total £ 68,540</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 22,160</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 100,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Development of distributed substation intelligence, paired with monitoring algorithms to detect specific network conditions.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>8</td><td>-5</td><td colspan="2">13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• Improved data manipulation
• Identification of specific load signatures
• Improve network visibility</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2015</td><td colspan="2">Duration of benefit once achieved</td><td>30 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">60%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£2,772</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">Potential for developing outputs is high. The project is mostly around building analytical tools on existing substation monitoring solutions so the technical risk is low.</td></tr>
</table>

Project Progress at March 2015	Following testing of this device, there is sufficient evidence that it would be able to detect even relatively small loads of particular equipment embedded within typical substations loads. It has also been found that by looking for a repeating pattern of certain electrical signatures, the detection accuracy can be improved and thus reduce the false alarm levels. Further work is being undertaken with stakeholders to assess the likely applications.
Collaborative Partners	EDF, Selex
R&D Provider	TTP

<table>
<tr><td>Project Title</td><td colspan="5">Domestic Demand Response Network Study</td></tr>
<tr><td>Description of project</td><td colspan="5">Although the potential of domestic DSM technologies to release network capacity may be significant, its future value is not yet well understood and quantified. This project is intended to enable WPD to quantitatively evaluate the opportunity of using flexible domestic demand and identify potential strategies to leverage DSM benefits, and provide insight into the impact of future technical, market and regulatory frameworks in the medium to long term, before committing to the expense of a significant trial or demonstration project.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 2,192
External £ 60,000
Total £ 62,192</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 28,955</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£91,147</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Potential scale of domestic demand response through control of space storage heating and hot water heating.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>13</td><td>-2</td><td colspan="2">15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Domestic Demand-Side-Management (DSM) could provide a number of benefits to Distribution Network Operators (DNOs), including deferring network investment, aiding network outage management or increasing the amount of distributed generation that can be connected to the existing distribution network infrastructure. By scheduling flexible load to coincide with the time of minimum demand, the generation hosting capacity of the network, as calculated using worst-case conditions, can be increased and more generation connected. Conversely, by ensuring that flexible load is not scheduled to operate during peak demand periods, demand-driven network overload situations can be avoided. This project will deliver benefit through a desktop assessment of the potential scale of DSM interventions.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2014</td><td colspan="2">Duration of benefit once achieved</td><td>30 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">60%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£1,572,095</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">There is a high potential for success as a number of mitigation techniques will be required to manage the emerging constraints appearing on the network.</td></tr>
</table>

Project Progress at March 2015	Following extensive network analysis, which included detailed load history and connected generation for the Devon and Cornwall distribution networks and scenario modelling of various types of distributed domestic demand side response techniques, a number of outcomes have been generated by the final report. The predicted value range of all these DSR services was wide and the cost implications of the various services employing different complexities is also significant to finding the best balance for implementation. Two key findings stand out from the work, namely that the technical requirements for accessing the fast frequency response value streams will be beyond the capability of DDSR and also that the greatest cost benefit comes from a simple timer-based implementation.
Collaborative Partners	None
R&D Provider	Smarter Grid Solutions

<table>
<tr><td>Project Title</td><td colspan="4">Phasor Measurement Trial</td></tr>
<tr><td>Description of project</td><td colspan="4">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.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 8,178
External £ 0
Total £ 8,178</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 65,360</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 73,538</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ nil
External £ nil
Total £ nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental / Technological Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>-3</td><td>14</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2014</td><td colspan="2">Duration of benefit once achieved</td><td>15 years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">NPV=(PV Benefits – PV Costs)x Success Probability</td><td>£51,410</td></tr>
<tr><td>Potential for achieving benefits</td><td colspan="4">The equipment has been used in Europe for similar applications.</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="4">Following the demonstration of the Phasor Measurement unit through IFI trials, the Phasor Measurement Unit has now been deployed and is available for use across the WPD network for specialist phase identification and snap shot voltage angle measurements.

The unit has been successfully used to confirm the network phasor relationships across the Low Carbon Hub substations, Skegness, Ingoldmells, Chapel St Leonards, Trusthorpe, Bambers Wind Farm and Alford using a range of connection methods, Voltage Presence Indicating System (VPIS), live line connectors and the secondary outputs of a 33kV substation Voltage transformer.</td></tr>
</table>

Collaborative Partners	None
R&D Provider	Sibille Faeca Electric (SFE)

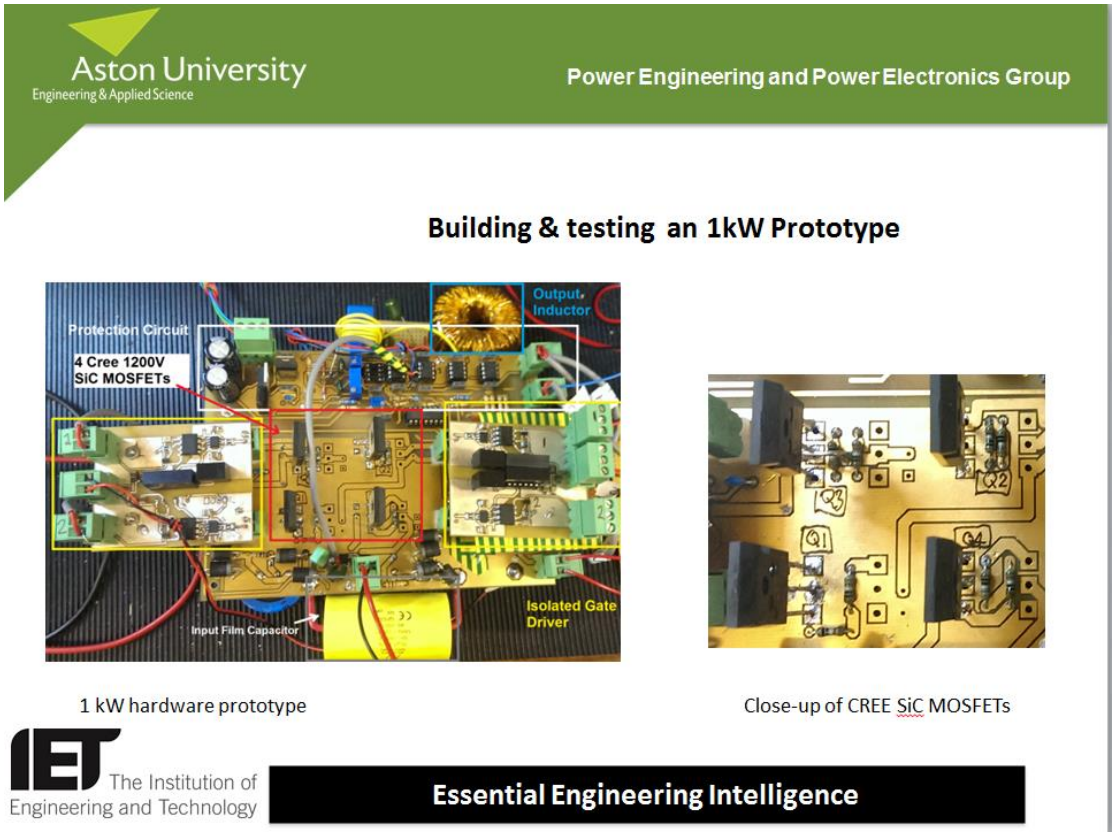
<table>
<tr><td>Project Title</td><td colspan="4">Smart Grid Design</td></tr>
<tr><td>Description of project</td><td colspan="4">Identify optimal network design configurations and arrangements for new and existing networks; identify potential changes in operational strategies and any required equipment characteristics.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 551
External £ 19,528
Total £ 20,079</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 163,509</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 650,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental / Technological Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>12</td><td>1</td><td>11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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 (I^2R) 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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2015</td><td colspan="2">Duration of benefit once achieved</td><td>20 years</td></tr>
</table>

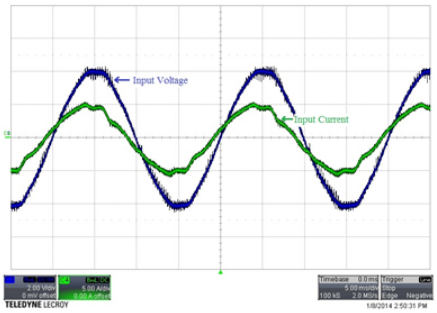
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£313,013
Potential for achieving expected benefits	The Knowledge Transfer Partnership allows close collaboration between academia and distribution network expertise, while the involvement of the Power engineering and power electronics, Computer science, and Non-linearity and complexity research groups provides access to the necessary expertise.		
Project Progress at March 2015	Design requirements for a power electronic conversion device have been finalised, including the various power cycle duties and thermal withstand specifications needed for an operational device. Power electronic gate topologies have been extensively tested in order to ensure risk of reverse injection and harmonic emissions are limited. A prototype unit has also been tested in a laboratory to prove the concept. This research has been presented at a number of national and international conferences, as well being fully documented in submitted research white papers.		
Collaborative Partners	EPSRC (through sKTP and CASE awards)		
R&D Provider	Aston University and E.ON New Build and Technology		



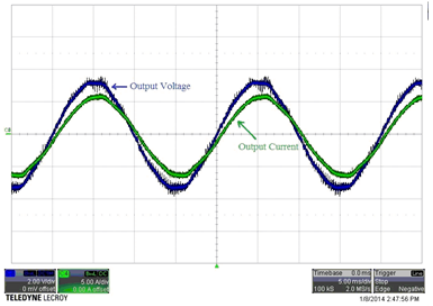
Aston University
Engineering & Applied Science

Power Engineering and Power Electronics Group

Prototype Results



Module input voltage (200 V/div) and current (5 A/div) waveforms for 1 kW, 0.98 power factor output power (5ms/div)



Module output voltage (200 V/div) and current (5 A/div) waveforms for 1 kW, 0.98 power factor output power (5ms/div)

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<table>
<tr><td>Project Title</td><td colspan="4">Reactive Power Compensation for Distribution Networks</td></tr>
<tr><td>Description of project</td><td colspan="4">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.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 862
External £ 13,700
Total £ 14,562</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 46,689</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 61,251</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution / Significant / Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>-3</td><td>10</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2015</td><td colspan="2">Duration of benefit once achieved</td><td>25 years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£44,255</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">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.</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="4">Using detailed network data from the LCNF Tier 2 LV Network Templates project, load flow models of five networks were established. Four of the networks were modelled with three-phase cables and assumed balanced three-phase loads. The other and largest network</td></tr>
</table>

	was set up as a detailed unbalanced model due to the significant proportion of single phase cable. For a range of cases, the effect of load, power factor, embedded generation and reactive power compensation were examined. The simulation results detailed how the voltage profiles over the range of current and future operating scenarios including with significant Low Carbon Technologies (LCT) uptake. When limitations in the voltage profiles were observed, reactive power mitigation solutions were modelled at different points across the network to understand how it could be used as a solution to voltage rise and voltage drop issues. It was shown that under heavily loaded conditions, there is a significant voltage drop across the 11kV/415 network supply transformer, which is more affected by variation in power factor than the voltage drop across the feeders, due to its higher X/R ratio. It was also shown that shunt capacitive compensation applied at the main substation may be useful to limit the voltage drop across the transformer. However, downstream compensation is not so effective in reducing feeder voltage drop but can, if sized correctly, help to reduce network currents and help to operate within cable ampacity. A further study looked at the upstream effects of LV reactive power compensation, which indicated that there was a minimal impact on 11kV voltage over a wide range of power factor including the case of over-compensation. The application of reactive compensation at the HV/LV transformer will now be reviewed in line with WPDs policies.
Collaborative Partners	None
R&D Provider	Cardiff University

<table>
<tr><td>Project Title</td><td colspan="3">Technical Assessment of Power Quality Issues</td></tr>
<tr><td>Description of project</td><td colspan="3">Confirm the extent of suspected power quality issues on an extensive sub-transmission network and consider the effect of alternative mitigation measures.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 5,283
External £ 71,201
Total £ 76,484</td><td>Expenditure in previous (IFI) financial years</td><td>Total £ 170,864</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 247,348</td><td>Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental / Technological Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>12</td><td>-2</td><td>14</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Deliver a better understanding of power quality issues and the cost effectiveness of potential mitigating solutions on customers.

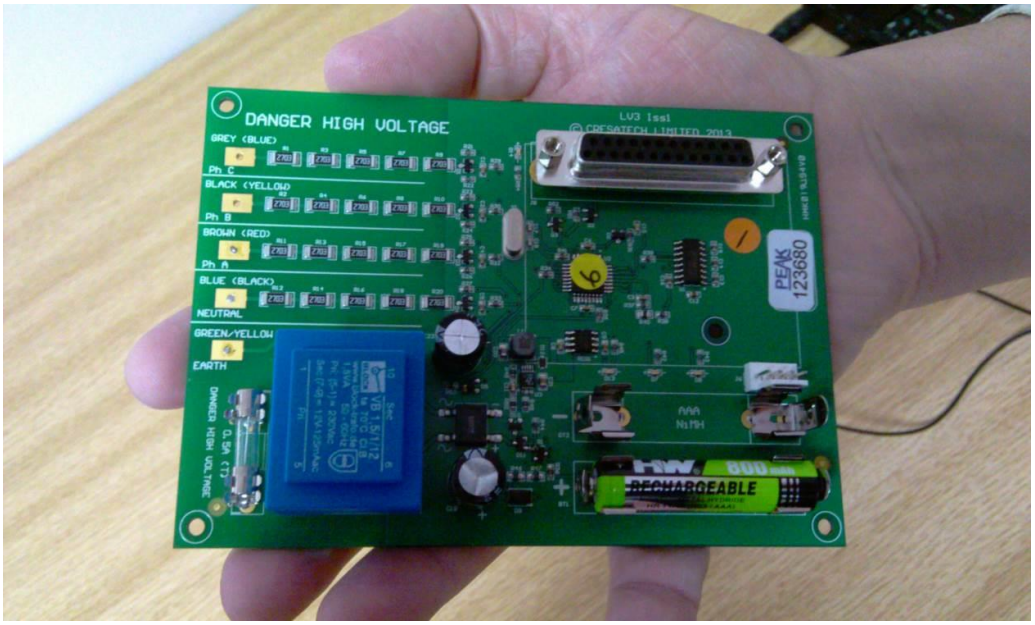
Determine the extent of propagation of power quality issues on a real network and allow the assessment of low loss distribution equipment and proposed future network configurations.

Verification of previous research methods, which of assessed alternative techniques to improve power quality</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2015</td><td>Duration of benefit once achieved</td><td>8 years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£187,770</td></tr>
</table>

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 2015	Various sources of unbalance have been modelled, looking at how this propagates across the network. Data from the monitors has been collected and returned to a central data repository. Development work has been completed on algorithms to process the outputs of the monitors to enable meaningful analysis. This research has further deepened WPD's knowledge in the area of power quality analysis monitors and tools, enabling standard methods of monitoring, data acquisition and extrapolation.
Collaborative Partners	None
R&D Provider	Manchester University, Embedded Monitoring Solutions, Sterling Power and E.ON New Build and Technology

<table>
<tr><td>Project Title</td><td colspan="4">CuTS LV Overhead Line Project</td></tr>
<tr><td>Description of project</td><td colspan="4">Development of an early warning/alarm system to send notification of network interference.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 2,168
External £ Nil
Total £ 2,168</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 98,786</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 100,954</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution / Significant / Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>14</td><td>-3</td><td>17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• 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</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2015</td><td colspan="2">Duration of benefit once achieved</td><td>30 Years</td></tr>
</table>

Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£12,752
Potential for achieving expected benefits	As the project progresses confidence that a suitable product can be developed increases. The deployment strategy remains key to delivering the benefit for the project. Proportionally the amount of theft on out network continues to be small compared with the size of the overall system and recent number sown a reduction. It continues to be 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 2015	A number of iterations of the design have gone through prototyping and the development of componentry has progressed into a high TRL, although the final TRL reached has not been sufficient to deploy onto a live network. The further funding required to develop this product to a standard for WPD's network was felt to be in excess of the benefit realised. The potential for a product in this area is still high, so we will continue to review the development of this and other similar devices until a sufficient TRL is reached.		
Collaborative Partners	None		
R&D Provider	Cresatech LTD		



Prototype theft detection unit

<table>
<tr><td>Project Title</td><td colspan="3">Power Networks Research Academy</td></tr>
<tr><td>Description of project</td><td colspan="3">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.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,128
External £ 6,788
Total £ 7,916</td><td>Expenditure in previous (IFI) financial years</td><td>Total £ 280,435</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 1,500,000</td><td>Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The projects for the first intake 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 intake 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 intake 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

The projects for the fourth intake of Academy scholars are:
• Using Power Electronics to increase Power Capacity without</td></tr>
</table>

<table>
<tr><td></td><td colspan="4">changing Infrastructure
• Effect of climate change on design and operation of meshed networks
• State Estimation for Active Distribution Network
• Influence of wind uncertainty on National Grid's Operating Reserve</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant, Technological substitution and Radical innovations</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>9</td><td>-1</td><td>10</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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/</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2013</td><td>Duration of benefit once achieved</td><td colspan="2">20 years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£ 200,000</td></tr>
<tr><td>Potential for achieving expected benefits.</td><td colspan="4">There are now a wide range of 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.
Western Power Distribution is directly involved in two projects. 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:</td></tr>
</table>

Project Progress at March 2015	**Easing Future Low Voltage Congestion with an AC-AC Conversion (University of Strathclyde)** Work on this project has been completed and results collected on a novel circuit design incorporating auto-transformer. The AC Chopper Prototype has also been completed and results collected. The final project thesis is aimed for completion this summer. Dissemination has been via a number of a published papers: • Journal Paper Published: IET Journal Generation Transmission and Distribution • Conference Paper Published: PEMD 2014 **Alternatives to SF6 as an insulation medium for distribution equipment (Cardiff University)** At the end of the project a PhD Thesis on the findings of the research of the design, tests and performance of CF3I high voltage switches / RMUs with suitability recommendations for power companies has been produced. The main contributions of this work are: • A review of present day SF6 switchgear and an extensive appraisal of the properties of CF3I and CF3I gas mixtures. • Developing and implementing a novel test rig that can be used to test CF3I-CO2 as an alternative insulation medium in practical MV switchgear • Experimental investigation and demonstration of CF3I-CO2 insulation capabilities • Developing a simulation approach in COMSOL that can determine whether a specific mixture of CF3I-CO2 can insulate equipment. This uses calculated effective ionisation coefficients of various CF3I-CO2 gas mixtures. • A proposal for vacuum interrupters to use CF3I gas mixtures as a replacement insulation to SF6 gas.
Collaborative Partners	EPSRC, IET, 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.

<table>
<tr><td>Project Title</td><td colspan="4">Active Fault Current Management</td></tr>
<tr><td>Description of project</td><td colspan="4">Development and demonstration project</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 2,599
External £ 92,144
Total £ 94,743</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 256,929</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 9,850,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution / Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>0</td><td>13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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</td></tr>
</table>

	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 2015	Following the device developer, Applied Superconductors Limited, going in to administration and ultimately ceasing to be an active business the Energy Technologies Institute (ETI) terminated the project. Therefore, during this reporting period the project has completed. Some of the research and development learning already carried out under this project has been integrated into other fault management or mitigation projects.		
Collaborative Partners	ETI and UKPN		
R&D Provider	ASL, Rolls Royce, and E.ON New Build & Technology		

<table>
<tr><td>Project Title</td><td colspan="5">Islanding Identification using Phasor Measurement</td></tr>
<tr><td>Description of project</td><td colspan="5">Islanding of electrical systems can occur when the demand in the immediate geographical area is supplied by embedded and distributed generation equal in magnitude, particularly if the loads are at the remote ends of a network.

This project aims to develop a substation phasor measurement device for installation in remote locations.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 1,835
External £ 65,067
Total £ 66,902</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 66,902</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Islanding of remote electrical grids and detection of those conditions</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>12</td><td>-7</td><td colspan="2">19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• Easier deployment of phasor measurement monitoring
• Detection of islanding conditions
• More rapid deployment of phasor measurement
• Integration of PMUs with lower bandwidth communications
• Ruggedisation of devices</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2015</td><td>Duration of benefit once achieved</td><td colspan="2">20</td></tr>
<tr><td>Probability of Success</td><td colspan="2">70%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£8,116</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">Transmission level products are already developed, but require incremental modification for installation in remote distribution substations</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="5">Extensive system testing has been completed on a new substation product. The ruggedised substation unit developed for usage in small remote substations can accommodate a number of input devices and voltages, whilst integrated with business as usual communication solutions.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="5">None</td></tr>
<tr><td>R&D Provider</td><td colspan="5">Psymetrix</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="5">Distributed Intelligence Proof of Concept</td></tr>
<tr><td>Description of project</td><td colspan="5">As substation monitoring increases on the network, so does the amount of data being gathered. However, it is often difficult to identify the significant information from the data using manual analysis techniques.

This project will develop a platform to improve network analysis by developing a system which can host a range of in field algorithms and analysis techniques to draw valuable information out of the data.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 20,565
External £ 225,324
Total £ 245,889</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 310,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Development of distributed substation intelligence, paired with monitoring algorithms to detect specific network conditions.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental / Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>14</td><td>-7</td><td colspan="2">21</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• Development of distributed analytics
• Improved data manipulation
• Reduce data traffic
• Improve network visibility
• Improve visibility of non-technical losses</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2015</td><td>Duration of benefit once achieved</td><td colspan="2">30</td></tr>
<tr><td>Probability of Success</td><td colspan="2">60%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£768,913</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">Potential for developing outputs is high. The project is mostly around building analytical tools on existing substation monitoring solutions so the technical risk is low.</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="5">A device platform for allowing remote, upgradable substation analytics has been developed and implemented in a number of locations in Hook Norton.

The concept of Distributed Intelligence is a viable and useful option to DNOs in the near future however, the availability and reliability of communications remains a significant factor in determining the application and extent to which Distributed Intelligence may be reliably deployed.</td></tr>
</table>

Collaborative Partners	Locamation
R&D Provider	EA Technology

<table>
<tr><td>Project Title</td><td colspan="5">PSR Scout</td></tr>
<tr><td>Description of project</td><td colspan="5">For many Low Voltage faults on the network, WPD are unaware of their occurrence till a customer calls in. For many of the customers on the Priority Services Register (PSR), an outage can have significant impact.

WPD would like to commission AND technology to design, develop and build a low cost (circa £25 pu) fault and voltage detector that can be plugged into the mains by the customer and notify us automatically in the case of a power cut. These will then be mailed to customers on the PSR with instructions as to how to self-install. The device will also be able to return voltage readings to help profile system voltages, as well as providing indication of loss of power supply.

WPD shall require an initial quantity of 500 units which we aim to trial with customers with a medically dependency on electricity on circuits with a high fault propensity.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 2,069
External £ 73,334
Total £ 75,403</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 75,403</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Detection of outages to support Priority Services Register customers.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>8</td><td>-7</td><td colspan="2">15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• Improved visibility of LV faults
• Support for WPD’s most vulnerable customers
• Initial development of automated fault detection capability prior to smart metering deployment</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2015</td><td colspan="2">Duration of benefit once achieved</td><td>10</td></tr>
<tr><td>Probability of Success</td><td colspan="2">80%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£3,943</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">Potential for developing outputs is high. The project is mostly around building analytical tools on existing substation monitoring solutions so the technical risk is low.</td></tr>
</table>

Project Progress at March 2015	Development of the device has been completed and lab testing has confirmed the reliability matches the required application. A small run of around 500 devices are currently in production for imminent deployment ahead of a much wider rollout into business as usual if proved successful.
Collaborative Partners	None
R&D Provider	AND Technology

AND Technology PSR Scout

<table>
<tr><td>Project Title</td><td colspan="4">Half Hourly Metered Customer Archetypes</td></tr>
<tr><td>Description of project</td><td colspan="4">Statistical Analysis of half hourly metered customer consumption data alongside assessing the availability and utility of publically available datasets for non-domestic customers to create scalable load profiles for non-domestic archetypes.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 16,937
External £ 60,165
Total £ 77,102</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 77,102</td><td>Projected 2015 - 2016 costs for Western Power Distribution</td><td colspan="2">Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">While standard load profiles exist for non-half-hourly metered customers, scalable profiles are not available for customers with greater consumption that are metered on a half hourly basis. These customers can dominate the load at distribution substations and modelling them well is essential for good quality load estimation.

A set of scalable non-domestic load profiles would allow DNO's to model the likely impact of new non-domestic customers with greater accuracy. Increasingly local authorities and a variety of research bodies wish to model energy consumption but their abilities are limited by the lack of example profiles for non-domestic customer types and their lack of access to customer data.

Providing scalable customer profiles would allow consistency of assumed consumption and provide representative data without disclosing actual consumption data for individual customers.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>8</td><td>-1</td><td>9</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Non domestic archetypes will allow planners a better view of the impact of new customers and the likelihood of load or voltage issues at different times of day for different days of the week and parts of the year. Having a shared view of these archetypes will reduce duplication of effort by individual parties involved in load estimation and improve consistency. This is expected to reduce the time spent by DNOS supporting load estimation by third parties.

Manipulating large volumes of half hourly data will help evaluate the tools and processes in readiness for the greater availability of smart meter data for non-half hourly customers. Scalable profiles could provide a way for non-domestic customers to compare their own energy consumption to an expected value, which may encourage actions to reduce consumption for those that are higher than average.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2015</td><td>Duration of benefit once achieved</td><td>20</td></tr>
</table>

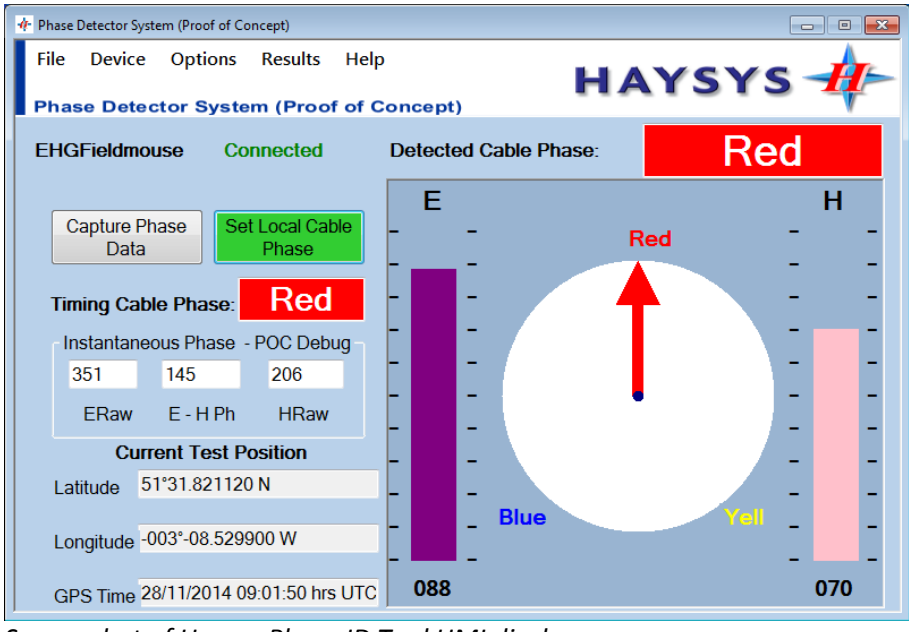
Probability of Success	70%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£885
Potential for achieving expected benefits	Meter data is already available for use. Large scale data handling and clustering has already been explored in the LCNF LV Network Templates project. Some comparison of data sets has already taken place to support other projects, but a definitive assessment has not been published.		
Project Progress at March 2015	Half-hourly metered load profile data has been analysed using a clustering approach in order to investigate the extent to which similarity based clusters could be identified. It has then been explored whether these cluster profiles could be used as representative profile archetypes, assigned to particular segments of the non-domestic sector (i.e. where segments are different use classes). This involved identification of the industry classes of the half-hourly customers in the clustering sample, such that the membership of the clusters could be understood and associations between particular industry classes and clusters identified. The key findings of the analysis were: • Non-domestic electricity consumers can be successfully clustered into groups on the basis of similarities in their load profiles. • However, significant variation is observed in the daily load profiles of customers in the same use class. • Address-level data on non-domestic premises is scarce, however it has been possible to match customers to an industry class on the basis of organisation names. • Clustering on the basis of load profile has been found to form mixed clusters, in terms of the industry classes represented. Nevertheless it has been possible to identify clusters that particular industry classes are strongly associated with.		
Collaborative Partners	None		
R&D Provider	Element Energy, University of Bath		

<table>
<tr><td>Project Title</td><td colspan="4">Phase ID Tool</td></tr>
<tr><td>Description of project</td><td colspan="4">The aim of this project is to design and develop a tool that can reliably detect and identify the individual phase a customer is connected to.

At present WPD can identify a customer’s individual feeder, but have no visibility of which phase of that feeder to which they are connected. Haysys have already completed some preliminary work around this and believe they can develop such a tool. They also believe that this tool could potentially detect the customers phase without the need to enter the premises.

If developed, the phase ID of every customer, combined with a Smart Metering roll out could potentially give a DNO full LV network monitoring.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 15,139
External £ 223,337
Total £ 238,476</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 238,476</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">At present the only way to gain visibility of the LV Network is to install expensive substation monitoring on every feeder of every substation. Each connected customer would need to have their phase connection identified to fully understand the complete loadings of a feeder/substation. With the proposed Smart Metering rollout, every connected customer would potentially be providing load data that DNO's could access. If the DNO also knew which phase they were connected to then complete visibility would be achieved. The Idea is to explore the possibility of developing a phase checking tool that could either be used by the Smart Metering installer when he connects the new meter, or by a DNO operator who could detect the phase connection with out entering the premises.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Transfer</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>16</td><td>-5</td><td>21</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">There are a number of benefits if full LV network visibility is achieved. For planning and design, the load profile of any feeder/ substation would be available by aggregating the connected customers demand combined with their phase ID. Overloaded Transformers would be more easily identified, so they could be targeted for early replacement. Network imbalance would become more visible and when corrected would reduce network losses. During fault location, the phase ID of the customers off and on supply would more accurately pin point the area of the fault thus reducing CML's. The effect of Distributed Generation through Low carbon Technologies would be more visible, giving a better understanding of how the existing network can absorb this without the need for expensive reinforcement.</td></tr>
</table>

Expected Timescale to adoption	2015	Duration of benefit once achieved	30
Probability of Success	85%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£362,116
Potential for achieving expected benefits	Haysys have under taken some development testing prior to submitting their proposal, and are confident in the method proposed. CGI & NPL		
Project Progress at March 2015	12 properties spread over 3 different distribution sub-stations and 2 different Primary sub-stations in the Cardiff area with phases having been already been determined as part of the Tier 2 LV Network Templates project were selected for the testing of the two devices. On 28th October 2014 the 12 properties were checked using the CGI & NPL hand held field unit. The unit stored the results and these were downloaded to a laptop and analysed back at NPL and the phase connections determined. All phase results corresponded to the known phase connections from the LV Templates data. On 29th November 2014, a field trial of the Haysys initial Proof of concept unit was undertaken on 12 properties. In the sample test, all but one of the properties was correctly identified. Further modifications have been fed back to improve the user interface and the sensitivity of the device, in order to develop the product.		
Collaborative Partners	None		
R&D Provider	Haysys /CGI/NPL		



Screen shot of Haysys Phase ID Tool HMI display

NPL & CGI Reference Unit installed at Ninian Park Sub-station

<table>
<tr><td>Project Title</td><td colspan="5">South Wales Voltage Reduction Analysis</td></tr>
<tr><td>Description of project</td><td colspan="5">This project aims to explore the relationship between voltage reduction and network response. Following the findings from the Low Voltage Network Templates (LVNT) LCNF project, the 11kV AVC settings in 3 of the 4 distribution areas in South Wales are being reduced. This project aims to analyse voltage and consumption data from the areas to measure the effects of the changes. Various studies suggest different demand responses to voltage changes and this project should bring some practical experience to the discussion</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 952
External £ 33,740
Total £ 34,692</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 34,692</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Network response to voltage reduction. The project aims to determine whether there is a noticeable change in LV voltage and consumption following a reduction in 11kV AVC settings</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental / Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>14</td><td>-1</td><td colspan="2">15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">If successful this project should confirm the effects of the voltage reduction and illustrate the following benefits:
• Reduction in demand
• Reduction in customer energy bills
• Reduction in CO2 emissions
• Additional headroom for distributed generation
With a better understanding of network response further voltage reduction may be possible across other areas increasing the benefits.
The analysis will also help determine the effect of micro-generation on the LV Voltage.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2015</td><td>Duration of benefit once achieved</td><td colspan="2">25</td></tr>
<tr><td>Probability of Success</td><td colspan="2">70%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£50,413,251</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">Using existing data and existing methods for weather correction the project has no engineering risk and is a purely statistical exercise. This will ensure we will get results, however these may be inconclusive. The main risk is that the implemented change is too small to infer any real change.</td></tr>
</table>

Project Progress at March 2015	A report has been published on a number of analyses of whether changes in 11kV AVC settings in South Wales had an effect on electrical demand, consumption and feeder voltage. The changes were from 11.4 kV +/- 200V to 11.3 kV +/-165V and were made in a selection of substations in the South Wales area in the latter part of 2014. Demand analysis was performed on over 700,000 data points from over 600 substations. Voltage analysis used over 10 million data points from substations and over 27 million from voltage monitors. A statistically significant reduction in demand was associated with substations that had changes in 11kV AVC settings. No significant change was found in substations that did not have changes in settings. Using all available daily data, the reduction was estimated to be 1.5% in average demand with a 95% confidence interval of (1.1% - 1.9%). This reduction was found to be robust to changes in the temporal resolution used for the analysis; 1.6% for monthly data. Using the methodology established in the LVNT project (LV Templates Closedown Report, Appendix B: South Wales Voltage Reduction), a 1.5% reduction would equate to an estimated reduction of 158.8GWh over a year, worth £16 million if all substations in South Wales were changed. The proportion of voltage measurements outside the statutory limits was very small, for example in November 2014 only 0.22% of ten-minute measurements at feeder end monitors were above 253V and 0.04% were below 216.2V.
Collaborative Partners	None
R&D Provider	University of Bath

<table>
<tr><td>Project Title</td><td colspan="5">Willenhall Energy Park</td></tr>
<tr><td>Description of project</td><td colspan="5">Due to the import and export capability of energy storage, it can be treated as both for the purposes of network design, which add to the required infrastructure for connection.

In this project, WPD will facilitate the connection of a large energy storage unit by leasing land adjacent to an existing substation to understand the connection requirements and network effects of such a device.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 7,700
External £ 75,042
Total £ 82,742</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 5,500,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Connection strategy and design of electrical storage and post-connection effects of operation.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>13</td><td>-8</td><td colspan="2">21</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• Reduction in predicted infrastructure costs for customers
• Reduction in time for planning energy storage connection by a template approach
• Understanding of typical energy storage operation
• Harmonic analysis of pre and post connection studies
• Protection and monitoring strategy for energy storage</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2016</td><td>Duration of benefit once achieved</td><td colspan="2">25 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">80%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£13,786</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">Energy storage has been deployed worldwide and the expectation is that when the price of energy storage reduces, the amount installed in the UK will increase. By ensuring we have a consistent and efficient design for connecting this technology, the increase in energy storage capacity will be facilitated.</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="5">Following a successful and installation phase of the EPSRC funded project, the energy storage park has been installed and energized on the network since Q1 2015.
By using this as a case-study for the installation of large scale energy storage, skills have been developed within WPD for the end connection design of this technology.</td></tr>
</table>

	The additional monitoring and analysis carried out on this connection, as well as the siting of the equipment near existing operation assets has facilitated the connection whilst mitigating any potential issues during operation.
Collaborative Partners	Toshiba, ABB, Portastor, Sterling Power, Converter Technology and Alpha Construction
R&D Provider	Aston University, University of Sheffield, University of Southampton

<table>
<tr><td>Project Title</td><td colspan="5">Offset Connection Feasibility</td></tr>
<tr><td>Description of project</td><td colspan="5">This feasibility study will set out to clarify whether it is technically and commercially viable to enable further solar PV generation to connect in areas that are presently constrained, by identifying commercial and industrial demands in the area that could be time shifted to increase demand during peak PV outputs. This work will determine if it is worthwhile trialling these arrangements in practice.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 990
External £ 35,101
Total £ 36,091</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 36,091</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ 35,000
External £ 115,000
Total £ 150,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Demand side response of industrial and commercial customers for the purpose of additional generator connections.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>7</td><td>-2</td><td colspan="2">9</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">If feasible, demand side response could be used to circumvent network constraints and connect additional distributed generation to local networks.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2017</td><td>Duration of benefit once achieved</td><td colspan="2">25</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£35,708</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">By analysing the consumption of existing I&C customers in the area, the amount of deferred load and the potential generation that can be offset by it can be determined.</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="5">The project completed in March and made a few clear recommendations based on the analysed information.
Whilst it is clear that ability for a time-shifted load to be used to enable further generation to be added, the surety and consistency of having this shift occur is essential to the business case of the generation. A number of barriers would prevent deployment in the studied zone:
• Very few customers would have >2MW of shiftable load
• The incentive to shift load would need to be large as the energy usage costs are small compared to the overall production costs
• There is no guarantee that the effect of time-shifting to initially enable generation will continue to be effective.
In conclusion, for the studied area, there is little confidence that this method of load shifting will be bankable by a developer. There are</td></tr>
</table>

	different methods which involve a greater number of small participants, which could decrease the risk of unavailability and also decrease the costs of operating such a scheme.
Collaborative Partners	None
R&D Provider	Regen SW

<table>
<tr><td>Project Title</td><td colspan="5">Aerial Fault Detection Technology Review</td></tr>
<tr><td>Description of project</td><td colspan="5">This report aims to present an overview of the current state of the art in aerial transmission line inspection technology by documenting the available technologies, their commercial availability both from equipment and service providers, typical airborne platforms and research activities within this field.

This report will also include a generic roadmap of the steps needed to move from ‘where we are today’ to ‘where we want to be tomorrow’.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 5,176
External £ 17,038
Total £ 22,214</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 530,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ 40,000
External £ 120,000
Total £ 160,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Sensing electrical faults at a distance using mounted equipment on airborne vehicles</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technology Transfer</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>15</td><td>0</td><td colspan="2">15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• Qualification of CML and CI impact through this approach
• Ability for single pass of patrols to detect multiple types of failure
• RF surveys to include full suite of possible failures.
• Automation of technologies to reduce overall flying time</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2019</td><td>Duration of benefit once achieved</td><td colspan="2">15 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£3,946</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">Technology already used for some fault location technology at higher transmission levels.
Other industries also use similar techniques for vegetation/crop management.</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="5">A report has now been produced documenting the possible benefits of deploying a number of airborne mounted technologies on each type of aircraft.
This review has also proposed a list of work packages that a utility may wish to consider in order to move towards full deployment of these technologies.
Will feasibility and review document will now form the basis of a further</td></tr>
</table>

	NIA project for Western Power Distribution.
Collaborative Partners	Elimpus
R&D Provider	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="5">Vehicle to Grid Phase 1 - Laboratory Trial</td></tr>
<tr><td>Description of project</td><td colspan="5">The aim of the project is to investigate the feasibility of electric vehicle to grid energy transfer and to understand the technical challenges and potential countermeasures for widespread adoption.
The project will be split into 2 distinct trial phases:
Phase 1: A static laboratory based test bed of the technology and a proof of concept mule vehicle conversion and test.
Phase 2: A real world trial of vehicles and charging posts equipped to enable bi-directional transfers of energy.
This proposal relates to Phase 1 only.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 7,781
External £ 203,386
Total £ 211,167</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 813,542</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The ability for EV charging infrastructure to be able to export back into the grid, improving power quality, eliminating local network constraints and trading into national ancillary balancing services markets</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental / Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>14</td><td>-1</td><td colspan="2">15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Phase 1 will test the feasibility of the following:
• The concept of energy transfer from an electric vehicle to the grid.
• The concept and mechanism, for the grid to request the vehicle to provide energy.
Phase 1 will also:
• Determine the impacts on vehicle battery life when vehicle to grid transfers are facilitated.
• Determine the efficiency implications of bi-directional energy transfers.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2020</td><td>Duration of benefit once achieved</td><td colspan="2">30</td></tr>
<tr><td>Probability of Success</td><td colspan="2">60%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£462,309</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">The potential application of this technology as a form of energy storage to complement the increasing development of renewable technologies is significant.
Delaying /avoiding the construction and also the deployment of existing</td></tr>
</table>

	fossil fuelled power plant indicates the high potential for this technology to be implemented.
Project Progress at March 2015	A vehicle mounted bi-directional charger/inverter has been developed and installed in a test vehicle for active deployment. Bench testing and validation of the developed specification requirements has been completed and the V2G elements should enable safe charge/discharge regimes. A further phase two was envisaged, but due to the infancy of V2G and potential uptake of this technology, the second phase has been put on hold.
Collaborative Partners	SSE, SP, UKPN
R&D Provider	FTS, University of Southampton

<table>
<tr><td>Project Title</td><td colspan="5">Improved Condition Assessment of Primary/Grid Substations</td></tr>
<tr><td>Description of project</td><td colspan="5">This project is intended to provide a business-as-usual approach to improve health indices for instrument transducers, circuit breakers, isolators, disconnectors, surge arrestors and cable sealing ends found in outdoor grid/primary substations</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 395
External £ 14,000
Total £ 14,395</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 14,395</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Improvement to outdoor switchyard asset health indices which can be fed into the condition based risk monitoring (CBRM) tool currently adopted by WPD to improve asset investment planning</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technology Transfer</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>23</td><td>-7</td><td colspan="2">30</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• PD Hawk instruments for use in future grid/primary substation maintenance programmes
• Development of a methodological approach to outdoor surveying using PD techniques
• Development of a data register
• Development of internal policy documents
• Improved accuracy of health indices
• Improved data for CBRM tools and investment strategy
• Dissemination with other DNOs</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2015</td><td>Duration of benefit once achieved</td><td colspan="2">30</td></tr>
<tr><td>Probability of Success</td><td colspan="2">85%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£7,712,046</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">High potential for success as PD instrumentation is used in the same proposed manner but for assets within indoor substations</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="5">Project has completed and a dissemination report has been circulated detailing the techniques used, the benefits for the CBRM data improvements and the methods used for collecting the data from PD tools.</td></tr>
</table>

Collaborative Partners	None
R&D Provider	EATL

<table>
<tr><td>Project Title</td><td colspan="5">ENA R&D Group Programme</td></tr>
<tr><td>Description of project</td><td colspan="5">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.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 2,794
External £ 16,907
Total £ 19,701</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 573,768</td></tr>
<tr><td>Total Annual Project Costs (Collaborative + external + Western Power Distribution)</td><td colspan="2">£ 580,761</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ 40,400
External £ 125,000
Total £ 165,400</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">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.

Reactive Power (REACT): In the last 2 years, there have been significant difficulties in managing voltage levels during minimum demand periods. Analysis of this issue has shown that the root cause is related to the significant decline in reactive power relative to active power. Whilst minimum active power demands have fallen by around 15% in the last 5 years, reactive power has declined by 50% in this time. Current trends for 2012 show that this reduction is continuing, broadly, across the country. In order to better understand the challenge of manage voltage levels within licence standards and to plan for additional future reactive compensation requirements, a thorough understanding of the reactive power trend needs to be developed.

DS2030: The DECC/Ofgem Smart Grid Forum was created by the Department of Energy and Climate Change (DECC) and Ofgem to support the UK’s transition to a secure, safe, low carbon, affordable energy system. The main issue discussed within the DECC/Ofgem Smart Grid Forum is how electricity network companies will address significant new challenges as they play their role in the decarbonisation of electricity supply. The Smart Grid Forum has established a number of Work Stream (WS) to examine particular aspects of future
networks.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental / Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>6.2</td><td>-10</td><td colspan="2">16.2</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">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</td></tr>
</table>

	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	**Reactive Power (REACT)**: The objectives corresponding to the First Year Report Stage 1 and the Second Year Six-month Report have been met within the last 12 months (May 2014 to May 2015) and the corresponding reports delivered. Two additional brief project status reports have also been delivered. The progress on the project includes: • The methodology to improve original DNO network models in order to mimic in time-series simulations the GSP behavior during periods of minimum load. • The identification of historic changes and trends using DNO network and monitoring data. • The quantification of effects on reactive power from PV penetrations, network changes and demand trends in primary substations. • The assessment of future reactive demand at GSPs of 4 DNOs for different trend-based scenarios. **DS2030**: The DS2030 project is expected to achieve its intended benefits. It will provide a set of generic nodal distribution network models that have been demonstrated to be technically viable to meet the needs of 2030 users. These models have now been developed and their viability will be demonstrated in the coming months. The models will be used to show how specific methods/solutions can be used to ensure technical viability of the networks and when particular methods/solutions may need to be applied. This analysis will be provided in the Stage 4 &5 results report. The final Stage 6 report for the project will use the outcomes of the studies to address the questions posed by the Smart Grid Forum about future distribution system operation, including a discussion of the roles and responsibilities of a DNO in 2030 in terms of supporting whole system optimisation, contrasted with the position today. Where appropriate this will highlight further specific development work that could be carried out		
Project Progress at March 2015	**Reactive Power (REACT):** The objectives corresponding to the First Year Report Stage 1 and the Second Year Six-month Report have been met within the last 12 months (May 2014 to May 2015) and the corresponding reports delivered. Two additional brief project status reports have also been delivered. It is important to highlight that the project was initially planned to start in		

	May 2013 but it actually did in August 2013. The Second Year Final Report Stage 2 is on track and will be completed by August 2015. The outcomes of the project are in accordance with the initial objectives of the project proposal. More specifically, the following tasks have been accomplished: • Identification of historic network and demand changes and trends. • Quantification of effects on reactive demand during minimum load from different distribution-based factors (i.e., demand trends in primary substations, network changes, penetration of photovoltaics). • Assessment of future reactive demand at transmission-distribution interfaces of different DNOs. • Production of improved network models, which unlike original DNO models mimic transmission-distribution interfaces during periods of minimum load, to be used for further studies **DS2030:** Works during the second half of 2014 focussed on defining the four representative networks that will be used for the study and the future scenarios that will be applied. The base networks were finalised and agreed in November 2014 and, following additional development work, the scenarios were finalised in early 2015. In addition, an international review was conducted to capture learning from work in other countries and this was concluded in September 2014. An updated version will be produced towards the end of the study to ensure any more recent work is identified. Towards the end of 2014, the key questions the DS2030 project aims to answer were reviewed. Minor revisions were agreed with the project Steering Group and WS7 in February 2015. Since the start of 2015, efforts have focussed on defining the detailed methodologies to be used in the network analysis studies. These were presented as a series of discussion papers which were reviewed and agreed by the Steering group and WS7. This stage was largely concluded by May 2015 and studies are now commencing. Both projects have been transitioned to the NIA scheme. Further information is available at the Smarter Networks Portal, please see links below http://www.smarternetworks.org/Project.aspx?ProjectID=1460#project-details http://www.smarternetworks.org/Project.aspx?ProjectID=1623#downloads

Collaborative Partners	National Grid; Scottish Power Energy Networks; Scottish and Southern Energy; Electricity North West 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.

<table>
<tr><td>Project Title</td><td colspan="3">EA Technology - Strategic Technology Programme
EATL STP Overhead Line Module 2 and Forum</td></tr>
<tr><td>Description of project</td><td colspan="3">Research and development into all aspects of Distribution Overhead Lines</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 6,199
External £ 50,629
Total £ 56,828</td><td>Expenditure in previous (IFI) financial years</td><td>Total £ 723,932</td></tr>
<tr><td>Total Annual Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 193,000</td><td>Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ 10,000
External £ 211,000
Total £ 221,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">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.</td></tr>
<tr><td>Type(s) of innovation involved</td><td>Incremental, Technical Transfer, Signifiant, Radical</td><td>Project Benefits Rating
16</td><td>Project Residual Risk
-9</td><td>Overall Project Score
25</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 2015 - 2016
Dependent upon project</td><td>Duration of benefit once achieved</td><td>Range 3-5 years
Dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 49 - 95%
Dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 42,652</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">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</td></tr>
</table>

	inception.
Project Progress at March 2015	The 2014/15 portfolio of projects consisted of: **SN0004:** **Probabilistic Approach to Overhead Line Rating** This project will demonstrate in a real environment the effects of applying constant current to multiple conductor samples so that their temperatures can be monitored along with co-incident weather parameters. A suitable Test Rig to enable delivery of Phase 2 of the project has been designed, constructed and commissioned. The test rig is located at WPD's depot in Victoria Road, Stoke-upon-Trent, with instrumentation and communications necessary to the level of data collection required, and the sustained remote operation of the Test Rig. The rig consists of 4 circuits, each capable of delivering up to 500A. A total of 3 different conductor sizes are used (50, 150, and 175mm^2 AAAC) across the 4 different circuits so that a range of conductor temperatures can be experienced simultaneously. Key learning from Phase 1 of this project is: • Establishing an experimental Test Rig in a location which is distant from the operational team based at EA Technology at Capenhurst is far from ideal although this has been partly offset by the support provided by WPD. • Previous projects building smaller scale Test Rigs are a poor proxy for the scope and scale of work involved in this project. • Starting the project in IFI funding programme and undertaking a transition to NIA has involved unexpected challenges. • The full outputs and benefits of this project will be realised in the further NIA Phase 2 project Updated information can be found at:- https://www.stp.uk.net
Collaborative Partners	Northern Power Grid, UKPN, Electricity North West, Northern Ireland Electricity, Scottish & Southern Energy and Scottish Power
R&D Provider	EA Technology Ltd

<table>
<tr><td>Project Title</td><td colspan="4">EA Technology - Strategic Technology Programme
EATL STP Cable Module 3 and Forum</td></tr>
<tr><td>Description of project</td><td colspan="4">Research and development into all aspects of Distribution Cables and underground equipment</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 6,890
External £ 90,508
Total £ 97,398</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 831,079</td></tr>
<tr><td>Total Annual Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 333,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Type(s) of innovation involved</td><td>Incremental</td><td>Type(s) of innovation involved</td></tr>
<tr><td>14</td><td>-8</td><td>22</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects in this Module will significantly increase the performance and reliability of the 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 shrink back 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;</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">A reduction in digging, causing less disruption to the public, reducing impact on the environment and avoiding disposal of soil to landfill;
Offset future increases in CAPEX and OPEX;
CI/CML savings per connected customer;
Reduce cable purchase costs;
Enforce Network resilience;
Implement strategies for reducing cable failures, resulting from excessive forces;
Reduction in number of cable faults;
Reduce design costs.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 2015 - 2016
Dependent on project</td><td>Duration of benefit once achieved</td><td>Range 3-5 years
Dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 45 - 100%
Dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£42,013</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">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.

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.</td></tr>
<tr><td>Project Progress at March 2015</td><td colspan="3">The 2014/2015 programme consisted of the following module:

S3174_2: Evaluating the performance of service cut outs
The reliability of Cut outs has always been a contentious issue with the DNOs, who operate a varied range of cut out types from several manufacturers, with some cut outs being several decades old.
There are also increasing demands on the requirements of a cut out regarding load profile and peak rating, which, when combined with its original specification, greatly affects its reliability and end of life.
The aim of this project is to carry out the research and development work required to enable informed decisions to be</td></tr>
</table>

	made on the future approach required to better manage cut-out assets. • This project also intends to explore alternative methods used worldwide in the same circumstances and explore if these could provide a better solution for this type of installation. • This project will evaluate the suitability of the current national standard for cut-outs (BS7657:2010) and if appropriate, look to replace it with a new functional specification that would allow for the introduction of new technology in this field, especially in light of extra demands that will be placed on these pieces of equipment. • Updated information can be found at:- https://www.stp.uk.net
Collaborative Partners	Northern Power Grid, UKPN, Electricity North West, Scottish & Southern Energy and Scottish Power
R&D Provider	EA Technology Ltd

<table>
<tr><td>Project Title</td><td colspan="4">EA Technology - Strategic Technology Programme
EATL STP Plant and Protection Module 4 and Forums</td></tr>
<tr><td>Description of project</td><td colspan="4">Research and development into all aspects of Distribution Plant and Protection equipment</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 5,249
External £ 109,196
Total £ 114,445</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 704,868</td></tr>
<tr><td>Total Annual Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 385,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>17</td><td>-9</td><td>26</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects within this Module have been cost effective and help improve reliability and safety of substations in distribution networks in line with government policy.

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

• 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 SF_6;
• 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</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 2012 - 2015
Dependent on project</td><td>Duration of benefit once achieved</td><td>Range 1 - 6 years
Dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 30 - 95%
Dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 32,721</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">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.</td></tr>
<tr><td>Project Progress to March 2015</td><td colspan="3">The 2014/2015 programme consisted of the following module:

S4181_10: 132kV Transformer Post Mortem 2014/2015

This project, through completing full post-mortems of 35 132kV transformers with a particular focus on relating mechanical strength of Low Voltage (LV) winding papers to transformer oil analysis and</td></tr>
</table>

	condition, will provide empirical evidence to establish a robust link between non-invasive tests and actual transformer condition. Based on this evidence, data thresholds may be modified to give a more accurate Health Index assessment. Greater confidence in the Health Index is expected to allow the serviceable life of 132kV transformers to be safely extended by between 5 or 10 years beyond their currently predicted End of Life (EOL). The findings of the report have provided a greater level of understanding with regard to the condition of 132kV transformers removed from service. This information will assist member companies in determining appropriate asset management strategies. Of the thirty 132kV transformers 30% were considered to be at end of life based on their condition. It is therefore possible that an extended life could be attained for transformers past that which the member companies may expect based on their calculate HI. Findings from the transformer post mortems have been used to derive guidance for the interpretation of results and a decision making protocol to allow asset managers to identify units at the end of life and those that can remain in service • Updated information can be found at:- https://www.stp.uk.net
Collaborative Partners	Northern Power Grid, UKPN, Electricity North West, ESB Networks, Scottish & Southern Energy and Scottish Power
R&D Provider	EA Technology Ltd

<table>
<tr><td>Project Title</td><td colspan="4">EA Technology - Strategic Technology Programme
EATL STP Networks for Distributed Energy Resources Module 5</td></tr>
<tr><td>Description of project</td><td colspan="4">Research and development into all aspects of Network design and management to enable an increased connection of distribution energy.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 15,857
External £ 16,417
Total £ 32,274</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 596,016</td></tr>
<tr><td>Total Annual Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 63,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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 design, 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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>14</td><td>-8</td><td>22</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects within this module have been cost effective and help improve reliability and safety of 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;</td></tr>
</table>

	• 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 2015 - 2016 Dependent on project	Duration of benefit once achieved	Range 2 - 5 years Dependent on project
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 2015	The STP5 portfolio has concluded the existing work programme, delivering all 11 projects across the programme up to March 2015. During the last reporting period, the group has worked together, ensuring there is a mechanism to continue the success of collaborative innovation projects into ED1. This has resulted in the Strategic Technology Programme developing into the new Collaborative Energy Portfolio administered by the ENA. Several Projects have looked at the solving technical issues on		

	distribution networks. These include understanding and detailing the practical and electrical limits to long AC cable connections associated with the use of long 132kV and 33kV cables, especially for new DG connections. A project has also reviewed the methodology of managing Fault level by splitting bus section, the benefits and the subsequent impacts on network operation and performance. The connection of addition Low Carbon Technologies such as heat pumps and electric vehicles could be limited by relatively high impedance of the Low Voltage network. A project has looked at various methods of reducing the supply impedance and the additional headroom created by reducing the supply limits, focussing on thermal, voltage and power quality capacity. With the high number of generation looking to connect to the network, one of the methods of managing voltage rise on remote networks is to absorb reactive power. Generation can be designed and configured in P-V mode, where the power factor of the generator is dependent on the network voltage. This project has concluded how generation performs in P-V mode and the key factors when looking at target voltages and slop settings. A project has also assessed real connection on at three different locations to identify the potential generation diversity between different types of intermittent renewable generation sources under non-firm and ANM connected generation. • Updated information can be found at:- https://www.stp.uk.net
Collaborative Partners	Northern Power Grid, UKPN, Electricity North West, ESB Networks, Northern Ireland Electricity, Scottish & Southern Energy and Scottish Power
R&D Provider	EA Technology Ltd

<table>
<tr><td>Project Title</td><td colspan="3">EA Technology - Partial Discharge Project and Forum</td></tr>
<tr><td>Description of project</td><td colspan="3">Research and development into all aspects of partial discharge in distribution equipment.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 2,356
External £ 6,650
Total £ 9,006</td><td>Expenditure in previous (IFI) financial years</td><td>Total £ 428,369</td></tr>
<tr><td>Total Annual Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 31,000</td><td>Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technical Substitution/ Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>15</td><td>-7</td><td>22</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">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
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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2010</td><td>Duration of benefit once achieved</td><td>10 Years</td></tr>
</table>

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 2015	**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. **Best Practice Guide** Following development across a number of years, a 'Best Practice Guide' has been published which lays down guidance for carrying out partial discharge testing and recommendations for using the information obtained to maximise business benefits. This guide was formed on the basis of the best practice questionnaire carried out in 2011-2012. 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. 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 2014-2015 through the user group and forum run by EA Technology		

	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. **PD Survey App** An application has been developed which enables PD surveys to be streamlined and allows the data to be collected through a single source, reducing errors when inputting or transferring information. **PD Hawk** The PD Hawk has been reviewed and a data capture application has been developed to enable quick transfers off the device. **White Powder Deposits** This piece of work has been proposed to understand what white powder deposits on switchgear are, what their causes are and what implications there are for repairing the equipment. Samples have been provided by the group to enable testing to take place.
Collaborative Partners	AWE, Northern Power Grid, 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
R&D Provider	EA Technology Ltd

<table>
<tr><td>Project Title</td><td colspan="4">EA Technology - Protective Coatings Forum</td></tr>
<tr><td>Description of project</td><td colspan="4">Research and development into all aspects of protective coatings on distribution equipment</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,073
External £ 7,295
Total £ 8,368</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 61,620</td></tr>
<tr><td>Total Annual Project Costs (Collaborative + external + Western Power Distribution)</td><td>£ 29,000</td><td colspan="2">Projected 2015 - 2016 costs for Western Power Distribution</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental/ Technological Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>12</td><td>-6</td><td>18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2010 - 2012
Dependent on adoption of legislation</td><td colspan="2">Duration of benefit once achieved</td><td>3 - 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>£ 25,533</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">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.</td></tr>
</table>

Project Progress at March 2015	An additional supplier has passed assessment which has enabled them to be added to the approved supplier list. Further assessments have been made of more potential paint suppliers including initial testing and factory visits. Trials of paint technologies have continued to aid in the development of this sector and information has been passed around the relevant involved parties. 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 suppliers.
Collaborative Partners	Northern Power Grid, 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