Regulatory Report for DG Incentives, RPZs & IFI

Regulatory Year 2008/09

By Central Networks

Foreword

Welcome to Central Networks' Innovation Funding Incentive Annual Report for 2008/09.

It is pleasing to report that a number of our research and development projects have reached a successful conclusion and have been adopted into the business.

These successes are enabling Central Networks to lead the way in transforming the energy sector by removing the technical barriers to participation by our customers in a low carbon economy.

This will be a challenging time for networks as electricity is again being considered as the primary fuel for Transport, Heating (and potentially Cooling) and also as an increase in distributed energy requires new thinking on how to control networks. The opportunity afforded by the need to replace aging assets allows investment in a sustainable network, which can be enhanced by providing advanced monitoring that communicates to active control systems. This intelligence will maximise the available network capacity to facilitate increases in demand and distributed energy, while ensuring a secure, flexible network delivers the power quality required by the economy and society.

Central Networks is also planning more investment to reduce our own environmental impact and to reduce the impact of climate change on our network. Several of the key initiatives in our research, development and demonstration portfolio address environmental mitigation and adaptation issues. These are integral to our desire to deliver a secure and sustainable energy network for the future.

Our vision to be recognised as the UK's leading Distribution Business remains unchanged and this means leading in safety, performance, delivery and innovation to provide our customers with a reliable and safe network and great customer service. By Changing Energy, we can help to transform the future of the UK.

John Crackett
Managing Director - Central Networks

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1. Introduction

The Innovation Funding Incentive (IFI) and Registered Power Zones (RPZ) mechanisms were introduced by Ofgem with the Distribution Price Control Review which took effect on 1 April 2005 (DPCR4).

This report contains both the IFI and RPZ reports for the two licensed areas of Central Networks East and Central Networks West.

It covers the period from 1 April 2008 to 31 March 2009, 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).

In addition to reporting on activities in 2008/09, this report highlights a number of key projects currently underway and presents intentions for future work within these mechanisms.

1.1 Context

Introduced by Ofgem in April 2005, the IFI & RPZ mechanisms were designed to encourage Distribution Network Operators (DNOs) to apply innovation in the way they pursue the technical development of their networks. Together these schemes promote technical research and development projects that deliver value to consumers through financial, quality of supply, environmental or safety benefits.

Ofgem recognises that the risk/reward balance for innovative projects is distinctly different to that of a DNO's core business. The incentives provided by the IFI and RPZ mechanisms are designed to create a risk/reward balance that is consistent with research, development and innovation.

The proposed incentives were consulted on as an integral part of the DPCR4 process and were widely supported by a large majority of consultees. Ofgem's Regulatory Impact Assessment 22 sets out the case for the introduction of the IFI and RPZ mechanisms.

The two main drivers for providing these incentives were the increasing need for investment in end of life asset renewal which would better position the networks for the future, and the provision of connections for an increasing capacity of distributed generation. It is recognised that these are significant challenges which will only be addressed through the application of technical innovation in asset investment and operation of networks.

We welcome the revisions to the ENA G85 IFI Good Practice Guide as published in December 2007 (GPG G85/2). These allow for the application of innovation to further areas of concern for distribution networks. Additionally, the benefits assessment methodology developed as part of these revisions provides a more flexible approach to assessing the non-quantifiable benefits and risks associated with innovative projects, and incorporating these into project appraisal in conjunction with the economic aspects of a project.

Ofgem's commitment to the scheme for the post 2010 years is also welcomed by Central Networks as a major factor in enabling us to progress a wide ranging portfolio of projects.

1.2 IFI

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

IFI projects can embrace any aspect of distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning. The detail of the IFI mechanism is set out in the Special Licence Condition C3, Standard Licence Condition 51 for Distribution Licences and the IFI Regulatory Instructions and Guidance (RIG). This can be summarised as follows:

A DNO may spend up to 0.5% of its Combined Distribution Network Revenue on eligible IFI projects, as defined by the industry Good Practice Guide G85/2. The DNO is allowed to recover from customers a significant proportion of its IFI expenditure. The percentage of project costs passed through to customers is set at 80% in 2007/08, reducing in 5% steps to 70% in 2009/10. This will revert to 80% in 2010/11 and remain at this level until 2014/15.

DNOs must openly report their IFI activities on an annual basis. These reports will be published on the Ofgem website. Ofgem will not approve IFI projects, but reserves the right to audit IFI activities if this is judged to be necessary in the interests of customers.

1.3 RPZ

The Registered Power Zones scheme is focused specifically on the connection of generation to distribution systems and encourages the development of new cost effective ways of connecting and operating generation.

The application of innovation in this area will deliver specific benefits to new distributed generators and broader benefits to consumers generally.

The RPZ mechanism is an extension of the Distributed Generation (DG) Incentive that was also introduced with DPCR4. The detail of the RPZ mechanism is set out in the Special Licence Condition D2 and Standard Licence Condition 51, with information and guidance provided in the Distributed Generation Regulatory Instructions and Guidance (DG RIGs). These mechanisms relate as follows:

The DG incentive allows DNOs to recover their generation connection costs by a combination of 80% cost pass through and an incentive per kW connected of £1.5/kW. This approach is expected to deliver a higher return to a DNO for generation connection schemes than other network investments.

If a DNO employs genuine innovation in its connection of a generation scheme(s), it can seek to register the connection scheme with Ofgem as an RPZ. Ofgem will assess, using the published criteria ("Further Details of the RPZ Scheme - Guidance Document", April 2005), whether the scheme qualifies as an RPZ. For all designated RPZs the incentive element of the DG Incentive is increased for the first five years of operation by £3/kW. In any year, a DNO's additional revenue from RPZ schemes is capped at £0.5M.

The estimates made by DNOs as part of the DPCR4 process indicated that some 10GW of generation could be connected in the next five years. This generation could connect at every distribution voltage level bringing new system design and operating challenges.

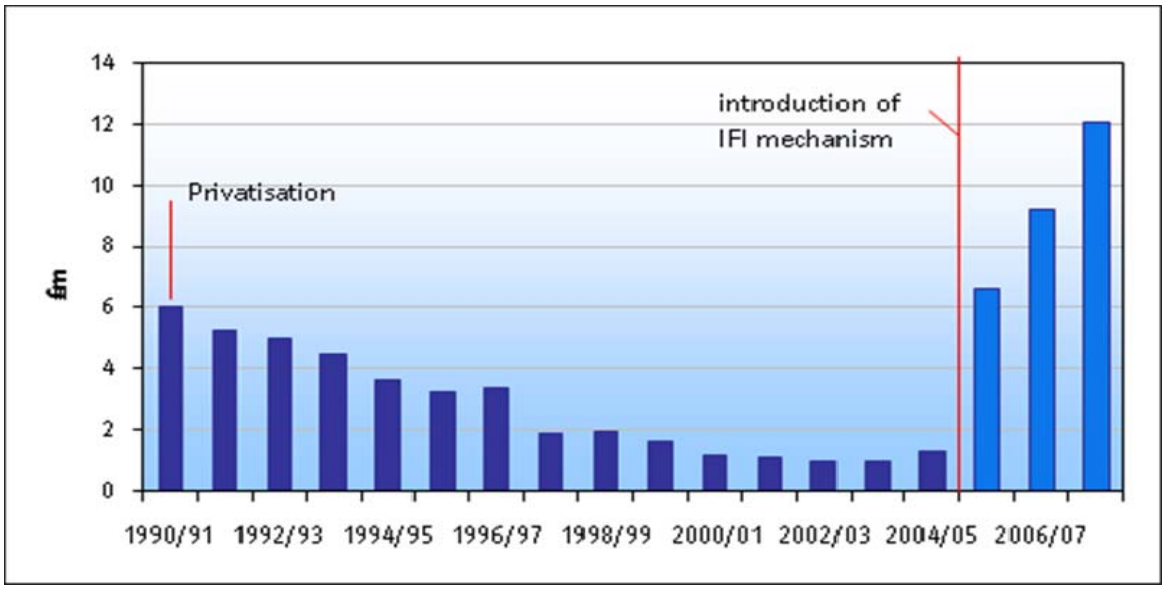
1.4 Summary of National Research & Development

Ofgem's IFI mechanism provides a clear example of the successful promotion of innovation within UK industry.

This incentive has directly led to investment in a portfolio of projects within the UK electricity distribution industry, which address a wide range of issues and engage with a variety of providers from business and academia at a critical time for the industry. In addition it has led to increased collaborations between the UK network operators.

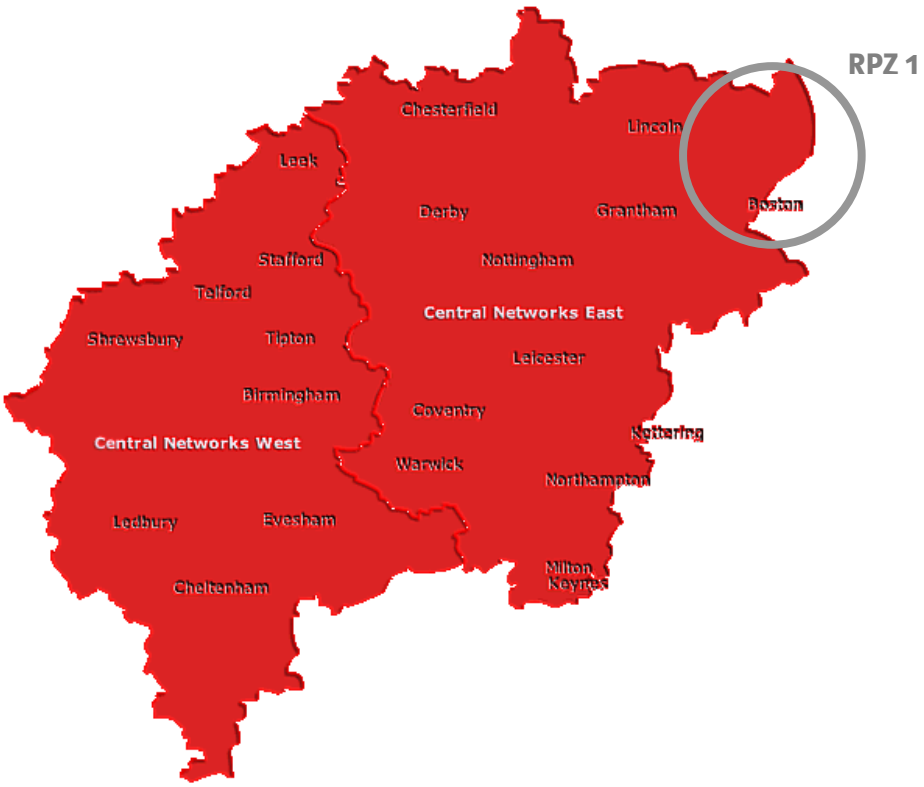
Figures suggest that the UK Distribution Companies' combined Research & Development (R&D) spend dropped steadily from ~£6m per year at privatisation to under £1m in 2003/04. The introduction of the IFI mechanism in April 2005 has seen R&D expenditure increase rapidly to over £12m in 2007/08 as shown below, with significant financial, customer, social and environmental benefits forecast.

Distribution Company Spend on Network R&D



1989/00 to 2003/04 data represents the collaborative spending on R&D by DNOs through a single provider
October 2004 to 2007/08 data shows reported total IFI investment (including early start projects from Oct 2004 to Apr 2005)

2. Company Structure



Central Networks is the electricity distribution business for the Midlands, formed by the amalgamation of East Midlands Electricity and Midlands Electricity distribution businesses. We are part of E.ON, one of the world's largest power and gas companies.

As the second largest electricity network operator in the UK we bring power to more than 10 million people across Central England from the densely populated city centres of Birmingham, Nottingham and Leicester to rural Shropshire, Gloucestershire and Lincolnshire. We cover an area from the Peak District in the north to the suburbs of Bristol in the south, and from the Welsh Borders to the Lincolnshire Coast.

Our core activities include the design, installation, commissioning, inspection, maintenance and repair of electricity distribution networks. Our network infrastructure includes 133,000km of underground and overhead cables - enough to go round the Earth four times - and almost 97,000 substations.

Central Networks' vision is "to be recognised as the UK's leading Distribution business" by achieving leading performance levels, maintaining effective and efficient delivery, and by applying innovation to provide our customers with a reliable and safe network and great customer service.

We are developing an active sustainability agenda incorporating the guiding principles of E.ON's Changing Energy initiative and Central Networks is rightly proud to have developed the UK's first RPZ.

3. Overview

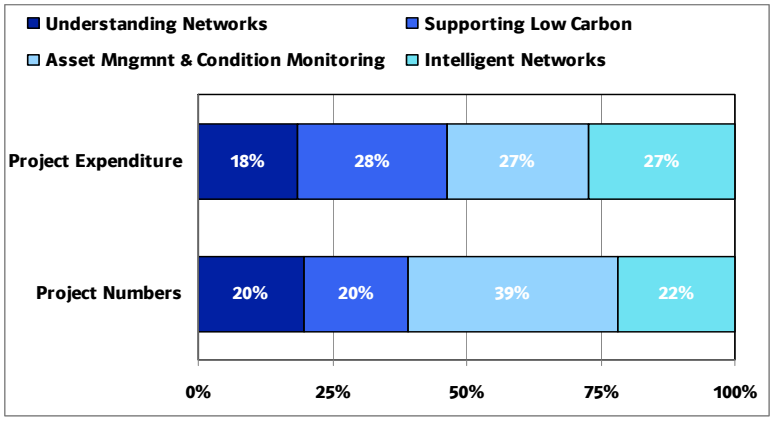
3.1 Central Networks' Objectives

The objectives of Central Networks' Research, Development and Demonstration are designed to be consistent with supporting Central Network's five strategic priorities, satisfy the requirements of E.ON UK's Changing Energy strategy and support E.ON's low carbon agenda. The four Key Themes of the R,D&D programme are:

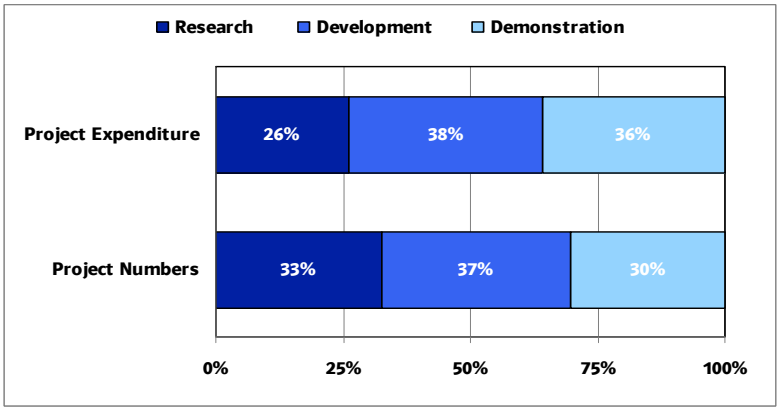
- Understanding Networks
- Supporting Low Carbon
- Asset Management & Condition Monitoring
- Intelligent Networks

Central Networks aims to develop a balanced portfolio of projects across these Key Themes, with projects embracing a range of different technological readiness areas, to provide a sustainable and comprehensive R,D&D programme of work.

At present, the IFI projects undertaken in 2008/09 are spread across the Key Themes as shown:

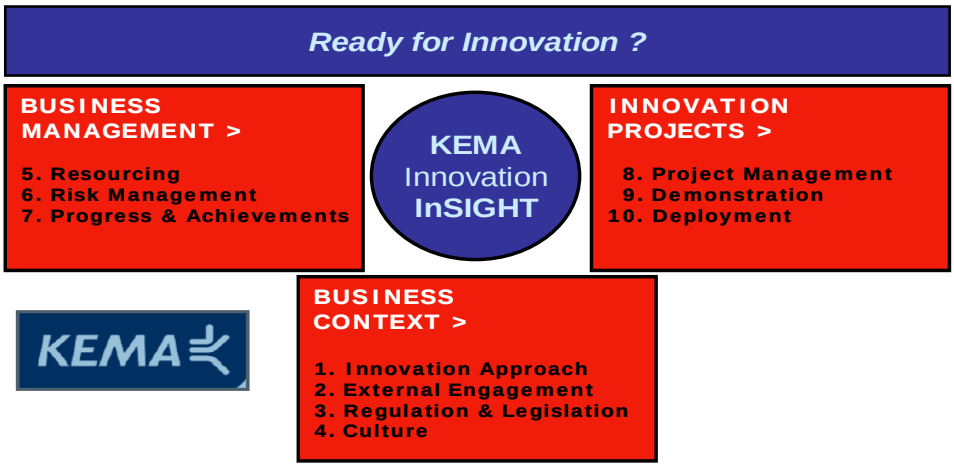


The portfolio of IFI projects undertaken in 2008/09 was balanced across research, development and demonstration as follows:



3.2 Independent Survey of Innovative Grids in Holistic Transition (InSIGHT)

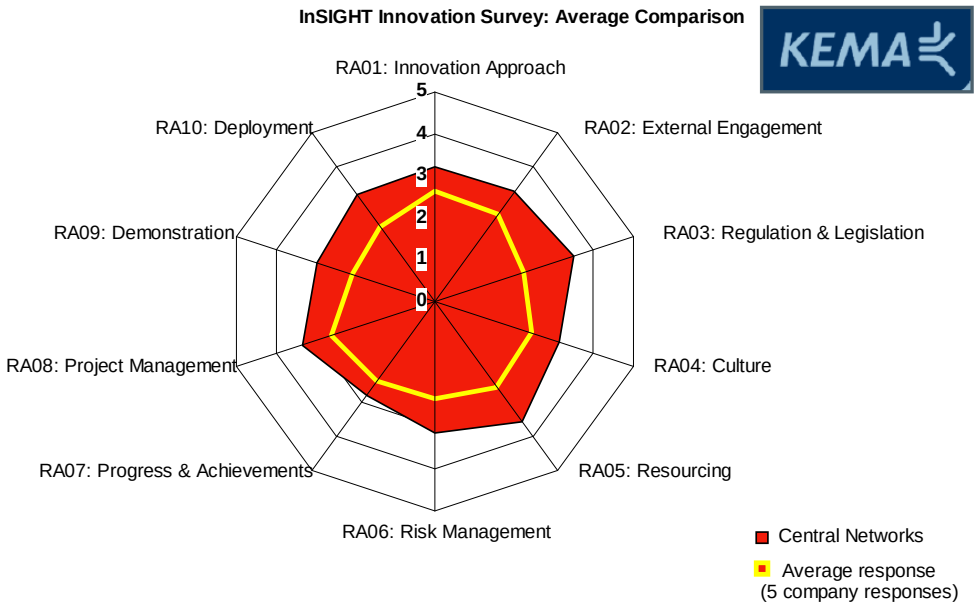
Recently Central Networks participated in KEMA's InSIGHT survey of electricity distribution companies. This survey is designed to calibrate companies on their readiness for responding to the future innovation challenges. The survey considered ten review areas under three broad categories:



Questions in each category were scored from 1 (no activity) to 5 (leading edge performance) and the average for each review area was plotted to allow comparison with other electricity distribution companies. This analysis highlighted that Central Networks consistently scored above peer average, and that Central Networks set or matched the benchmark score in 50% of the review areas:

- Regulation & Legislation
- Culture
- Resourcing
- Demonstration
- Deployment

Central Networks also scored the highest possible score (5) for the question that addressed the implementation of demonstration projects on real power systems. This is an area which all the other benchmark companies have found challenging and Central Networks' achievements to date are a distinguishing feature. The results for Central Networks are shown below:



3.3 End of Year Report

The table below presents the End of Year Report for DG Incentives, RPZs & IFI.

Regulatory report for DG Incentives, RPZs & IFI
Reporting year 2008/09

Central Networks

Distributed Generation (DG) Incentive		East	West	Total
Total Incentivised DG Capacity	MW	30.8	1.5	32.3
Total Capex for DG	£m	£1.6	£0.05	£1.65
Use Of System Capex for DG	£m	0	0	0
Shared Connection Capex for DG	£m	0	0	0
Assets transferred out of DG Capex to Demand Capex	£m	0	0	0
DG Network Unavailability	MWh	47.6	8.9	56.5
DG Network Unavailability Rebate Payment	£m	0	0	0
Operational & Maintenance Costs for DG	£m	£0.11	£0.08	£0.19
Innovation Funding Incentive (IFI)				
IFI Carry Forward	£m	£0.66	£0.45	£1.11
Eligible IFI Expenditure	£m	£0.91	£0.91	£1.81
Eligible IFI Internal Expenditure	£m	£0.14	£0.14	£0.29
increase over previous reporting year	%	-12%	-12%	-12%
Network Revenue by License Region	£m	£315.4	£271.1	£586.5
Number of Eligible Projects		45	45	45
Portfolio NPV of Benefits	£m	£3.7	£3.7	£7.4
Registered Power Zones (RPZ)				
RPZ 1	name	Skegness and Fens CN(e)		
RPZ DG capacity	MW	0		
RPZ starting year	yr	2005/06		
RPZ 2	name			
RPZ DG capacity	MW			
RPZ starting year	yr			

3.4 IFI Project Benefits

The anticipated benefits of each project within Central Networks' R,D&D portfolio clearly show the potential value of the IFI scheme both to Central Networks and to its customers. It should be noted, however, that although quantified financially, not all the projects will result in tangible financial deliverables to Central Networks in terms of direct savings or deferred investments, as the benefits may have been derived from the perceived strategic or risk management value or the project could be designed to avoid future potential costs.

While some of the new technologies and approaches that Central Networks 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. A 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.

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. During the year, a number of the listed projects have successfully delivered benefits and a selection of these, are described in more detail on the Central Networks Research and Development web page: http://www.eon-uk.com/distribution/275.aspx.

3.5 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 both the tangible financial benefits and a range of non financial criteria. These are listed below, but are more fully described in the IFI Good Practice Guide.

- NPV of Financial Benefit
- Knowledge Transfer Benefit
- Safety Benefit
- Environmental Benefit
- Network Performance Benefit

Each item in the Generic Assessment Score is weighted in accordance with company strategy and this score can be seen on each of the individual reports.

The Net Present Value (NPV) of Financial Benefit associated with each project is calculated by taking the present value of the estimated benefits, multiplying them by the probability of success and then subtracting the present value costs (including where appropriate the implementation costs). 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. These NPV of Financial Benefit figures can be seen on each of the individual project reports.

The Risk Assessment calculation quantifies the potential risks inherent with each project by scoring risk and mitigation factors. Again these are listed below, but are more fully described in the IFI Good Practice Guide.

Risk

- Innovation Level
- Development Type

Mitigation

- Average Annual Spend per Company
- Leverage (Collaboration Ratio)
- 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, £80k for CN) have been 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 and two SuperGen programmes have been reported on in this way.

4. Project Highlights

4.1 Introduction

In last year's IFI report two projects were selected as Highlights – Automation Algorithms and Dynamic Line Ratings. Central Networks is pleased to announce that both of these R,D&D projects were successful adopted during the 2008/09 period.

Firstly, on 23rd September 2008, Gareth Evans from Ofgem official opened the East Coast RPZ scheme by remotely switching on the over-current protection scheme at Skegness. The RPZ utilises the Dynamic Line Ratings of the 132kV overhead line circuits between Boston and Skegness to maximise the current carrying capacity of these circuits at times of maximum wind, thereby increasing the amount of wind generation that can be connected on the east coast.

Secondly, on 20th March 2009, a decision was taken to roll out the Control System Automation Algorithm to the entire Central Networks (east) secondary distribution system. This decision followed a period of extensive testing and controlled demonstrations. Now in the event of a fault, the automation algorithm can improve the service that Central Networks provides to customers by immediately initiating remote switching to isolate the faulty section and then to restore the customers on as much of the surrounding healthy network as possible. In the first full month of operation the Automation Algorithm restored over 17,000 Customers.

This restoration period takes less than 3 minutes, irrespective of the state of the network when the fault occurs. This is because the connectivity of the Control System Diagram allows the algorithm to trace the network in real time to determine critical network parameters, which are essential to efficient and safe restoration strategies. The critical parameters include; running arrangements, loading conditions, network constraints, remotely controlled switching positions, protection or fault sensor operation, operational restrictions and other safety issues.

4.2 Partial Discharge Monitoring of Switchgear

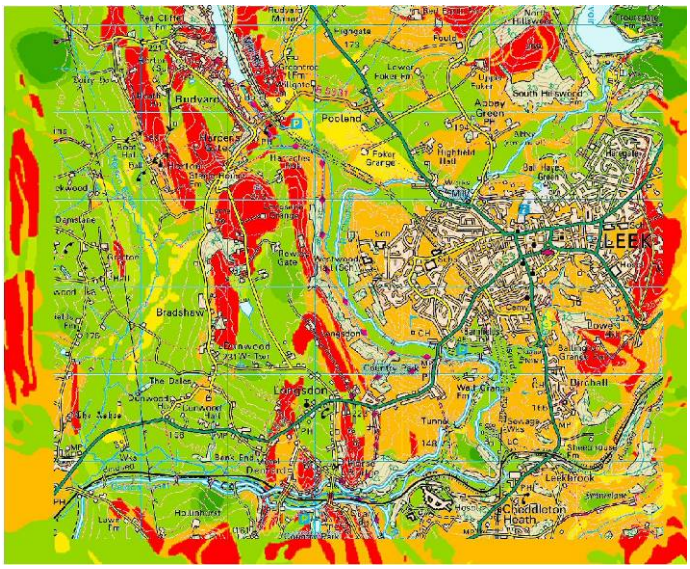
The insulation associated with high voltage equipment can be prone to failure because of undesirable electrical discharge. This electrical discharge can occur due to the presence of contamination or moisture on the surface of the insulation or because of hidden inherent faults within the insulation material itself.

EA Technology at Chester have developed a device which continuously monitors the condition of switchgear by checking for partial discharge activity. Each device has two types of sensor, firstly a TEV sensor which is designed to monitor for electromagnetic discharge activity that can occur within any voids inside the insulation material. Secondly, an ultrasonic sensor, which is designed to detect the high frequency noise associated with electrical discharge activity on the surface of the insulation.

Central Networks have installed a trial of partial discharge monitoring equipment at 17 selected sites where switchgear with a known history of partial discharge activity was located. The equipment was set up to continually monitor the switchgear at the substations concerned and then send this information via a radio link to a remote monitoring point.

Following the installation of the equipment, indications suggested significant partial discharge was occurring at several of these sites. As a result the switchgear at these sites was investigated further and advanced stages of deterioration of the insulation and associated equipment were found due to partial discharge activity. If the partial discharge had been left to develop unchecked, then it is possible that the switchgear could have failed.

4.3 Earthing Information System



Adequate earthing is essential for the safe operation of electrical distribution networks, since this can determine the ability of protective devices to operate swiftly. Without adequate earthing, voltages can rise to levels that are dangerous to people and damaging to equipment.

As the second largest distribution network operator in the UK, each year Central Networks installs a significant number of new substations and other devices where adequate earthing must be provided.

To calculate if earthing is adequate when using a deep-drive installation technique, it is important to know both the depth to any under-lying inpenetrable subsurface and the conductivity of the soil deposits at the installation location. These parameters were known independently to the British Geological Survey (BGS) and the National Soil Resources Institute (NSRI) at Cranfield University, but needed to be integrated to produce a usable tool that could predict the actual earthing requirements at any desired location. Therefore in collaboration with EDF energy, Central Networks initiated a two year IFI project to develop an overlay for our Geographical Information System which would enable designers and project managers to understand the earthing requirements of any site.

4.4 IFI Collaboration

Central Networks seeks to promote collaboration and cooperation between participating DNOs and other external organisations, such as universities and research establishments. Central Networks also recognises the value of collaborating with other industry expertise and has continued to develop partnerships within all these sectors throughout the 2008/09 reporting year.

One key collaborative initiative is the Energy Technology Institute:

Energy Technologies Institute (ETI)

E.ON UK is one of the six founder members of this 50:50 public / private partnership and Central Networks has become actively engaged in representation on the Network and Storage Strategic Advisory Group. Networks are perceived by the ETI to be critical enablers of future energy and climate change technologies, through their ability to facilitate connection and management of a diverse portfolio of low carbon technologies.

The three high level ETI Energy Networks and Storage Programme Work themes are:

- Adaptation of Networks so that they can enable a higher penetration of renewable and distributed generation with good security and quality of supply.
- Management of Networks to provide greater flexibility between supply and demand to offset high CO2 peak demand.
- Reduction in CO2 and environmental impact of current and future Networks.

Central Networks believes that the ETI can provide an excellent opportunity for the partners to collaborate on developing projects, which will radically change the UK's Energy Networks landscape. The ETI aims to inject some £100m per year into UK-based energy research to deliver a step change in funding, strategic direction and outcomes of UK energy science and technology.

Central Networks helped to shape the initial research agenda of the Network and Storage Strategic Advisory Group and an ETI Energy Network stakeholder Event held in the East Midlands on 17th September 2008, confirmed that priority areas for initial project development were:

- Fault Current Management
- Connection and integration of offshore renewable energy farms into the UK power system
- Power flow and increased network capacity
- Energy storage

Additionally two further priority areas were identified for further analysis, potentially leading to future activities:

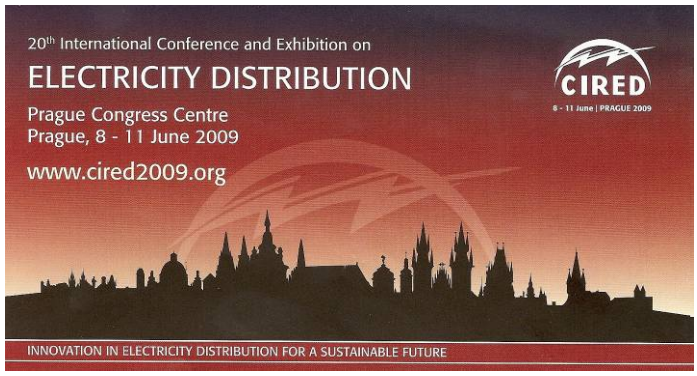
- Long term UK energy infrastructure outlook
- Operational flexibility

4.5 IFI Dissemination

Enabling a wider dissemination of the knowledge gained from IFI projects is seen as an important objective within Central Networks. To avoid the culture of reports being written and filed, where possible, R&D providers are required to prepare an annual review presentation and on completion of the project, a concluding presentation, which will be presented to Central Networks' representatives at face-to-face meetings.

Presentations have also been made to facilitate dissemination external to the company. In particular presentations have been made at the GE ENMAC Users Conference (Automation Algorithm) and EATL Partial Discharge Seminar (PD Demonstration).

IET CIRED 2009 Conference (Prague)



Central Networks are pleased to have been involved in the preparation of seven scientific papers for presentation at the 20th International Conference on Electricity Distribution (CIRED). Six of these papers were jointly authored with our R&D providers. CIRED, held in June 2009, is Europe's leading International Conference on Power Distribution Engineering. The papers prepared for presentation were:

- 0023 Self-healing networks performance improvements by Automated Switching Algorithm
- 0468 Increasing Voltage headroom for the connection Distribution Generation
- 0530 Use of Web based Partial Discharge monitoring to extend Asset Life
- 0560 Analysis of Distribution Losses and Life Cycle CO_2 Emissions
- 0690 Evaluation of Alternative Distribution Network Design Strategies
- 0733 Dynamic Line Rating Protection for Wind Farm Connection
- 0950 Examination of the Impact of possible Distribution Network Design on Network Losses

5. Strategy & Portfolio Management

Future networks will be required to operate more flexibly, efficiently and reliably. The projects within our IFI portfolio will improve Central Networks' existing performance and provide us with the ability to meet future challenges. They will also allow us to ensure the successful integration of new technologies into existing networks.

Our R,D&D strategy supports E.ON UK's low carbon leadership and Changing Energy strategy by developing our understanding of and preparation for the possible future network technologies and designs that will facilitate a Low Carbon economy.

5.1 Key Themes

Central Networks' is committed to helping government tackle the threat of climate change. Under the guiding principles of E.ON's Changing Energy initiative, our R,D&D Strategy will contribute to the Government objectives of achieving 20% renewable energy generation by 2020, with a 80% reduction in CO_2 emissions by 2050.

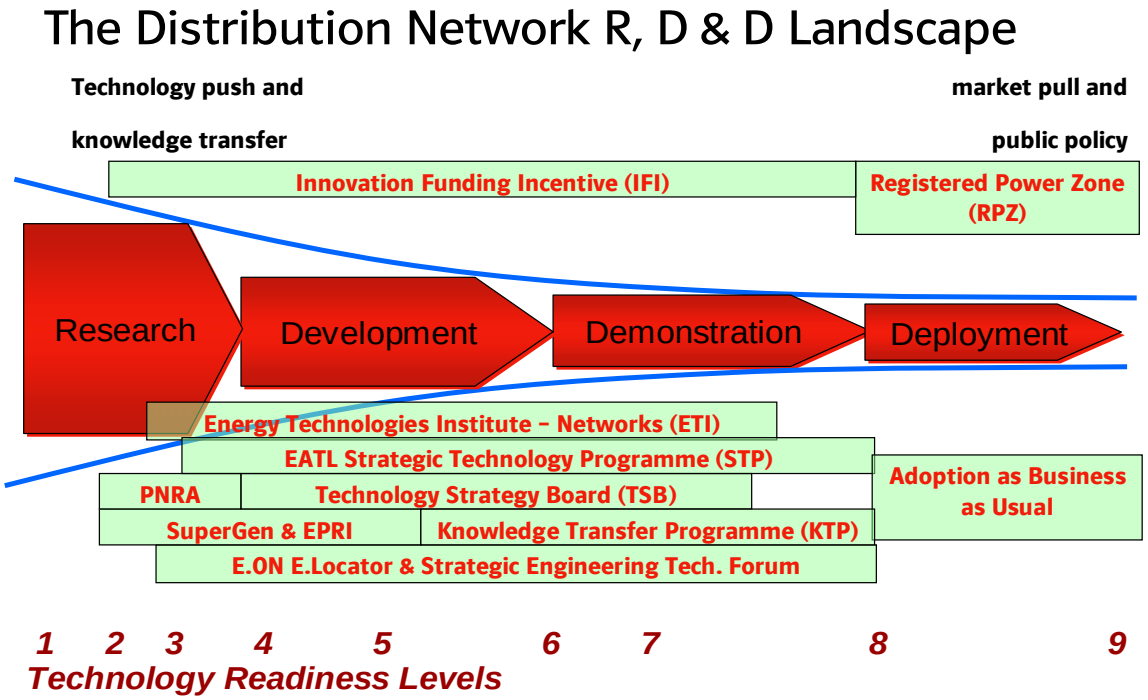
Central Networks' R,D&D Strategy aims to balance four Key Themes:

- **Understanding Networks** - Understanding the capabilities and limitations of existing networks technologies and design across each of Central Networks' strategic objective areas is essential in a changing environment that will challenge the accepted fundamental architecture of traditional networks. Likewise understanding and demonstrating the opportunities from future technologies and designs will enable early adoption of potentially disruptive innovations and ensure their successful integration into existing networks.
- **Supporting Low Carbon** - Supporting E.ON UK's low carbon leadership and Changing Energy strategy by understanding and preparing for the possible future network technologies and designs that will facilitate a Low Carbon economy. Reducing network losses and enabling the economic connection and operation of new types of renewable power sources and distributed generation without reducing network performance or increasing operational risks are the main thrust of this theme.
- **Asset Management Condition Monitoring** - Against a background of an ageing asset base, networks will be required to operate more flexibly, efficiently and reliably. This is expected to result in more complexity in network design and operation and this will have to be balanced by a need to reduce the safety, health and environmental risks. Developing the next generation of asset management tools and techniques will facilitate this objective and maximise the value of Central Networks in the long term, in addition to making our network more environmentally sustainable.
- **Intelligent Networks** - Intelligent Networks are expected to feature prominently in all future network scenarios, whether to support asset management, network performance, active network control, commercial applications, demand side management or network stability. Obtaining, communicating, analysing and processing data are fundamental requirements of future network management. Innovative technologies and arrangements that provide economic and reliable solutions will improve efficiency and enhance customer service.

5.2 Landscape

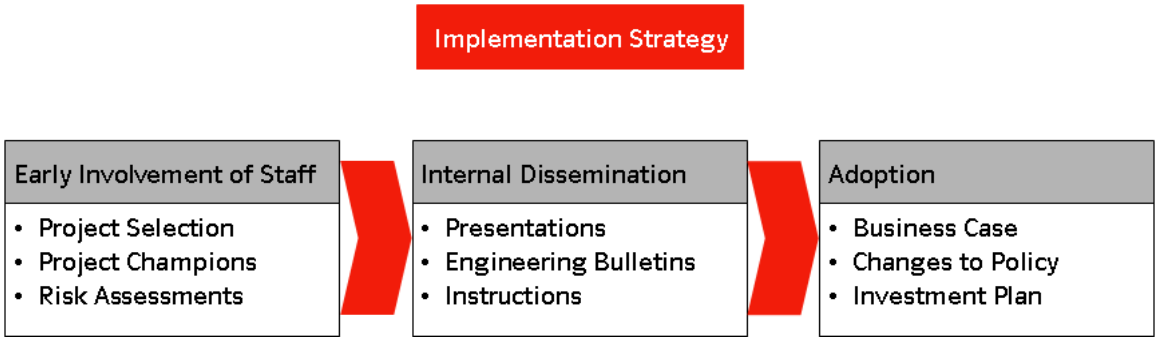
Our programme will include projects from all aspects of the Research, Development and Demonstration landscape, embracing projects of technology readiness levels (TRL) from TR2 to TR8. As projects are developed they progress through the technology readiness timeline until they reach the stage where they can be adopted as Business as Usual. Central Networks R,D&D programme will deliberately endeavour to maintain a mix of projects with different TRL, both in quantity and financial commitment.

The picture below represents the Distribution Network Research, Development and Demonstration Landscape mapped across the technology readiness timeline. Included are the TRL limitations of the IFI and RPZ mechanisms and the principle delivery channels have also been positioned to show their areas of activity. Central Networks intends to continue to engage with all of these delivery channels.



5.3 Adoption

The critical aspect for all successful R&D projects is the transfer from demonstration to adoption. This is essential for IFI scheme objectives if benefits are to be delivered to customers. Central Networks has developed its Implementation Strategy as represented in the diagram below.



With the adoption of more projects anticipated a formal Project Adoption Process (PAP) has been introduced to aid the transfer of individual R,D&D projects in to Business as Usual. At the point of transfer a PAP document will be issued detailing the following information:

- Business Objective Alignment Statement
- Cost Benefit Statement (Adoption Business Case)
- Implementation Strategy
- Integration Impact Statement
- Training Needs Identification
- Health and Safety Case
- Environmental Impact Statement

The diverse portfolio of Central Networks' R,D&D projects includes new technologies and approaches that will result in real practical benefits when adopted, along with other projects that contribute to our increasing knowledge base.

6. Project Partners

Central Networks' portfolio of IFI projects balances collaborative and independent projects seeking to minimise the cost of R,D&D whilst ensuring ideas can be taken forward in a timely manner.

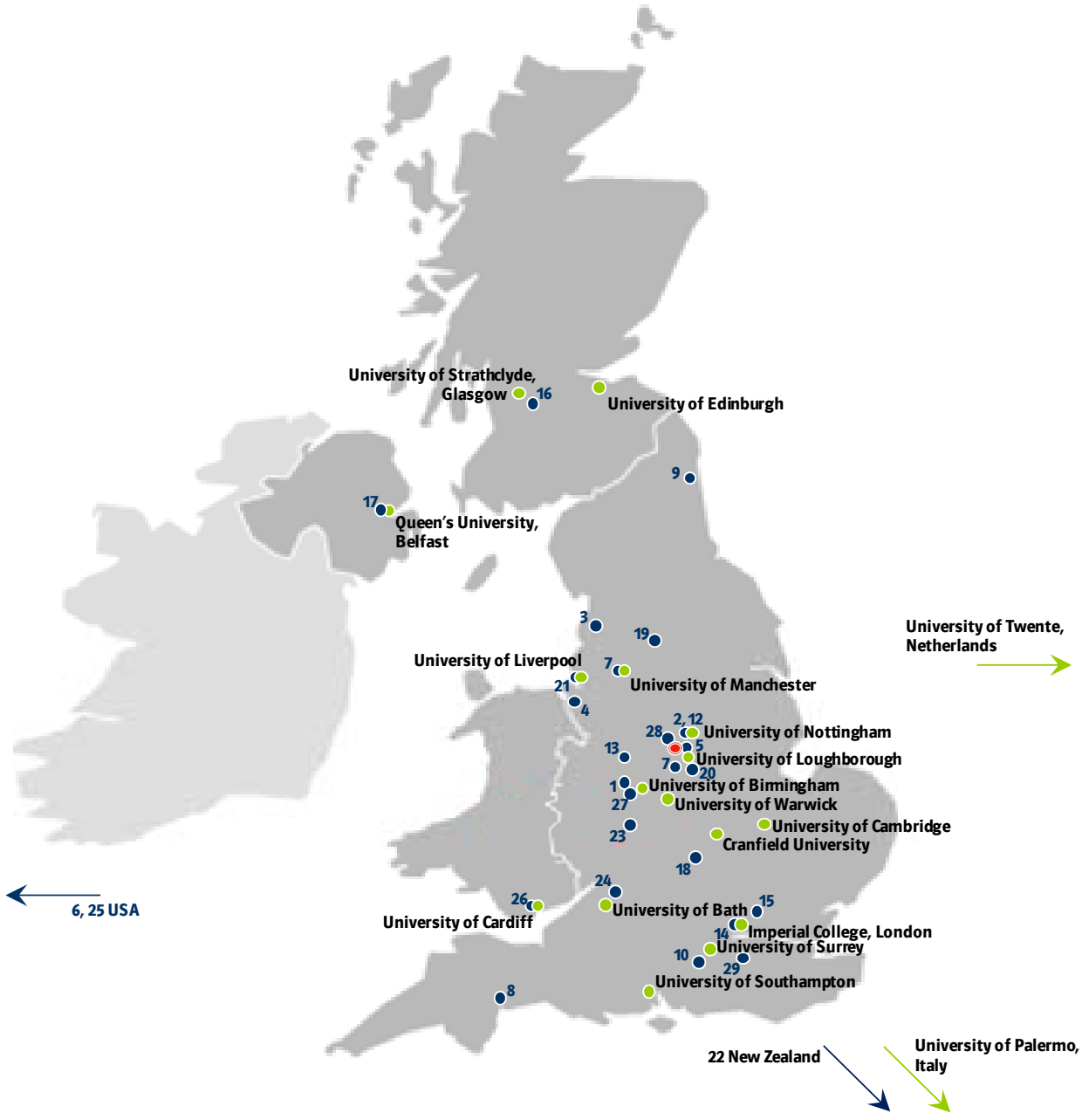
The encouragement by Ofgem of collaboration within the IFI incentive brings with it additional benefits beyond the immediate project outcomes.

Industrial collaborations not only provide new opportunities for established companies, but critically also provide support for young, or Venture Capital funded, businesses pioneering the development of energy efficient technologies. Successful IFI projects offer opportunities to develop and trial beneficial innovative technology with the aim of bringing new products to market.

The engagement and dialogue key to the success of collaborations with the academia research base gives university researchers and students an industrial perspective valuable to future research opportunities, in addition to allowing the open exchange of ideas between sectors.

Through bodies such as the Engineering Education Scheme, companies may also make links with schools to introduce the next generation to the opportunities available within industry and instil a sense of an environment for innovation.

The map below presents a selection of key project partners with whom we have been pleased to work during 2008/09. Brief descriptions of the research establishments and industrial partners are also provided on the subsequent two pages.



- Central Networks' Headquarters, Pegasus Business Park
- Universities
- Research Establishments & Industry

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

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

3 Clarkson Database Services – provide consultancy to the electricity distribution industry in analysing and modelling engineering problems at the R & D level and provide software to supplement major company systems and databases.

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

EA Technology is a Power Asset Management Company with a world-class reputation for delivering innovative business solutions to companies, which supply, distribute and use energy. The company operates the internationally acclaimed Strategic Technology Programme (STP), of which all UK DNOs are members.

5 E.ON Engineering - is part of the E.ON group and leads the group's Research and Development activities. E.ON Engineering (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.

E.ON Engineering prides itself for utilising excellence in scientific research and practical experience to deliver complex engineering solutions that provide real customer value. Focussed on innovation, energy technologies and engineering, it provides technical services and products as diverse as risk-based asset management of technical assets and advanced technology development for a sustainable low carbon future.

6 EPRI - the Electric Power Research Institute (EPRI) conducts multi-disciplinary research and development to meet challenges in electricity generation, delivery and use. Based in the United States, international participation in its technology, operations and environmental programs includes companies from a further 40 countries.

7 ETI - The Energy Technologies Institute is a UK Based company formed from global industries and the UK government. It brings together projects that create affordable, reliable, clean energy for heat, power and transport.

The ETI demonstrate technologies, develop knowledge, skills and supply-chains, inform the development of regulation, standards and policy, and so accelerate the deployment of affordable, secure low carbon energy systems.

8 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

9 NaREC Development Services Ltd - is a leading research and development platform for new, sustainable and renewable energy technologies, supporting the evolving energy industry and transforming innovative new technologies.

10 PPA Energy Ltd - is one of the UK's leading energy consultants. PPA Energy's team comprises a group of highly experienced professionals specialising in techno-economic and management consultancy services for the for the energy sector, with particular emphasis on the power sub-sector.

11 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.

12 4Energy (4e) - is a technology start-up company which designs, develops and manufactures innovative and environmentally friendly climate control devices for industrial and utility applications.

13 AREVA T&D - is a world leader in the transmission and distribution of energy. AREVA T&D provides a complete range of innovative products, systems and services across the whole energy value chain from generation to power consumption.

14 Arup - Arup Energy provides multidisciplinary services focused on energy sector companies engaged in upstream activities from exploration to transmission and distribution, with energy projects developed and delivered across the globe.

15 Current Communications - provides electric utilities a Smart Grid solution that increases the efficiency and reliability of the electric grid while reducing the environmental impact of electric usage.

16 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.

17 Embedded Monitoring Systems – Sub.net is the latest generation of substation monitoring systems from Ems, incorporating wide ranging monitoring and recording functionality for use in the electricity supply industry.

18 Fundamentals Ltd - specialise in the design, development and manufacture of measurement and control equipment for transmission and distribution power systems.

19 GE Energy - provide products and services for all areas of the energy industry. GE has a comprehensive transmission and distribution portfolio with products and services that enable grid intelligence systems and processes.

20 Infoterra - a leading provider of geo-information products and services delivers reliable geospatial knowledge to customers; from satellite and aerial data acquisition to analysis, from developing software to hosting information.

21 KOREC - is one of Trimble's largest distributors worldwide, supplying advanced GPS equipment and solutions to the construction, surveying and GIS mapping industries.

22 MiMoMax Wireless Ltd – provide MiMo based fixed digital radio products and services designed to optimise the utility of the available spectrum. Products are designed to fulfil requirements such as SCADA, Power Line Protection, or Network Back Haul.

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

24 RFL Communications – supply fully integrated networked solutions, providing a full range of design & consultancy service through to the build and implementation of data, voice and video networks.

25 Rolls Royce – is a world-leading provider of power systems and services, operating in the global aerospace, marine & energy markets. Rolls Royce Energy supplies a wide range of power systems, with solutions encompassing generation technologies, control systems, energy delivery & systems integration and manufacturing design.

26 Strategy & Solutions - are involved with earthing system design and assessment, providing measurement, design, policy support, research & development and training services.

27 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.

28 USi - provides engineering services and advanced technology products for the electric power delivery industry, including the design, manufacture and installation of custom engineered electrical and electronic equipment and systems.

29 Willow Technologies - is a specialist supplier of electrical and electronic devices focused on the niche markets of sensing, switching and specialist resistors.

Other Partners - Central Networks 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 Central Networks is bound by mutual confidentiality agreements not to disclose this.

7. Expenditure from IFI Projects

In the year ending March 2009, Central Networks reduced its expenditure on IFI projects slightly. It should be noted that because of the tapering of the IFI recovery in the period up to April 2010, the recovery rate is now lower than that applicable after that date.

The table below details the expenditure during the April 2008 - March 2009 IFI reporting period.

Project Title	External	Internal	Total
EA Technology - STP Overhead Line Module 2 & Forum	£47,584	£5,183	£52,767
EA Technology - STP Cable Module 3 & Forum	£56,873	£5,033	£61,906
EA Technology - STP Plant/Protection Module 4 & Forums	£44,197	£10,380	£54,577
EA Technology - STP Networks for Dist. Energy Module 5	£56,128	£15,382	£71,510
EA Technology - Protective Coatings Forum	£6,490	£671	£7,161
EA Technology - Partial Discharge Project & Forum	£111,147	£7,988	£119,135
ENA R&D Group Programme	£12,177	£5,291	£17,469
EPRI - Advanced Distribution Automation	£23,414	£974	£24,388
EPRI - Intelligent Universal Transformer	£32,472	£1,150	£33,622
Dynamic Ratings Project	£87,874	£36,955	£124,829
Optimising System Design for Performance and Losses	£65,006	£3,722	£68,728
Active Fault Current Management	£67,672	£10,690	£78,363
Understanding Networks with High Penetrations of DG	£55,114	£7,313	£62,427
Effect of Electric Vehicles on Distribution Networks	£36,940	£2,119	£39,059
SuperGen V (AMPerES)	£0.00	£4,383	£4,383
Passive Battery Conditioning for Rural R/C Devices	£0.00	£4,053	£4,053
Non Invasive Overhead Line Inspection Techniques	£1,660	£824	£2,483
Substation Communication Development	£28,878	£9,491	£38,368
Impact of Climate Change on the UK Energy Industry	£13,920	£7,149	£21,069
EA Technology ACTIV Project	£53,049	£16,673	£69,723
Control System Automation Algorithm	£0.00	£42,142	£42,142
SuperGen (FlexNet)	£40,000	£10,736	£50,736
City Centre S/stn Cooling	£15,575	£1,178	£16,753
Vegetation Management	£41,000	£14,552	£55,552
Aerial Mapping Demonstration	£17,667	£4,586	£22,253
Flood Risk Modelling	£32,900	£1,609	£34,509

Vermin Deterrent	£22,000	£1,642	£23,642
GPS Recording of Underground Equipment	£0.00	£6,861	£6,861
Radiometric Arc Fault Location	£15,950	£1,348	£17,298
Transient Fault Detection from Disturbance Recorders	£52,969	£10,146	£63,115
Pole Mounted Fault/Load Monitor	£25,693	£3,567	£29,260
Earthing Information Systems	£0.00	£4,504	£4,504
Demand Side Management Demonstration	£70,922	£1,897	£72,819
Networks to improve Power Quality	£38,305	£1,783	£40,088
Power Communications Meter	£30,825	£3,181	£34,006
Smart Sensors (Smart Dust)	£154,231	£5,074	£159,305
Power Networks Research Academy	£20,610	£4,438	£25,048
Helicopter Partial Discharge Detection	£6,393	£2,201	£8,594
Environmental Monitoring of Fluid Filled Cables	£18,140	£4,119	£22,259
ZEFAL – Zero Fault Level Generation for Active Urban Network	£33,770	£2,145	£35,915
PV Solar for Substation Supplies	£13,210	£2,058	£15,268
Urban Heat Island Study	£3,770	£73	£3,843
Black Start Study	£18,190	£353	£18,543
Power Line Carrier Demonstration	£8,000	£3,155	£11,155
Harmonics issues on Distribution Networks	£38,000	£738	£38,738
Total	£1,518,716	£289,514	£1,808,230

The expenditure on IFI projects is equally divided between the two Licensed Distribution Companies that are owned by Central Networks.

Internal expenditure varied considerably between projects, but the total internal expenditure was 16.01% of the total cost.



8. Future Intentions

8.1 Future Projects for 2009/10

In line with our R,D&D Strategy, we will continue to develop a balanced portfolio of projects engaging in multi-collaborative and bilateral innovative projects with universities, research establishments and industry.

In addition to the projects taken forward as planned from the 2008/09 reporting year, a series of new projects will be commenced in the 2009/10 reporting year. These include the following major new R,D&D projects:

- Protection to Improve Network Reliability with increasing embedded generation
- Tree Growth Regulator Trial
- Optical-Acoustic Tap-changer Monitor

8.2 Tree Growth Regulator Trial

Central Networks are pleased to confirm their support for this new project, which will start in 2009.

Tree growth regulators (TGRs) are used outside the UK to retard the growth of trees in proximity to overhead electricity lines. The principle active ingredient used is Paclobutrazol (PBZ), which acts by suppressing the production of 'gibberellin' the plant hormone that controls cell elongation. The effect is that it reduces tree growth and biomass, without significantly altering its appearance. Research has shown that in addition to reducing tree growth and biomass, PBZ has a positive effect on tree vigour, significantly increasing the growth of fine roots. The demonstrated benefits of PBZ are increased drought tolerance of amenity trees and disease resistance against foliar diseases such as leaf botch and scab.

The intention is not to generally apply TGRs, but to specifically target their application to trees where landowners refuse consent to allow pruning beyond the minimum cut (termed restrictive cuts). The positive effect on the vigour of treated trees should appeal to tree owners and reduce utility costs by allowing future pruning intervals to be brought in line with the interval applicable to the remainder of the circuit.

Before being used for this application, PBZ must be approved by the Pesticides Safety Directorate (PSD) and a scientific trial must be carried out in accordance with ORETO guidelines. On 18th February 2009 the PSD issued an Administrative Experimental Approval (AEA) to ADAS for this trial. In addition to ADAS, the Bartlett Tree Research Laboratory (Reading University) will be involved. The project is supported by six UK DNOs.

8.3 Identification of Future Work Areas

Clearly the identification of new projects is key to the continued success of the IFI and RPZ initiatives, and to the future of distribution networks. During the forthcoming year we will undertake a range of activities in developing our portfolio of projects, including:

- Internal Workshops - to obtain expert views on potential future projects which address the issues faced by distribution networks of the future and deliver benefits to our customers and the environment
- Gap Analysis - to identify areas that can be strengthened within our R,D&D portfolio which fit within the IFI criteria and align with our objectives and E.ON's Changing Energy initiative, and to review developments within the future networks landscape to identify new potential threats and opportunities that merit research
- Work with Collaborative Partners - to explore ideas resulting from the dialogue and exchange of knowledge and experience with external groups

The R,D&D projects identified will address the issues which face the Distribution Network of the future and will enable us to achieve our aspiration of Changing Energy for the better to make a difference for our customers and the environment.

9. Individual Project Reports for Period April 2008 - March 2009

The following pages contain the Individual Project Reports for IFI projects undertaken by Central Networks during the 2008/09 regulatory year.

Project Title	EA Technology - Strategic Technology Programme **EATL STP Overhead Line Module 2 and Forum**		
Description of project	Research and development into all aspects of Distribution Overhead Lines		
Expenditure for financial year	Internal £ 5,183 External £ 47,584 Total **£ 52,767**	Expenditure in previous (IFI) financial years	Total **£ 137,513**
Total Project Costs (Collaborative + external + Central Networks)	**£ 315,285**	Projected 2009 - 2010 costs for Central Networks	Internal £ 5,500 External £ 50,200 Total **£ 55,700**
Technological area and / or issue addressed by project	The STP overhead network programme for budget year 2008/9 aimed to reduce costs and improve performance of overhead networks by increasing understanding of issues that have a negative impact on costs and performance. The programme is expected to also have a positive impact on safety and environmental performance. The projects all address real problems that have been identified by the module steering group members as significant and which require technical investigation and development. The projects completed within 2008/09 year include: S2126_4 Monitoring conductor temperature at fixed current – at Cashlie and Queensferry; S2132_2 Validation of ice accretion models using Deadwater Fell; S2136_3 Continued involvement with European Project COST 727; S2138_2 Investigation of live-line jumper-cutting limitations; S2143_2 Develop in-situ degradation monitor for aluminium OHL conductors – Stage 2: Feasibility study; S2146_2 Torsion tests on composite insulators - Stage 2: Effect of torsion on tension insulators; S2149_2 High durability OHL fittings - Stage 2: Costing for testing prototype high durability fitting; S2150_1 Evaluation of TDR for assessment of tower foundations; S2152_1 Evaluate performance of Czech Icemeter at Deadwater Fell; S2153_1 Suitability of hand-held PD detector for condition assessment of pole-top equipment; S2154_1 Experimental investigation of novel conductors – Stage 1: Icing; S2156_1 Build Three Prototype Field Pole Leakage Current Detectors; S2159_1 LV shrouding - review of current practices and standards. The projects still in progress at March 09 include: S2110_4 Extend OHRAT to include User Defined Covered Conductor, S2136_4 & 4A European Project COST 727: Measuring and forecasting atmospheric icing on structures, including Czech ice meter trial; S2143_3 Develop in-situ degradation monitor for Al OHL conductors - Stage 3 Instrument Development; S2147_2 Increasing vibration limit of CCs to 20%UTS using multiple std or single Hi-mass SVDs,		

<table>
<tr><td></td><td colspan="4">S2151_2 Alternatives to wood poles - Stage 2: Erection and fitting trials on concrete poles,
S2154_2 Experimental investigation of novel conductors at Deadwater Fell – Stage 2: Vibration;
S2157_1 Novel conductors for 132kV wood pole lines.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Technical Transfer, Signifiant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>15</td><td>-9</td><td>24</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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 these projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain benefits including:
Cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults;
Reduce levels of premature failure of assets and so avoid of risk of injury or loss of life or damage to property as a result of falling overhead lines;
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
Extend the service life of towers and reduce potential levels of tower failures;
Review alternatives to wood poles;
Reduce lifetime costs by the appropriate use of alternative materials;
Give Members a better understanding of novel conductors for new-build or re-conductoring 132kV wood pole lines that gives lower capital cost, minimum visual impact, environmental acceptance than other methods of improving power transfer.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Range 2011 - 2014
Dependent upon project</td><td>Duration of benefit once achieved</td><td>Range 2-10 years
Dependent on project</td></tr>
</table>

Probability of Success	Range 10 - 50% Dependent on project	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 64,624
Potential for achieving expected benefits	A number of these projects are at early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. STP has delivered a number of notable innovations since its inception.		
Project Progress at March 2009	Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year. Updated information can be found at:- https://www.stp.uk.net		
Collaborative Partners	CE Electric, EDF Energy, Electricity North West, Northern Ireland Electricity, Scottish & Southern Energy, Scottish Power and Western Power		
R&D Provider	EA Technology Ltd		

Project Title	EA Technology - Strategic Technology Programme **EATL STP Cable Module 3 and Forum**		
Description of project	Research and development into all aspects of Distribution Cables and underground equipment		
Expenditure for financial year	Internal £ 5,033 External £ 56,873 Total **£ 61,906**	Expenditure in previous (IFI) financial years	Total **£ 146,701**
Total Project Costs (Collaborative + external + Central Networks)	**£ 383,992**	Projected 2009 - 2010 costs for Central Networks	Internal £ 5,100 External £ 58,500 Total **£ 63,600**
Technological area and / or issue addressed by project	The STP cable network programme for budget year 2008/9 aimed at identifying and developing opportunities to reduce the costs of owning cable networks. The reduction of whole life cost through greater reliability and improved performance of cables and associated accessories comes under the remit of Module 3. Where appropriate, Module 3 worked with other Modules to achieve common goals. The projects completed within the 2008/09 year include: S3132_12 & 15: CRATER Near Real time Determination & functionality development; S3148_4 Requirements for earthing and bonding of single core MV power cables: feasibility of earthing and bonding of single core MV cable systems; S3151_1 Understanding and controlling thermo-mechanical forces in cables systems: Study to assess work carried out on thermo-mechanical forces in cable systems; S3152_1 Separable connectors and cable compartments in 11 kV switchgear; S3153_1 & 2: Economics and environmental impacts of distribution cable losses: Model development including CO_2 burden calculation; S3168_1 & 2: Comparing future designs of HV and EHV polymeric cables: Review of current specifications and designs and study to determine the interaction between resin and semi-conducting layers; S3169_1: Further studies on the retraction of insulation and over-sheath of cables; S3171_1: Jointing on to wet cables. The projects still in progress at March 09 include: S3132_16: CRATER annotation; S3144_2: Comparison of processes for the treatment of redundant fluid filled cables: Comparative field trials; S3151_2 & 3 Understanding and controlling thermo-mechanical forces in cables systems: Modelling of thermo-mechanical forces in cable systems; S3155_1 Trial testing of triplex cable in plastic ducts; S3157_1 Partial discharge testing of MV cable systems to provide asset risk management data;		

<table>
<tr><td></td><td colspan="4">S3164_1: Develop fluid filled cable design tool;
S3165_1: Performance ageing tests on polymeric terminations,
S3166_1 & 2: Performance of cold- and heat-applied accessories under resin: Assessing interaction between resin and semi-conducting layer.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>-8</td><td>21</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO Member of the programme to gain the following benefits, including:
Offset future increases in CAPEX and OPEX;
CI/CML savings per connected customer;
Reliable, safe and easy to use method of detecting excess moisture in paper insulation of cables;
Reduce excavation required in locating leaks from fluid-filled cables, reduce the times and costs of leak location, and also reducing outage times;
Reduce cable purchase costs;
Reduce design costs,
Increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 2010 - 2012
Dependent on project</td><td>Duration of benefit once achieved</td><td colspan="2">Range 2-10 years
Dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 15 - 50%
Dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£ 87,318</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. STP has delivered a number of notable innovations since its inception.</td></tr>
<tr><td>Project Progress at March 2009</td><td colspan="4">Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year.

Updated information can be found at:- https://www.stp.uk.net</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">CE Electric, EDF Energy, Electricity North West, Scottish & Southern Energy, Scottish Power and Western Power</td></tr>
<tr><td>R&D Provider</td><td colspan="4">EA Technology Ltd</td></tr>
</table>

Project Title	EA Technology - Strategic Technology Programme **EATL STP Plant and Protection Module 4 and Forum**		
Description of project	Research and development into all aspects of Distribution Plant and Protection equipment		
Expenditure for financial year	Internal £ 10,380 External £ 44,197 Total **£ 54,577**	Expenditure in previous (IFI) financial years	Total **£ 145,585**
Total Project Costs (Collaborative + external + Central Networks)	**£ 329,138**	Projected 2009 - 2010 costs for Central Networks	Internal £ 10,000 External £ 45,500 Total **£ 55,500**
Technological area and / or issue addressed by project	The aim of the 08/09 Substation Programme was to develop already well established themes such as life extension of aged assets within legal and health and safety constraints, examination of new technologies, developing an understanding of, and innovative solutions for, the impact on substation assets of increasing levels of distributed generation on networks and condition monitoring techniques. The majority of projects have not only resulted in essential knowledge transfer, they have enabled skills to be developed between STP 4 Members and European partners. Key examples of this were the participation in the AM Forum, (S4185_4), reviewing how transformers are connected within Europe (S4221 _2). Each of which has contributed significantly to developing better understanding of electrical plant, improving safety implications, utilisation, performance and life cycle. Some of these projects have resulted in the creation of further supplementary projects for 2009/2010. The projects completed within the 2008/09 year include: S4164_5: Tap changer monitor stage 5; S4178_2: Impedance Testing of Substation Batteries; S4181_3: Ongoing Programme Of Transformer Post Mortems; S4209_2: Post Maintenance Testing: Project Workshop Jan 09; S4222_2: Alternatives to ENATS 35-1 Transformers: Extension 315KVA Ground Mounted Transformers; S4233_1: 145kV Earthing switch Asset Management Manual; S4235_1: Researching New Techniques for Optimising Plant Maintenance Policies; S4237_1: Battery Cabinet Temperature Control; S4238_1: Module 4 Information Dissemination; S4239_1: Research and Testing of Electrical Contact Cleaning Products; S4241_1: Study of Circuit Breaker Timing Measurements & Methods; S4244_1: Review of methods to dissipate pressure in Substations during equipment failure. The projects still in progress at March 09 include: S4164_5: Tap changer monitor stage 5; S4178_2: Impedance Testing of Substation Batteries;		

<table>
<tr><td></td><td colspan="4">S4185_4: European AM Forum Membership 08/09;
S4221_2: Out Of Phase Modelling Report;
S4224_1: X/R Extrapolation of 12kV Vacuum circuit Breakers;
S4226_1: Environmental Corrosion, Specification, Testing of Plant & Equipment;
S4230_1: Optimisation of Operational Support and Response for Electrical Plant & Equipment;
S4236_1: Aquagen recombination system;
S4245_1: Switchgear – Effect of Low Power Factor Switching. (Joint Investigation with STP5: S5181_1).</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>-9</td><td>23</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO Member of the programme to gain the following benefits, including:
Offset future increases in CAPEX and OPEX;
CI/CML savings per connected customer;
Preventing disruptive failures of oil-filled equipment, tapchangers, earth switches increasing safety and avoid unnecessary scrapping of serviceable components will alleviate environmental impact,
Liaison with European Utilities to share new technology and failure modes;
Increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 2009 - 2014
Dependent on project</td><td colspan="2">Duration of benefit once achieved</td><td>Range 2-8 years
Dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 10 - 100%
Dependent on project</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 67,777</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. STP has delivered a number of notable innovations since its inception.</td></tr>
<tr><td>Project Progress at March 2009</td><td colspan="4">Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year.
Updated information can be found at:- https://www.stp.uk.net</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">CE Electric, EDF Energy, Electricity North West, ESB Networks, Scottish & Southern Energy, Scottish Power and Western Power</td></tr>
<tr><td>R&D Provider</td><td colspan="4">EA Technology Ltd</td></tr>
</table>

Project Title	EA Technology - Strategic Technology Programme **EATL STP Networks for Distributed Energy Resources Module 5**		
Description of project	Research and development into all aspects of Network design and management to enable an increased connection of distribution energy.		
Expenditure for financial year	Internal £ 15,382 External £ 56,128 Total **£ 71,510**	Expenditure in previous (IFI) financial years	Total **£ 150,861**
Total Project Costs (Collaborative + external + Central Networks)	**£ 454,239**	Projected 2009- 2010 costs for Central Networks	Internal £ 15,000 External £ 58,500 Total **£ 73,500**
Technological area and / or issue addressed by project	During the budget year 08/09, Module 5 has consolidated the work programme by clustering much of the work around a number of key issues of relevance in the planning, design and operation of networks for distributed energy resources; namely, fault level management, network losses, load related investment, circuit ratings, power quality and micro-grids. Most of the projects aim to increase network performance and reduce risk whilst having a positive impact on DNOs' environmental performance. The projects completed within the 2008/09 year include: S5169_1 Route plan to transform networks from passive to active networks, S5161_2 Standard Risk Assessment Approach to DNO protection requirements, S5183_1 Communications for active network management, S5187_1 Module 5 participation in ENARD Annex II DG System Integration, S5188_1 & 2 Latest developments in issues associated with low carbon network designs, S5189_1 Techniques for assessing harmonic distortion from generation plant, S5193_1 Fault level management, S5194_1 Load related investment - Feasibility study, S5195_1 Network Losses - Feasibility study, S5197_1 & 2 Power Quality Issues - voltage dips and swells, S5198_1 Micro-grids - Feasibility study, S5200_1 LV Fuse Reach, S5201_1 Distribution Network Losses – Loss Reduction Initiatives. The projects still in progress at March 09 include: S5147_8 Micro-generator clusters - Stage 8 - extension of monitoring / analysis, S5151_5 Network Risk Modelling - Stage 5, S5181_1 Effect of low power factor switching, S5190_1 Whispergen output characteristic monitoring, S5204_1 Monitoring and impact of domestic heat pumps, S5205_1 Fault level management - Feasibility Study.		

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>9</td><td>-10</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">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:

• Contributing to the achievement of Government white paper aims of introduction of significant numbers of micro-CHP units to the UK homes by 2010 and greater numbers beyond then;
• Paving the way for more actively controlled networks in support of a move to a lower carbon economy;
• Enhancing the knowledge and awareness of overseas best practice in DG system integration, which can be applied, as appropriate in the UK;
• Reduction in the cost of connections for developers seeking to connect load and distributed generation;
• Understanding of the potential to use the Senergy / IMASS connection modelling tool to simplify / reduce the cost of providing indicative connection costs;
• Developing a more consistent, knowledgeable and auditable application of LV fuse reach across the network, hence a more reliable network reducing CML/CI;
• Being better placed to assess the possibilities for real reductions in losses on DNO networks to reduce GB GHG emissions;
• Understanding how to accommodate energy saving technologies such as heat pumps into distribution network design.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 2009 - 2016
Dependent on project</td><td>Duration of benefit once achieved</td><td>Range 1-15 years
Dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 5 - 60%
Dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 89,367</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive. STP has delivered a number of notable innovations since its inception.</td></tr>
</table>

Project Progress at March 2009	Most projects or project stages started in the module during 08/09 have been completed, but some projects span more than one year. Updated information can be found at:- https://www.stp.uk.net
Collaborative Partners	CE Electric, EDF Energy, Electricity North West, ESB Networks, Manx Electricity Authority, 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 - 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 £ 671
External £ 6,490
Total £ 7,161</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 21,432</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 44,944</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 1,000
External £ 7,000
Total £ 8,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The projects undertaken through budget year 2007/08 addressed real problems that had been identified by the forum members as significant and which required technical investigation and development. Projects were 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 application.</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.</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 2009	• Quality assessment and evaluation continues on a number of different Volatile Organic Compounds (VOC) compliant paint systems (e.g. Water Based and Epoxy systems). In addition water based pints containing various anti-corrosive pigments are being tested as an alternative to Zinc Phosphate. This work includes laboratory prohesion tests on samples and post application on-site monitoring of treated structures. Field inspections and tests have also been carried out on modified MIO and vinyl systems. • Electrical testing of polymeric insulators contaminated with urethane alkyd paint has been completed. The insulators were tested after ageing using Central Networks' UV cabinet. • The issue of current paint system toxicity has been investigated and a report prepared.
Collaborative Partners	CE Electric, EDF Energy, Electricity North West, National Grid, Scottish & Southern Energy and Scottish Power
R&D Provider	EA Technology Ltd and Central Networks

<table>
<tr><td>Project Title</td><td colspan="4">EA Technology - Partial Discharge Project and Forum</td></tr>
<tr><td>Description of project</td><td colspan="4">Research and development into all aspects of partial discharge in distribution equipment.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 7,988
External £ 111,147
Total £ 119,135</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 156,114</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 515,146</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 5,000
External £ 15,000
Total £ 20,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The projects undertaken in 2008/09 addressed real problems that had been identified by the group members as significant and which required technical investigation and development. Projects were 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 a cost effective permanent partial discharge condition monitoring system using Transient Earth Voltage and Ultrasonic detection.</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="4">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</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2010</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 46,829</td></tr>
</table>

Potential for achieving expected benefits	The demonstration installations have already been successful with investigations at several sites, where significant partial discharge was detected, directly leading 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 2009	• The trial has been extended by the installation of a further six remotely monitored Partial Discharge Detection systems at selected Central Networks Substations where switchgear with a history of partial discharge activity was located. This brings the total number of substation sites being monitored to seventeen. Within these sites there are 240 nodes, monitoring ten different types of switchgear. • Reactive work has taken place at a number of sites where indications suggested significant partial discharge was occurring. • All sites with Partial Discharge monitors now have humidity and temperature sensors fitted to identify if any of the detected partial discharge events can be correlated to environmental events. Two sites which show a correlation between Partial Discharge and humidity will be fitted with dehumidifiers. • Tests on several types of equipment are continuing, to determine partial discharge profiles of Long Term Degradation of Switchgear. • A joint Scientific Paper entitled 'Use of Web based Partial Discharge Monitoring to extend Asset Life' was prepared for CIRED 2009 (Prague) conference. A one page bulletin has been produced, which describes in more detail the Central Networks PD demonstration. This can be viewed on the Central Networks Research and Development web page: http://www.eon-uk.com/distribution/275.aspx
Collaborative Partners	AWE, CE Electric, CLP Hong Kong, EDF Energy, Energy North West, ESB Networks, Guernsey Electricity, Manx Electricity Authority, MoD, Northern Ireland Electricity, Scottish and Southern Energy, Scottish Power, Singapore Power and Western Power
R&D Provider	EA Technology Ltd and Nortech

<table>
<tr><td>Project Title</td><td colspan="3">ENA R&D Group Programme</td></tr>
<tr><td>Description of project</td><td colspan="3">Projects initiated by the Energy Networks Association (ENA) R&D Working Group. The ENA represents all UK Network Operators.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 5,291
External £ 12,177
Total £ 17,469</td><td>Expenditure in previous (IFI) financial years</td><td>Total £ 28,075</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 71,453</td><td>Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 5,500
External £ 20,500
Total £ 26,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The projects undertaken through 2008/09 address real problems that had been identified by the ENA Working Group as significant and which required technical investigation and development.
• Harmonic impedance modelling – Commission a study and develop practical design guidance. The report covers the detailed modelling of cable and overhead line components. Particular attention is paid to cable models appropriate for distribution networks, as this is was the initial objective of the project and literature on modelling of cables is not as widespread as that for other items of equipment.
• SG14 Earthing Project – Improve the existing modelling of distribution earthing systems by assessing the impact of lower voltage earth electrodes on higher voltage 'hot zones' and measuring the resistance of actual distribution substation earth systems.
• Loss of Mains Project - Testing on a range of LoM relays in order to develop a clear understanding of the stability of these relays when confronted by a range of network disturbances applied at a range of relay settings. This information will be used to develop a matrix of optimum settings and test procedures for relay specification.
• Vacuum Bottle Project - Although to date there have been few failures, existing Network Operators have large populations of vacuum interrupters and some of these are approaching the manufacturer's declared guaranteed life expectancy (20 years).
The feasibility phase of a project on Potential Impacts of Climate Change on network resilience will start in April 2009 and will be reported on in the 2009/10 IFI submission.</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>Overall Project Score</td></tr>
<tr><td>12</td><td>-5</td><td>17</td></tr>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="3">Harmonic Impedance modelling - The study objective is the development of an ETR type guidance note to supplement G5/4 (2001) and help reduce and simplify modelling requirements for relatively small capacity 33kV and 11kV connections.
Earthing Project - The project will determine the effects of LV earth systems on the potential touch and step voltages around adjacent HV systems. The results of this should determine the means to provide cost effective, safe earthing systems without the need for extensive separations between HV and LV electrodes, which in a PME system may be impractical and costly to achieve and maintain.
Loss of Mains Project - An improved understanding of LoM relays. Use of more effective settings resulting in a reduced number of unwanted generator trips due to system disturbances. More effective use of LoM relays (e.g. as interface protection) resulting in reduced installation costs.
Vacuum Bottle Project - Feasibility, development and demonstration of possible field test equipment that can determine the residual life of existing vacuum bottles.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2012</td><td>Duration of benefit once achieved</td><td>10-40 Years</td></tr>
<tr><td>Probability of Success</td><td>25%-75% Dependent upon project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 200,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">Harmonic Impedance Modelling - The frequency dependent behaviour of overhead lines and cables was assessed. A sensitivity analysis has shown that simplified models and power frequency models may be used to represent the harmonic behaviour of a single core conductor overhead line and cable with a reasonable degree of accuracy over the frequency range assessed.
Earthing Project - The results from tests and simulations can be used to propose a recommended procedure for measuring transfer potential between HV and LV systems, suitable for inclusion in a DNO policy document.
Loss of Mains Project - The final report provides the basis for new settings guidelines which should enable the majority of perceived benefits to be achieved.
Vacuum Bottle Project – Project is in data collection stage.</td></tr>
</table>

Project Progress at March 2009	**Harmonic impedance modelling** - An interim report has been issued following the first section of work on the cable modelling which addresses the technical cable modelling issues on the original project brief. The extension to the brief to stage 2.5 as it is called is the focus of the final report which is taking the time and will not be available until the meeting of the working group on the 9th of July 2009. **Earthing Project** - During the first phases of the project (as per IFI 2007-2008) the project team were able to confirm by calculation and measurement (including analysis at two live substations) that the LV electrode system interacts with the external potentials created by a close, but electrically separated HV installation. The findings are completely new and help to explain why there is so little evidence of damage to LV equipment when there is an HV earth fault on equipment quite close by. It was possible to quite closely match the theoretical and measured results at the two live test substations but they were each considerably more complicated that the vast majority of installations in terms of their earthing requirements. Because the finding are so new and unexpected there is a need to carry out the following additional activities, which it is anticipated to take 15 months to complete: (1) Theoretical and practical measurements at a simple substation whose earthing arrangements match what is or should be done at the majority of sites throughout the UK. (2) Use computer models of similar and improved earthing arrangements for the same type of substation to develop several case study examples. These will consider changes to the electrode orientations, separation distances, electrode depths etc. Not only will these help explain the effects, but they will also be used to develop more appropriate earthing strategies rules and support equations. The case studies will be documented in a manner that permits publication. (3) Make the findings known in the UK, Europe and Internationally. The main reason for this is to ensure that the new practices become established and for this they must be reflected in the standards that are presently being developed. (4) Prepare text describing a method for calculating the transfer potential for inclusion in ENA TS 41-24. **Loss of Mains Project** - The final report has been published and will be presented as an ENA Technical Report. The only outstanding item is for the ENA Protection Assessment Panel to produce a ENA TS for "Functional Test Requirements for Loss Of Mains Relays" **Vacuum Bottle Project** – Data Collection and Testing Vacuum bottles continue to be recovered from service in Central Networks and tested to identify their residual life.

Collaborative Partners	CE Electric, EDF Energy, Electricity North West, National Grid, Northern Ireland Electricity, Scottish & Southern Energy, Scottish Power and Western Power
R&D Provider	TNEI, EA Technology, Strategy & Solutions, University of Strathclyde and Sterling Power

<table>
<tr><td>Project Title</td><td colspan="3">Electric Power Research Institute - Advanced Distribution Automation</td></tr>
<tr><td>Description of project</td><td colspan="3">EPRI Program 124.005
Research into an Integrated Sensor and Monitoring System for Advanced Distribution Automation</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 974
External £ 23,414
Total £ 24,388</td><td>Expenditure in previous (IFI) financial years</td><td>Total £ 87,800</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 5,700,000</td><td>Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 1,500
External £ 26,700
Total £ 28,200</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The distribution system of the future will be based on Advanced Distribution Automation that includes two key aspects:
• Enabling new system configurations, such as looped feeders, islandable circuits and bi-directional power flows. Such capabilities will make a system more flexible, more able to operate reliably and able to recover from or reduce the impact from outages.
• Integration and strategic use of new intelligent electric devices (IEDs) to enable the use of flexible electrical architecture to produce not only new system configurations, but also to provide a means for expanding customer service options.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technical Substitution / Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-3</td><td>13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">The first generation of integrated sensor and monitoring systems for Advanced Distribution Automation will increase:
• Distribution Reliability by providing continuous monitoring of vital system operating parameters to allow strategic operation of the distribution system.
• Network Utilisation of existing infrastructure by allowing closer control of voltage profiles and maximising energy throughput.
• Flexibility of the network by optimising system performance under changing conditions caused by outages or demand / supply changes.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2015</td><td>Duration of benefit once achieved</td><td>10 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>£ 78,108</td></tr>
</table>

Potential for achieving expected benefits	The project costs are identified early stage costs. They do not reflect the likely full costs of implementation.
Project Progress at March 2009	• A policy paper on the use of IEC 61850 for distribution automation has been under development, identifying both the key benefits and the challenges associated with using this standard. • Information has been circulated regarding the Georgia Power company ADA project. This is based around automation of circuit reclosers. The general objective has been to create a broad scale automatic restoration scheme involving multiple circuits and multiple device manufacturers. Additional objectives were to avoid a SCADA upgrade, utilise legacy equipment and multiple manufacturers and deploy schemes in high load areas that require multiple tie points for restoration.
Collaborative Partners	E.ON Engineering
R&D Provider	Electric Power Research Institute

<table>
<tr><td>Project Title</td><td colspan="4">Electric Power Research Institute - Intelligent Universal Transformer</td></tr>
<tr><td>Description of project</td><td colspan="4">EPRI Program 124.006
Research into a Solid State replacement for conventional power transformers.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,150
External £ 32,472
Total £ 33,622</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 75,112</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 6,500,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 1,500
External £ 36,400
Total £ 37,900</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The Intelligent Universal transformer is an advanced power electronic design that can replace conventional copper and iron transformers. It has the increased functionality necessary for operating on future distribution networks.</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>11</td><td>-2</td><td>13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Intelligent Universal Transformers will provide operating benefits and increased functionality over conventional transformers:
• Increased Utilisation of existing infrastructure by regulating voltage, power factor and frequency.
• Active power quality functionality will eliminate dips, and harmonic distortion.
• Increased customer service options such as DC (or high frequency), three phase power from a single phase line. Remote condition monitoring and control may also provide the option for passive DSM.
• Reduced environmental and safety issues as it will contain no hazardous or harmful dielectrics.</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>£ 31,385</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The project costs are identified early stage costs. They do not reflect the likely full costs of implementation</td></tr>
</table>

Project Progress at March 2009	Silicon Power Corp (SPCO) has been contracted by EPRI to design, build, and test a prototype 100kVA IUT. SPCO is teaming up with Satcon Corporation as a technology consultant and with Howard Industries (HI) as a commercialisation partner. The proposed 100kVA IUT will be a single phase pole-mounted unit, rated for 13.8kV primary, 120/240V secondary. The design has been verified through simulation, and construction and testing of a 25kVA stack and its subcomponents is underway. In parallel with the bench tests, the design of the 100kVA system and procurement of major components for the 100kVA system is proceeding. Results of the bench tests will be incorporated in the final unit design on an on-going basis. This will lead to a robust design for the 100kVA unit. The 25kVA stack bench test will also serve as a lead-in to the construction and testing of a 100kVA IUT in 2009. This 100kVA single phase pole mounted unit will then be factory tested to ensure that the core functionality operates as expected.
Collaborative Partners	E.ON Engineering
R&D Provider	Electric Power Research Institute

<table>
<tr><td>Project Title</td><td colspan="4">Dynamic Ratings</td></tr>
<tr><td>Description of project</td><td colspan="4">Central Networks has developed the first RPZ in the UK. This involves the application of an active rating to a 132kV overhead line based on real time measurements of ambient temperature and wind speed.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 36,955
External £ 87,874
Total £ 124,829</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 194,855</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>Phase 1 £ 345,000</td><td colspan="2">Projected 2009 – 2010 costs for Central Networks</td><td>Internal £ 15,000
External £ 24,380
Total £ 39,380</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Active ratings calculations based on CIGRE 207 equations are carried out at our control centre as part of the RPZ load management scheme that will curtail generation in the event of the line rating becoming exceeded. In addition there are two innovative areas, which required further research and are being funded via the IFI mechanism:
• Risk assessments identified the requirement for a local autonomous overload protection scheme, which calculates the line rating from local parameters in the event of a loss of communications. This would enable a higher current rating to be maintained while preventing the line thermal rating from becoming exceeded.
• As verification of the assumptions made in the derived ratings, sensors will be attached temporarily to the conductors at various critical positions on the overhead line.
• An additional Phase will start in 2009, which will identify the spatial and temporal requirements of alternative sources of dispersed weather data to enable Dynamic Ratings to be applied to any circuit within Central Networks.</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>15</td><td>-3</td><td>18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The project will:
• Develop and demonstrate an overload protection system which is compatible with a central controlled active rating load management scheme.
• Verify the derived rating of the overhead line by comparing with measured real time conductor data.
• Allow Dynamic Ratings to be used on all Primary Overhead Circuits in the UK.</td></tr>
</table>

Expected Timescale to adoption	Phase 1 – Adopted Phase 2 - 2011	Duration of benefit once achieved	20 Years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 214,376
Potential for achieving expected benefits	Once all equipment has been installed, a period of intensive monitoring will carried out to verify the original assumptions and identify if any further issues will need to be resolved.		
Project Progress at March 2009	• On 23rd September 2008, Gareth Evans from Ofgem launched the UK's first RPZ by remotely switching on the overcurrent protection scheme at Skegness. • Comparisons between the calculated line temperature and real measurements from the Power Donut sensors on the 132kV overhead line have shown that there is a close match between actual and theoretical calculations. This has allowed accuracy and resolution requirements to be adjusted. • A joint Scientific Paper entitled 'Dynamic Line Ratings (DLR) Protection for Wind Farm Connections' was prepared for CIRED 2009 (Prague) conference and a second for CIGRE PES 2009 (Calgary) conference. A one page bulletin has been produced, which describes in more detail this project. This can be viewed on the Central Networks Research and Development web page: http://www.eon-uk.com/distribution/275.aspx		
Collaborative Partners	AREVA, USi and Metrological Office		
R&D Provider	AREVA, E.ON Engineering and Metrological Office		

<table>
<tr><td>Project Title</td><td colspan="4">Optimising System Design for Improved Performance and Reduced Losses</td></tr>
<tr><td>Description of project</td><td colspan="4">The project aims to provide Central Networks with an optimising tool, which will consider both performance and system losses of alternative networks, under different degrees of distributed generation penetration, as well as to provide the parameters necessary to identify the financial impacts associated with each alternative.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 3,722
External £ 65,006
Total £ 68,728</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 258,847</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 315,000</td><td colspan="2">Projected 2009 – 2010 costs for Central Networks (Estimate for SDND Tool additional demonstration)</td><td>Internal £ 4,000
External £ 28,000
Total £ 32,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">There is a need for more quantitative analysis of the life cycle costs of network investment. Whereas buying cheaper network components may result in short term savings, Distribution Network operators need to consider how to achieve both improved performance and reduced losses in the network and to consider these in a network environment that contains distributed generation.

We already have developed performance tools, which can be used to develop both strategic and tactical plans, but there is no clear understanding of where losses occur in the distribution system. It is important not to develop these tools in isolation, but recognise that optimal network solutions are required.</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>Overall Project Score</td></tr>
<tr><td>14</td><td>2</td><td>12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The primary aims of this project are to:
(i) deliver better customer service
(ii) reduce system losses
(iii) lower long term operational costs

The optimising tool will be used to facilitate the following:
• Identification of optimum improvement strategies that could include fundamental changes to circuit topology as well as incremental improvements to design.
• Generate optimum network designs that are flexible enough to accommodate different levels of Distributed Generation penetration.
• Influence future asset replacement decisions to maximise the effectiveness and efficiency of the network design and allow the development of design guidelines.
• Provide a mechanism to influence future regulation by providing an objective mechanism for understanding the performance and</td></tr>
</table>

	efficiency drivers of different network designs.		
Expected Timescale to adoption	2012	Duration of benefit once achieved	20 Years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 187,159
Potential for achieving expected benefits	Project is on track and will complete in May 2009.		
Project Progress at March 2009	• The report detailing the analysis of losses on the existing Central Networks distribution system topologies 'Loss calculations for Central Networks' was shared with Ofgem to assist in informing their DR5 losses Incentive decisions. • Report on the 'Impact of cable conductor size on life cycle CO_2 emission' produced and is likely to lead to a change in Central Networks' cable utilisation design criteria. • Following completion of the modelling work a draft version of the Statistical Distribution Network Design (SDND) tool has been provided for testing by Central Networks' Designers and a workshop has been arranged to provide feedback on this design optimisation tool. • Three joint scientific papers have been prepared for CIRED 2009 (Prague) conference. • An additional demonstration of the effectiveness of the SDND tool's capabilities will be undertaken using a real urban Network.		
Collaborative Partners	Imperial College London and E.ON Engineering		
R&D Providers	Imperial College London, CREST Loughborough, Clarkson Database Services, Mathematical & Computer Modelling and E.ON Engineering		

<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 £ 10,690
External £ 67,672
Total £ 78,363</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 25,446</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 319,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 5,000
External £ 15,000
Total £ 20,000</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 economical viability of different active fault current management technologies and identify a preferred option that will facilitate active fault level management in a distribution network.</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.

• How to specify a fault current limiter</td></tr>
</table>

Expected Timescale to adoption	2013	Duration of benefit once achieved	20 Years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£182,874
Potential for achieving expected benefits	Project focus has been broadened to include other Active Fault Current Management alternatives and participation with the ETI has allowed the option of a large scale demonstration to be explored.		
Project Progress at March 2009	• Feasibility of the magnetic fault current limiter remains uncertain. • Evaluation of a Fault Coupling Device (FCD), which employs conventional L/C components with solid state switching devices to mitigate voltage dips and decouple faults. Work at LV has demonstrated the principle is sound and a model of an 11kV FCD device has been developed to allow network studies to be carried out on realistic networks. • A report has been written to provide information on active fault current management to the ETI. This assesses the feasibility for further development and demonstration of this technology by the ETI. The report reviews the various techniques and the status of their development. It identifies possible network locations, calculates the potential benefits of each and quantifies the number of potential applications on the UK distribution network. The report also describes the technical and financial considerations for a full scale demonstration project.		
Collaborative Partners	ETI		
R&D Provider	AREVA T&D, University of Palermo and E.ON Engineering		

<table>
<tr><td>Project Title</td><td colspan="4">Understanding Networks with High Penetrations of Distributed Generation and other Low Carbon Technologies</td></tr>
<tr><td>Description of project</td><td colspan="4">Development of a distribution network model onto which different types and penetrations of Distributed Generation and other Low Carbon Technologies can be incorporated to understand the effects which could be encountered on real networks.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 7,313
External £ 55,114
Total £ 62,427</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 47,742</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>Phase 1 £ 91,500
Phase 2 £ 80,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 4,500
External £ 20,000
Total £ 24,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">New and existing developments are being promoted with the aim of achieving zero carbon communities. This challenges traditional distribution network design in a number of ways:
• There is a requirement to absorb large penetrations of micro generation on to the LV network. (This requirement may extend to several substations where major redevelopment is being proposed.)
• Other low carbon conservation measures applied in the same areas means that local generation could exceed demand at certain periods of the day.
Central Networks would like to support such Low Carbon initiatives by modifying network design to both minimise network losses while maximising the amount of generation that can be accommodated without infringing fault level or statutory voltage limitations.
Network modelling of real sites will be compared with the theoretical study on the Loughborough network being carried out by Loughborough University, Centre for Renewable Energy Systems Technology (CREST) using their Unbalanced Load-Flow Software. Central Networks is providing network data and monitoring actual load and voltage profiles to support this work.
Certain Low Carbon Technologies will substitute electricity for alternative fuel vectors at the domestic level and a second project phase will incorporate these low carbon technologies (e.g. Heat Pumps and Electric Vehicles) and also likely domestic climate change adaptation technologies (e.g. Air Conditioning) into the network model.</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>15</td><td>-2</td><td>17</td></tr>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="3">• Identification of changes required to conventional network design to maximise the penetration of micro generation and other Low Carbon Technologies.
• Understanding the effect of increasing generation output from a cluster of micro generation on the distribution network. In particular thermal rating, voltage rise and fault level.
• Understand the effect of increasing demand from clusters of Low Carbon Technologies and other likely domestic climate change adaptation technologies on the distribution network. In particular voltage drop, flicker and power factor.
• Ability to ensure that any modified design also reduces network losses.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2013</td><td>Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 16,231</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">Modelling results have provided a greater understanding of the effect of clusters of micro-generation on distribution networks. Opportunities for measurements of real micro-generation sites has been limited to two substations on an 'Eco Development', but monitoring equipment has also been used to monitor low carbon demand technologies such as Heat Pumps and this information will be used in Phase 2 of the project.</td></tr>
<tr><td>Project Progress at March 2009</td><td colspan="3">• Further high resolution power quality meters have been installed at additional locations to measure real and reactive power demands of the representative circuits at 1 minute intervals. Two of the original meters will also be moved to new locations
• A domestic electricity demand model capable of providing data with a one-minute time resolution has been completed. The model is constructed at the level of individual household appliances and their usage is based on surveyed time-use data. This provides for appropriate temporal energy use diversity between simulated dwellings. Occupancy data allows the correlated usage of appliances and micro-generation to be represented within an actively occupied dwelling, as well as representing the sharing of appliances, such as lighting, in dwellings with multiple occupants. The core of the model is the simulation of active occupancy, which is provided as one of a number of common data inputs to the individual appliance models. The use over time of domestic appliances is stochastically simulated.</td></tr>
</table>

	The simulation uses a set of physical input factors, such as active occupancy and the level of natural light which are both used to determine the demand for lighting. In a high-resolution simulation, the power demand of all appliances and micro-generation in use at a given time is summed to give an overall domestic demand profile for each dwelling in the simulation. The model is validated by comparing the demand profiles against the measured data being recorded as part of this project.
Collaborative Partners	None
R&D Provider	Centre for Renewable Energy Systems Technology (CREST) Loughborough University and E.ON Engineering

<table>
<tr><td>Project Title</td><td colspan="4">Effect of Electric Vehicles on Distribution Networks</td></tr>
<tr><td>Description of project</td><td colspan="4">Investigate the impact of charging electric vehicles on conventionally designed distribution networks.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 2,119
External £ 36,940
Total £ 39,059</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 23,150</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>Phase 1 £ 90,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 2,000
External £ 5,000
Total £ 7,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The project is looking at the potential impact of Electric Vehicles on the existing UK Distribution Grid systems and considers how the energy in the car battery might be returned to the grid at times of peak load or for system support. ″Vehicle-to-Grid in the UK (V2GUK)″.

It aims to understand the requirements and limitations of the energy demands of a network-connected vehicle fleet when connected to a real distribution network.

Develop a system-level network management strategy to level the demand loading and maximise efficiency, and a local management strategy to control individual vehicle network connections, along with further strategies implemented on board the vehicles.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution / Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>14</td><td>-1</td><td>15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The proposed research will provide knowledge to overcome the barriers in the use of network-connected vehicles by the development of models to represent operating conditions.

Identify real world demand requirements on distribution networks from charging / storage / discharging cycling as determined by actual vehicle operation and the capabilities of the distribution network load.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2013</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 35,159</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Progress after initial delays has been good.</td></tr>
</table>

Project Progress at March 2009	• An impact tool has been completed. This takes into account the connection of a range of Electric Vehicle battery sizes charging at different charge rates. The tool has been used to project an Electric Vehicle load onto measured data for 33kV feeder circuits in Leicester. • A range of connection scenarios at varying uptake levels of Electric Vehicles has been exercised using the impact tool. As a result an insight of the Electric Vehicle impact on the distribution network has been gained specifically for Grid Supply Points, Bulk Supply Points and Primary substations. • In the absence of network data for LV circuits a general analysis of LV circuits has been carried out and this data incorporated from the Electric Vehicle research. • Using the Impact tool and the connection scenarios, mitigation techniques have been assessed and demonstrated. • A report outlining the findings from the above items and describing the input and development of the Impact tool has been completed. The second phase of this project is now under development.
Collaborative Partners	Warwick University, ARUP and E.ON Engineering
R&D Provider	Warwick University and E.ON Engineering

<table>
<tr><td>Project Title</td><td colspan="4">SuperGen V AMPerES</td></tr>
<tr><td>Description of project</td><td colspan="4">Asset Management and Performance of Energy Systems. This is a four year major multi party collaborative project. The research programme is split into 6 work packages & 25 activities. Most of the research will be carried out by the universities. A Central Networks representative has been identified for each work package so that research can be steered toward delivering benefits to the DNOs.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 4,383
External £ Nil
Total £ 4,383</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 138,346</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 2,800,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 5,000
External £ Nil
Total £ 5,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The Engineering and Physical Sciences Research Council (EPSRC) is the major research funding agency for Universities in the UK. One of the EPSRC initiatives is funding work in the area of Sustainable Power Generation and Supply and a call was put out in 2004 to a group of universities to address the issues facing the UK energy infrastructure. The SUPERGEN consortium was formed which addresses a range of issues through a number of targeted work programmes. SUPERGEN and has active collaboration with UK industry funded by IFI and has created a real cross-interest community.
In essence there are 5 main activities:
• improving knowledge of plant ageing
• developing condition monitoring techniques
• developing plant with reduced environmental impact
• developing new protection and control techniques
• enhanced network performance and planning tools</td></tr>
<tr><td rowspan="2">25,00Type(s) of innovation involved</td><td rowspan="2">Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>-4</td><td>15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected aims of the project are:
• To deliver a suite of intelligent diagnostic tools for plant
• To provide platform technologies for integrated network planning and asset management
• To progress plans to develop and implement improved and reduced environmental impact networks
• To develop models and recommendations for network operation and management</td></tr>
</table>

Expected Timescale to adoption	2013	Duration of benefit once achieved	20 Years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 150,000
Potential for achieving expected benefits	Asset management is core to the business. The appropriate use of the emerging opportunities for condition monitoring is key to optimising performance, both financially and in quality of supply. Some of the technologies being developed in this programme are likely to be utilised, however much more important is the broader window this work gives to the global research community. Through demonstration sites the true value of condition monitoring will be identified, enabling appropriate business decisions on adoption of technologies.		
Project Progress at March 2009	The project has been running for over three years and will end on schedule in January 2010. Overall progress has been excellent, and to budget. Development of condition monitoring architecture for power networks has progressed well and is being implemented on a National Grid transmission transformer. Diagnostic and support modules are included, and exploit a range of ageing models including those developed within this project. Implementing these systems within the unique architecture ensures the technologies can be used to embrace ongoing developments and will provide flexibility in future deployment. Work on ageing has shown that the rate of damage may not be affected by harmonic content, but resulting partial discharge signals change significantly. Thus measurements may be susceptible to variation in power quality, leading to incorrect interpretation. An AC optimal power flow method for assessing the maximum distributed generation (DG) penetration in distribution networks has been developed. A model is under development for simulating reliability indices in meshed distribution networks, based on the best available reliability data. In addition, new approaches to considering the uncertainty in reliability data within generation adequacy assessments have been devised. A novel method of detection of loss of grid techniques is being developed. A low-cost system with internet broadcast capability has also been developed: four are currently in operation. An investigation into how regions of a distribution network can operate during emergency islanded mode conditions is also underway. PP-based alternatives to XLPE cable insulation have been characterised. Additional funding has been secured for the more applied work to develop routes to commercial exploitation. Vegetable oils have been shown to be a basis for replacement of mineral oils in HV equipment.		

	A holistic methodology for calculating conductor ampacity and sag, has been developed. The methodology has been employed to analyse the behaviour of low-sag composite conductors on a 33kV wood-pole structure. This has identified benefits and may reduce the need for new overhead lines and allow greater stability for connection of distributed generation. The model is now being utilised on a wood-pole line of Scottish Power and a lattice tower line on the National Grid, and may substantially improve the performance of sections of the network without major infrastructure changes. Technical Exchange: The annual technical meeting in November 2008 was a significant success with over 70 attendees, and allowed access to new developments and broad discussion between the utilities. A final technical meeting, with presentations and posters, will be held in November 2009 to ensure maximum exposure of the collective work carried out within this project. All publications and reports are available to all the partners from a secure web site. Examples of reports written specifically for the industrial partners in the last 12 months are: • Validation of a phasor measurement system distributed across the Northern Ireland Network • Construction of an experimental test-rig that allows generating plant, loads and voltage source converters to be connected to the utility and a controllable diesel generator • Final report on high temperature low sag conductors • Evaluation of Multiplexing techniques to simplify hardware requirements for radiometric PD monitoring • The evaluation of multiplexing techniques to simplify hardware requirements for radiometric partial discharge monitoring • Radiometric PD sensor arrays for retro fitting into in-service plant • A definition of data standards for interoperability • Tool to collect and access data from TNO demonstrator site In addition, to date, over 33 Journal papers have been published or submitted, and 100 conference papers have been published. Technology & trials: The following demonstrator projects have been implemented: • The detection, control and protection synchronous islands have been demonstrated on a 50kVA diesel generator installed outside the laboratory at Queen's University. The demonstration employs a real-time phasor measurement system. • Optimized design of existing overhead lines is being demonstrated by Manchester through analysis of a Scottish Power wood pole line, and a National Grid lattice line.

	• A unique installation for transformer monitoring at National Grid comprising of two 275/132kV, 180MVA transformers, lead by Strathclyde is implementing results of research on condition monitoring architectures, diagnostics and machine learning. • Six substations are being monitored for SP and one for NG by Liverpool University. • Strathclyde and Liverpool have been applying knowledge-based partial discharge analysis and chromatic analysis to data from EDF Energy cable monitoring systems. These will be used to prove data acquisition technology and develop interpretation tools. Further information can be obtained from: www.supergen-amperes.org
Collaborative Partners	National Grid, Scottish Power, Scottish and Southern, Western Power Distribution, EDF Energy Networks, Electricity North West, CE Electric, NIE and Advantica
R&D Provider	Universities of Edinburgh, Liverpool, Manchester, Queens (Belfast), Southampton and Strathclyde

<table>
<tr><td>Project Title</td><td colspan="3">Passive Battery Conditioning for Rural Remote Control Devices</td></tr>
<tr><td>Description of project</td><td colspan="3">Development and demonstration of a passive battery conditioning unit. These units will be retrofitted into existing control boxes associated with remotely controlled pole mounted equipment to extend the life of the standby batteries by maintaining the battery temperature between suitably defined limits.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 4,053
External £ Nil
Total £ 4,053</td><td>Expenditure in previous (IFI) financial years</td><td>Total £ 78,213</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 84,000</td><td>Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 2000
External £ Nil
Total £ 2000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">Central Networks has approximately 4000 remotely controlled pole mounted devices installed on its network. These devices are an essential part of our automation strategy and are required to operate when the power system is de-energised. To enable this, each device has a float charged lead acid standby battery located within the device's associated control box.

The life of these batteries is being considerably reduced by thermal effects within these exposed control boxes and necessitates an intensive battery replacement programme to avoid a loss of performance and protection capabilities on the network.</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>9</td><td>-3</td><td>12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">This project aims to design and produce a passive battery conditioning unit that can be retro-fitted within the most prevalent type of existing control boxes and maintain the battery temperature between suitably defined limits such that extended battery life results.

The benefits are:
• Reduced operational costs associated with battery change programme and disposal of scrap batteries.
• Assurance of required performance and protection capabilities on network.

Reduced environmental impact, as batteries will not need such frequent replacement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2013</td><td>Duration of benefit once achieved</td><td>20Years</td></tr>
</table>

Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 58,832
Potential for achieving expected benefits	Initial testing indicated that battery temperatures could be maintained between predetermined limits, which should extend battery life with consequential cost, reliability and environmental benefits.		
Project Progress at March 2009	Remote monitoring of field sites is ongoing. An ENA R&D project to quantify the amount of battery life extension remains under consideration. A one page bulletin has been produced, which describes in more detail this project. This can be viewed on the Central Networks Research and Development web page: http://www.eon-uk.com/distribution/275.aspx		
Collaborative Partners	None		
R&D Provider	4Energy		

<table>
<tr><td>Project Title</td><td colspan="4">Non Invasive Overhead Line Inspection Techniques</td></tr>
<tr><td>Description of project</td><td colspan="4">Demonstrate and evaluate a series of innovative tools and equipment that are robust, relatively easy to carry and can be used to inspect and measure potential defects on pole top equipment without climbing the pole.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 824
External £ 1,660
Total £ 2,483</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 9,977</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 17,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 3,000
External £ 1,500
Total £ 4,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Regular inspections are carried out on the Overhead Line assets, in the form of helicopter or ground foot patrols. Both these types of inspections have their limitations as they do not allow very close visual inspection or detailed measurements to be taken at the pole top.
Climbing inspections are occasionally carried out where such activity is possible, but this normally requires an outage and incurs safety risks from working at height.</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>9</td><td>-5</td><td>14</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits of this condition assessment tool are:
• Independence from outage requirements and their time constraints
• Measurements provide improved information from sites which allows consistent investment decision making process for overhead lines
• Negates need for climbing thereby reduces safety risks to staff</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2011</td><td colspan="2">Duration of benefit once achieved</td><td>10 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>£ 7,580</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The costs are identified early stage costs. They do not reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive.</td></tr>
<tr><td>Project Progress at March 2009</td><td colspan="4">Following several unsuccessful tests, equipment has been modified and further field trials are planned.</td></tr>
</table>

Collaborative Partners	None
R&D Provider	Eastgood (HK) Ltd, Video capture Ltd,

<table>
<tr><td>Project Title</td><td colspan="4">Substation Communication Development</td></tr>
<tr><td>Description of project</td><td colspan="4">Demonstration of future communication options for Control, System Protection, Data Acquisition and Communication to distributed intelligent electronic devices at operational sites.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 9,491
External £ 28,878
Total £ 38,368</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 107,124</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 315,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 6,500
External £ 61,000
Total £ 77,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">An extensive communications infrastructure has been developed over time to provide critical operational communications and as a result these use a wide range of different technologies with provision from a variety of sources.

Some of these technologies are reaching the end of their useful life and at least one of our service providers has announced that they wish to withdraw some of their services by 2011 and replace it with a Next Generation Networks (NGN), which will not support the current specific requirements of the connected equipment.</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>13</td><td>-2</td><td>15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The operational communications network which will be developed as a result of this trial will have the following benefits:
• Backward compatibility with existing systems and legacy equipment / protocols
• Forward compatibility with future systems and new applications
• Reduced construction costs and time than existing systems
• Reduced running costs from infrastructure simplification and the use of remote management software
• Greater reliability from robust architecture and redundancy
• Increased security from encryption of both encapsulated legacy protocols and modern standards
• Ability to connect with distributed Intelligent electronic devices (IEDs)</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2013</td><td colspan="2">Duration of benefit once achieved</td><td>25 Years</td></tr>
</table>

Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 159,287
Potential for achieving expected benefits	The project content has increased, as opportunities to test alternative equipment have become available. This has resulted in the original costs and benefits being recalculated.		
Project Progress at March 2009	• Installed remote site equipment at 10 substation sites continues to be monitored and assessed. • Trial Ethernet Bridge using border gateway protocol (dynamic routing) - This has proven to provide a reliable operational communications option, with seamless communication link transfers occurring during unplanned system re-syncs ensuring 100% route availability. • Mimomax trial links - Two separate radio links have been installed with monitoring equipment between adjacent operational sites. These links are both approximately 30 – 40 miles and will be used to test; 1) teleprotection and 2) SCADA / voice communications. Bit error and signal strength results on both links have proved satisfactory for the proposed tests. • GPRS Terminal Server – Initial bench tests have been successful on a prototype device and some minor modifications will be made.		
Collaborative Partners	None		
R&D Provider	BT, E.ON IS, Mimomax and Nortech		

<table>
<tr><td>Project Title</td><td colspan="3">Impact of Climate Change on the UK Energy Industry</td></tr>
<tr><td>Description of project</td><td colspan="3">In 2006 the Met Office carried out a scoping study on the impacts of climate change on the UK energy industry. The report was the result of collaboration between E.ON UK, EDF Energy, National Grid and the Met Office Hadley Centre to scope the impacts of climate change on the UK energy industry.

This Phase 2 project was industry funded; it involved 11 UK energy companies and was undertaken by the Met Office. It focussed on the priorities identified by the earlier scoping study.

During the project new tools and methods required to understand the impact of climate change on the energy industry were developed and new data resources designed to address gaps in underpinning information were produced.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 7,149
External £ 13,920
Total £ 21,069</td><td>Expenditure in previous (IFI) financial years</td><td>Total £ 80,358</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 554,000</td><td>Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 1,500
External £ 1,600
Total £3,100</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The project has been run as a series of work packages (WP). Those WPs relevant to distribution and transmission are described below:

• WP1 - Modelling Energy Impacts. Models created to assess impacts of climate change on Electricity Demand, Conductor Performance, Transformer Performance, Cables, Overhead Network, and Wind Power.

• WP2 - Guidance for the Energy Industry on the use of the United Kingdom Impacts Programme new scenarios of climate change (UKCIP09).

• WP3 - Climate Models and Wind Projections. Investigating methods of including estimated future wind resource in wind farm viability.

• WP4 - Climate Change and Underground Cable Performance. Modelling future soil conditions to increase understanding of the impacts of climate change on cables.

• WP6 - Climate change and the Urban Heat Island Effect. Producing information on the urban heat island for use when planning infrastructure in cities.

• WP7 - Final reporting and presentation of the results to each company.

• WP8 - Predicted climatologies for the UK: 2008 - 2018</td></tr>
</table>

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>18</td><td>-5</td><td>23</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits of project are:
• For the elements assessed an understanding of the sensitivity to climate change and key meteorological drives of the impacts. This will highlight priorities for adaptation.
• New models for projecting impacts suitable for inclusion in climate models or for application to climate model output.
• Guidance on the application of climate models to energy industry applications which should result in appropriate use of climate information by Networks.
• New information on urban heat islands and climatologies for the next 10 years to assist infrastructure design and planning.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2011</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>50%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£ 100,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">EP2 project is complete. This was a year long project that finished at the end of May 2008 on time and to budget and to specification.
Project outputs and reports are now available via the project website.
The project has highlighted some areas of Networks where no change to existing practice is required because of climate change and other areas where adaptation may be beneficial.
The new models that have been developed and used in this project will be a useful legacy.</td></tr>
<tr><td></td><td colspan="4">The new information produced specifically for the energy industry has been demonstrated to have significant benefits over what was available previously.
The principle deliverables include a reports specifically aimed at transmission and distribution company infrastructure. Major topics covered are e.g. the impact of urban heat islands on transformer operation and the impact of climate change generally on soil moisture as it impacts the operation and life of distribution cabling.</td></tr>
</table>

Project Progress at March 2009	The following are the headline results: • With a few exceptions, such as the thermal ratings of equipment and apparatus, there is currently no evidence to support adjusting network design standards. For example existing design standards for overhead line conductors do not require change. • The risk profile for transformers will be affected. Design thresholds of temperature will be exceeded more often and there will be more hot nights in cities. • Soil conditions will change; higher temperatures and seasonal differences in soil moisture are expected. Summer soil temperature values currently used will need to be increased by around 0.5°C per decade. • Historical climatologies are no longer valid because climate is not stationary. The new climatologies that take account of climate change are already being adopted and will improve demand forecasting and planning out to 10 years ahead. We still await the DEFRA funded UK Climate Impact Project report (UK CIP09), which will provide additional studies concerning the assignment of probability distributions to the climate changes impacts predicted by EP2. We understand that this report will now be published in mid 2009, in the interim the Met Office have used a number of informed source documents in coming to the predictions of EP2. A UK CIP workshop will be held in late 2009 as part of EP2. An executive summary of the Impact of Climate Change on the UK Electricity Industry can be viewed on the Met Office EP2 website: www.ep2.org.uk
Collaborative Partners	All UK Network operators and most energy supply businesses.
R&D Provider	Met Office

<table>
<tr><td>Project Title</td><td colspan="4">EA Technology ACTIV Project</td></tr>
<tr><td>Description of project</td><td colspan="4">This project investigates active voltage control to increase the efficiency of existing distribution networks and facilitate the connection of more distributed generation. It will undertake demonstrations of the Fundamentals SuperTAPP n+ automatic voltage control (AVC) relay and develop associated modelling criteria for network planners.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 16,673
External £ 53,049
Total £ 69,723</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 46,324</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 300,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 3,000
External £ 17,000
Total £ 20,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">To investigate the performance of the Fundamentals SuperTAPP n+ AVC relay to regulate voltage on 33kV and 11kV network feeders with load and generation present.</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>Overall Project Score</td></tr>
<tr><td>13</td><td>-7</td><td>20</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits of the project are:
• Enabling the connection of distributed generation using a simple solution which requires minimal network modification
• Improving the voltage profile of supply
• Reducing the requirement for network extensions or reinforcement and increasing the capacity for the connection of distributed generation
• Reducing the risk of voltage being outside statutory limits and thus damaging equipment and injuring personnel</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2010</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 223,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">With one trial site installed with promising initial results and a further two identified, there is a high probability that the expected benefits will be achieved.</td></tr>
</table>

Project Progress at March 2009	• The project is currently on schedule and budget. The first relay and monitoring equipment was installed during March in two transformer sites in CE Electric, which has a landfill generator connected on one feeder that is also supplying load • Initial results show that the estimation follows the generator output well for a landfill gas generator with a steady output. It was able to estimate significant changes in output. • Detailed network analysis have been carried out on a 33kV network in Central Networks, which has several wind turbines connected in preparation for a further installation during 2008/09.
Collaborative Partners	CE Electric, EDF Energy and Scottish Power
R&D Provider	EA Technology Ltd, Fundamentals Ltd and E.ON Engineering

<table>
<tr><td>Project Title</td><td colspan="4">Control System Automation Algorithm</td></tr>
<tr><td>Description of project</td><td colspan="4">Development and demonstration of Self Healing Networks by using an automated switching algorithm which can carry out real-time circuit tracing to identify source and alternative supplies.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 42,142
External £ Nil
Total £ 42,142</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 65,946</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 128,000</td><td colspan="2">Projected 2009- 2010 costs for Central Networks</td><td>Internal £ 20,000
External £ Nil
Total £ 20,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Preconfigured automated switching schemes triggered by protection operations, loss of supply or automatic switch operation are generally intolerant of abnormal network running arrangements and are not particularly suitable for distribution networks where regular reconfiguration is necessary for maintenance or repair activities.

Preconfigured automation schemes also need to be individually adapted for individual circuits and therefore require changing if the normal running arrangement is altered for any reason. As this is a regular occurrence on large 11kV distribution networks, it creates a considerable maintenance commitment.</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>14</td><td>-2</td><td>16</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Increased probability of correct restoration operations because the automation algorithm will trace circuit configuration in real time and adapt to any changes. All relevant information on the network held in the control system will be taken into account.
• Improved fault restoration times because algorithm will allow deployment of automation to networks irrespective of abnormal running arrangements or network alterations.
• More efficient data management since no preconfigured schemes are necessary. Operators do not have to switch schemes in/out.
• Improved safety due to ability to carry out real time checks for work activity and temporary plant operational restrictions on circuits.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2009</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>50%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 533,000</td></tr>
</table>

Potential for achieving expected benefits	Automation Algorithm has been adopted. Only minor development is still ongoing. CN(w) deployment awaiting Control System change.
Project Progress at March 2009	• Automation Algorithm trialled on sample network, and closely monitored to understand performance. • Algorithm pre-requisites, assumptions and requirements subject to minor refinement. • ALARP Risk Assessments completed for Centrally Controlled Sequence Schemes. • Meetings with EDF Energy and GE Energy to discuss incorporating the Algorithm into the standard ENMAC product. • Automation Algorithm trial extended to include all remote control devices in one delivery centre. • On 20th March 2009, following successful demonstration period, agreement reached to apply Automation Algorithm to entire CN(e) secondary network. • Scientific Paper prepared for CIRED 2009 (Prague) conference.
Collaborative Partners	GE Energy
R&D Provider	Central Networks

<table>
<tr><td>Project Title</td><td colspan="4">SuperGen - FlexNet</td></tr>
<tr><td>Description of project</td><td colspan="4">SUPERGEN FlexNet will put in place a substantial body of work that will build on the achievements of SUPERGEN FutureNet and lay out the major steps, technical, economic, market design, public acceptance and others, that will lead to flexible networks, including starting to showcase these so that they can be taken up by the commercial sector, Government and Regulators for practical implementation.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 10,736
External £ 40,000
Total £ 50,736</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 27,489</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 7,600,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 8,000
External £ Nil
Total £ 8,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The Engineering and Physical Sciences Research Council (EPSRC) is the major research funding agency for Universities in the UK. One of the EPSRC initiatives is funding work in the area of Sustainable Power Generation and Supply and a call was put out in 2004 to a group of universities to address the issues facing the UK energy infrastructure. The SUPERGEN FutureNet consortium was formed which addresses a range of issues through a number of targeted work programmes and this was extended in 2007 to become SUPERGEN FlexNet. Some key questions being addressed are:
How can we judge the degree of flexibility needed?
How can flexibility be achieved?
How much flexibility should come from primary plant giving margin and how much from secondary plant giving enhanced controllability?
What constrains or encourages flexibility, what technologies are acceptable and what economic frameworks and public policies provide flexibility at the least overall long term cost?</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>-2</td><td>13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Each work stream is expected to deliver benefits.
Shape & Size of Future Electricity Networks will build on FutureNet scenarios.
Markets & Investments will investigate economic issues of the electricity market.
Power System Electronics will investigate why capital cost, cost of power losses and concerns over local network integration result in</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">power electronic systems are currently restricted to voltage control.
• Smart, Flexible Controls will help network operators understand the benefits of changing network operation philosophy and the requirements for implementation.
• Customers, Citizens & Loads will analyse potential contributions that customers and responsive demand can make towards enabling a more flexible energy system, identify barriers to this participation and possible remedies, and analyse place-related factors shaping public acceptance of a more flexible network infrastructure.
• Validation & Showcase will provide the basis for testing research outcomes in a representative environment and demonstrate their effectiveness in addressing problems central to the realisation of flexible power networks.
• Future Energy Mix will consider possible energy changes in 2050 and examine the impact of these changes on energy transportation networks.
• Future LV Networks will investigate losses through auditing and analysing the relative impact of load-profile, sharing, imbalance and sag on losses.
• Education, Deliberative Engagement & Public Acceptance of Future Network will inform social issues and engagement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2012 onwards</td><td>Duration of benefit once achieved</td><td>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>£ 200,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">The new researchers are now integrated in the consortium and working well. Industrial partners have been providing case studies and data to allow researchers to make specific assessments of technologies. The "validation and showcase" workstream is now producing detailed plans for its crucial role in promoting the benefits. Research topics within FlexNet have been identified as directly supportive of the ENSG 2020 Vision and efforts are underway to create some focused studies on this vision. Similarly, we expect benefits for future distribution network design based analysis of the evolution of demand in the electricity sector and demand side management.</td></tr>
</table>

Project Progress at March 2009	The Management Executive meets quarterly and receives detailed progress reports. Thirty PhD projects and 20 research assistants have started although slow recruitment means detailed plans have been adjusted in some cases. Good progress has been made on various forms of modelling: energy resource models, transmission system models and distribution planning models. On top of these there are now outputs to support transmission access review and the security and quality of supply standards. Generic approaches to distribution planning for high DG penetration are being advanced and new technologies such as soft normally-open points are being evaluated. Work on demand-side control has reviewed European experience and proposed operational and settlement options for the UK. Researchers on the Future Energy Mix workstream supported the LENS report with techno-economic appraisals and that work is now disseminated. Further information can be obtained from: www.supergen-networks.org.uk/index.htm
Collaborative Partners	CE Electric, EDF Energy, Electricity North West, EPSRC, National Grid, Scottish and Southern Energy and Scottish Power
R&D Provider	Universities of Bath, Birmingham, Cambridge, Cardiff, Edinburgh, Manchester, Strathclyde, Surrey and Imperial College London

<table>
<tr><td>Project Title</td><td colspan="4">City Centre Substation Cooling</td></tr>
<tr><td>Description of project</td><td colspan="4">This project will develop passive cooling techniques to apply to existing secondary substations. The cooling solutions will address the issues of reinforcement and the growth of air conditioning and cooling in city centre sites.

Specifically deployment will:
• Lower secondary transformer skin temperatures by 10°C on all sites enabling load ratings to be re-benchmarked
• In conjunction with the battery management ensure that power is available for automatic regeneration when required.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,178
External £ 15,575
Total £ 16,753</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 22,513</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£125,000</td><td colspan="2">Projected 2008 - 2009 costs for Central Networks</td><td>Internal £ 1,500
External £ Nil
Total £ 1,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Cooling of secondary transformer without recourse to large forced convection or vapour compression air conditioning systems.

Developing systems that are easy to fit to existing substations with minimal changes for specific site requirements, use less power than a domestic light bulb with little maintenance requirement.

Extend the capability of passive cooling in substations to ensure that the need for moving parts is drastically reduced.</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>Overall Project Score</td></tr>
<tr><td>10</td><td>-6</td><td>16</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits include:
• Extended life of installed transformer capacity.
• The removal of load rating issues from secondary transformer sites especially during summer months</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2009</td><td colspan="2">Duration of benefit once achieved</td><td>20 Years</td></tr>
<tr><td>Probability of Success</td><td>85%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£128,340</td></tr>
</table>

Potential for achieving expected benefits	Following improvements identified with the Alpha system, expectations are high regarding a successful outcome to this project. Although installation of the final system was delayed, this provided an opportunity for a more extensive monitoring period during the summer of 2008 and improvements to be incorporated into the final design from the experience gained at other sites. This work has been undertaken in conjunction with a Carbon Trust sponsored project in the telecommunication sector to provide alternative methods of cooling to traditional solutions.
Project Progress at March 2009	• Replacement passive cooling system has been successfully installed in Birmingham Wholesale Market. The 3MVA Substation is heavily loaded and subjected to non-cyclic refrigeration demand. • Equipment at the site is being monitored and final report will be provided in Q3 2009. • Advice has been given regarding optimal types of passive ventilation which will be applicable to other installations.
Collaborative Partners	EDF Energy
R&D Provider	4Energy

<table>
<tr><td>Project Title</td><td colspan="4">Vegetation Management</td></tr>
<tr><td>Description of project</td><td colspan="4">This project proposes to:
• Monitor vegetation growth at 1650 sites across the UK network
• Develop a software model, which will take into account factors such as tree species, bio-climatic area, and the effect of climate change, in order to estimate the speed of vegetation growth at different sites.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 14,552
External £ 41,000
Total £ 55,552</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 141,960</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 1,740,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 25,000
External £ 37,000
Total £ 62,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Historically vegetation management has been based on a single time based interval across the company, but rate of vegetation growth differs because of locational micro climates and soil conditions.
Nationally the growing season has been increasing due to climate change factors.</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>Overall Project Score</td></tr>
<tr><td>14</td><td>-4</td><td>18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The software tool will enable Central Networks and other DNOs to predict whether areas are high growth or low growth areas, and hence allow two-fold savings:
• In high-growth areas, proactive cutting can be carried out, therefore reducing the number of outages (by cutting before the vegetation enters the live zone) and cost to DNOs.
• Simultaneously, cutting cycles in low growth areas will be extended, resulting in fewer spans being cut each year.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2011</td><td colspan="2">Duration of benefit once achieved</td><td>20 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>£400,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The measurements for the first year of the project have been completed and analysed. The results indicate a very strong correlation between bioclimatic zones and tree growth rates. This indicates that the project has a high potential to deliver the expected results.</td></tr>
</table>

Project Progress at March 2009	The first year of the project has been completed successfully and exceeded our expectations in terms of the results obtained. The first measurements for 2009 have now been completed with a second measure programmed for November 2010.
Collaborative Partners	EDF Energy, Electricity North West, Scottish and Southern Electric, Scottish Power and National Grid.
R&D Provider	ADAS

<table>
<tr><td>Project Title</td><td colspan="4">Aerial Mapping Demonstration</td></tr>
<tr><td>Description of project</td><td colspan="4">A demonstration of how aerial digital photography can be used to enhance existing geospatial systems and confirm existing data positioning.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 4,586
External £ 17,667
Total £ 22,253</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 42,902</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 94,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 4,500
External £ 8,000
Total £ 12,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The introduction of OSMasterMap as a background for existing GIS data has had the unforeseen consequence of certain asset types (in particular overhead distribution poles), which will retain their inaccurate position on the new map base. Software is available to correct these inaccuracies, but there was an uncertainty as to the degree original data was correctly positioned and therefore a risk that any errors could be compounded.

Conventional digital orthophotograph provides a mechanism to accurately position overhead poles and can also provide asset height information. This can therefore be used to identify any errors as well as to provide additional functionality. In addition the latest digital imagery can also provide CIR (False Colour Infrared) and panchromatic imagery. These can be used to develop Digital Surface Models classified by vegetation type and height.</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>15</td><td>-1</td><td>16</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">This project will demonstrate the capabilities of aerial digital photography for providing information on overhead assets. In particular the following areas shall be evaluated:
• Understanding potential pole positioning errors.
• Identifying long spans where conductor clashing may be a problem.
• Providing ground clearance information.
• Location of different vegetation types.
• Location of vegetation of different heights.
• Identifying land use type including recreation and potential fishing sites.</td></tr>
</table>

Expected Timescale to adoption	2009	Duration of benefit once achieved	20 Years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 167,000
Potential for achieving expected benefits	Initial progress has been very satisfactory and this project is likely to achieve the expected benefits.		
Project Progress at March 2009	• A trial to demonstrate how pole positions could be accurately positioned on GIS data sets from analysis of aerial photography was undertaken for part of Gloucestershire and Worcestershire. • The trial indicated that there were insufficient errors to justify the expenditure involved in a complete remapping exercise. • A programme to analyse suspect excess span lengths, which could be more susceptible to clashing in high winds is under development. This uses pole and tower positions previously obtained from the earlier Leicestershire data capture.		
Collaborative Partners	None		
R&D Provider	Infoterra and Rolta		

<table>
<tr><td>Project Title</td><td colspan="4">Flood Risk Modelling</td></tr>
<tr><td>Description of project</td><td colspan="4">Predicting flooding and calculating flood risk is complex. The Environment Agency provides information on the risk from river flooding (fluvial) and sea breach, but information on floods caused by direct runoff (pluvial) is limited. The extreme precipitation of July 2007 caused at least one pluvial event in the Central Networks region and there is a need to identify the potential risks at critical sites.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,609
External £ 32,900
Total £ 34,509</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 12,521</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 97,500</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 4,500
External £ 25,000
Total £ 29,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Pluvial flooding results from high intensity or prolonged heavy rainfall leading to overland flows and ponding. Flooding can also occur due to exceedence or blockage of watercourses and drainage systems. The risk depends upon a number of factors including topography, amount of impermeable surface within upstream catchment areas and the drainage capacity within the catchment area.
Using a series of modelling tools on GIS and OS data will allow catchment areas around critical sites to be identified and the quantity of runoff calculated. Existing drainage and watercourse features can then be modelled and restrictions identified where pluvial risks are identified. Information from the DEFRA 'Making Space for Water' programme will be included.</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>15</td><td>-1</td><td>16</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The proposed work will help to identify those critical sites at risk from pluvial flooding and enable a strategy that will prevent equipment damage to be developed.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2011</td><td colspan="2">Duration of benefit once achieved</td><td>25 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>£ 33,408</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">This project has progressed well, but some delays were experienced with identifying suitable sites to validate the model.</td></tr>
</table>

Project Progress at March 2009	• Final version of Pluvial Flooding Report has been produced detailing a cost effective risk assessment approach to identifying sites with the highest risk of pluvial flooding, based on topography details and probable runoff volumes. The runoff volume is dependent upon the catchment area characteristics, including soil imperviousness and an urban index function. • This method was also compared with previous pluvial flooding models designed for smaller catchment areas in mainly rural applications. Variations between the model outputs are being investigated and a validation exercise undertaken. • The models have been used to identify potential sites within Central Networks that may have an increased probability of pluvial flooding, but further analysis is required.
Collaborative Partners	None
R&D Provider	ADAS

<table>
<tr><td>Project Title</td><td colspan="4">Vermin Deterrent</td></tr>
<tr><td>Description of project</td><td colspan="4">Research the cause of vermin damage and the efficiency of various means of deterrent.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,642
External £ 22,000
Total £ 23,642</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 6,022</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 30,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</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 growth in the UK's grey squirrel population has resulted in a perceived increase in supply interruptions caused by vermin contact to overhead line plant and equipment.
This project will identify the type of equipment and locations at risk from grey squirrel damage and what can be done to reduce their attraction. This will include an investigation of the use and effectiveness of humane deterrents.</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>7</td><td>-4</td><td>11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The aim of this project is:
• Reduction in number of supply interruptions from vermin contact
• Consequential improvement to performance & saving of fault costs
• Demonstration of a proactive approach to environmental protection</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2010</td><td colspan="2">Duration of benefit once achieved</td><td>20 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>£ 3,656</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The initial work has identified areas which will be explored in more depth.</td></tr>
<tr><td>Project Progress at March 2009</td><td colspan="4">• As part of this project students from Ecclesbourne School supported by ADAS and Central Networks staff carried out a research project as part of their involvement in the EES.
• The effectiveness of various deterrents (including visual, and acoustic) were investigated. Their preference was for a variable ultra-sonic deterrent.</td></tr>
</table>

	• ADAS have also investigated a number of alternative humane solutions to the vermin problem and have visited a sample of sites where electrical outages attributed to vermin have occurred. Their report details previous research into the long term effectiveness of various deterrents and advises on any the legal restrictions associated with them.
Collaborative Partners	Engineering Education Scheme (EES)
R&D Provider	Ecclesbourne School, Derby and ADAS

<table>
<tr><td>Project Title</td><td colspan="4">GPS Recording of Underground Equipment</td></tr>
<tr><td>Description of project</td><td colspan="4">Demonstrate the viability of GPS equipment to record underground equipment and identify the requirements both for electronic transfer of data and the operator interface.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 6,861
External £ Nil
Total £ 6,861</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 14,150</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 21,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</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 upgrade to OSMasterMap will enable the accurate capture of asset locations using GPS recorders. A demonstration of this technique using hand held equipment will be carried out to prove the functionality and identify how best to achieve a user-friendly operator interface.

Positioning underground assets such as cables and joint positions is considered to be the most challenging requirement (regarding satellite visibility) and provided the most benefits (buried assets would be the most difficult to locate in the future).

Determining a user-friendly operator interface to the GPS recorder device, such that information transfer can be efficiently carried out, while data entry requirements could be kept simple, but sufficiently comprehensive to fulfil business needs.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>8</td><td>-3</td><td>11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The accurate location of buried assets will assist future work, by:
• Reducing the time spent finding buried equipment
• Increasing safety when future excavations are being carried out by internal or external parties

Providing a GPS recording device with a user-friendly interface will benefit measurement collection, by:
• Reducing the time spent recording the position of equipment
• Ensuring that the device is used and that the required information is captured</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2011</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>50%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 29,000</td></tr>
</table>

Potential for achieving expected benefits	Benefits will not be delivered
Project Progress at March 2009	• After extensive trialling of the GPS receiving equipment, it has been decided that there is insufficient cost benefit to proceed with this project.
Collaborative Partners	None
R&D Provider	Korec and Central Networks

<table>
<tr><td>Project Title</td><td colspan="4">Radiometric Arc Fault Location</td></tr>
<tr><td>Description of project</td><td colspan="4">Applied research, and follow up installation of a system to triangulate fault locations on overhead lines from the high frequency radio wave signatures produced from an arcing fault.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,348
External £ 15,950
Total £ 17,298</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 223,500</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 2,600
External £ 8,600
Total £ 11,200</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The principle of the technology is:
• There is a correlation between RF discharges and network faults on overhead lines
• The RF signal can be picked up by a radio antenna up to around 70km away
• If antennae are spread across the network, a mesh is formed – in a similar manner to the GSM network
• If a fault can be accurately clocked, triangulation can be used from a number of base stations to give an approximate geographic location (accuracy ~300m)
• If this information is linked to GIS / SCADA data a more accurate fault location can be obtained</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>10</td><td>-5</td><td>15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">If successful, the use of radiometric ’cells’ could be used to accurately locate fault locations on all overhead line networks within that zone.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2011</td><td colspan="2">Duration of benefit once achieved</td><td>10 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>£ 99,489</td></tr>
</table>

Potential for achieving expected benefits	The project has achieved a degree of success already and the analysis of the data collected so far is ongoing. Previous work by Strathclyde University funded by EPSRC and Midlands Electricity indicated that Power System related arcing events can be detected radiometrically and determined the optimal frequency for reception. As the project has progressed and more 'in the field' experience has been gathered it has become possible to make changes to the equipment setup which allow the sensitivity of the equipment to be increased and data to be gathered more quickly thus increasing the chances of success.
Project Progress at March 2009	• Development of software for logging events and analysis of the signal wavefronts has been completed. • Four monitoring station sites have been selected in Scotland for the trial and three sites have been brought into service: Shotts – Dec 2008 Kirkintilloch – Feb 2009 Bellshill - Feb 2009 • At each site, detection equipment has been installed and commissioned for the trial. • A number of correlations have been made between fault records and the data collected.
Collaborative Partners	Scottish Power, Western Power Distribution, Scottish & Southern Energy, Electricity North West and CE Electric UK
R&D Provider	University of Strathclyde

<table>
<tr><td>Project Title</td><td colspan="4">Transient Fault Detection from Disturbance Recorders</td></tr>
<tr><td>Description of project</td><td colspan="4">Use of Disturbance Recorder information to determine a search area for of potential faults by interpreting the waveform characteristics associated with self-healing pecking faults.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 10,146
External £ 52,969
Total £ 63,115</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 265,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 12,500
External £ 133,000
Total £ 145,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Pecking faults are small discharges caused by; voids within the insulation of distribution cables, or surface tracking over compromised insulation on equipment. The discharges are insufficient to cause circuit protection devices to initiate a trip signal and will self-heal temporarily. As these network disturbances do not cause loss of supply and are difficult to detect, they are normally ignored, but evidence suggests that they can re-occur at irregular intervals and are often the precursor to the development of a more serious fault. If these incipient faults can be identified with equipment that can detect the small dips on the voltage waveform and short surges in current, then proactive action could be taken. If the pecking fault waveform changes are sufficient to allow the disturbances to be interpreted as an impedance value to the point of fault, then this information can be used with GIS data to determine search areas allowing these potential faults to be located and rectified before they cause a loss of supply to any customers.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>2</td><td>11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Detection of incipient self-healing faults will improve network performance and reduce customer interruptions by determining the location of potential faults and enabling proactive asset management.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2013</td><td colspan="2">Duration of benefit once achieved</td><td>20 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>£ 393,229</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Initial installations have provided useful disturbance records of incipient faults.
Initial meetings with R&D providers were very positive.</td></tr>
</table>

Project Progress at March 2009	• Installation of five disturbance recorders at two substations has provided useful disturbance records of incipient faults. These records have been shared with several relay manufacturers to ascertain the current capabilities of existing equipment. • Five other substations have been identified as potential sites for disturbance recorders. These have different circuit characteristics from the initial installations and will increase the probability of capturing more useful disturbance records. Two other companies are interested in supplying detection equipment and this is under consideration. • Initial work by R&D providers will be to determine feasibility of determining fault location from the captured example waveforms. • Installation of trip battery monitoring circuits at substations with electro-mechanical relays has the added benefit of providing performance information about the circuit breaker and protection whenever a fault occurs. This information is normally unavailable at these locations.
Collaborative Partners	Embedded monitoring Systems (EMS) Ltd
R&D Provider	Elimpus (Strathclyde University) and E.ON Engineering

<table>
<tr><td>Project Title</td><td colspan="4">Pole Mounted Fault Passage Indicators</td></tr>
<tr><td>Description of project</td><td colspan="4">The aim of this project was to develop and trial a reliable non-contact Fault/load remote monitor up to 33kV.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 3,567
External £ 25,693
Total £ 29,260</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 75,121</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 106,500</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 2,000
External £ Nil
Total £ 2,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Fault Passage Indicators (FPIs) have been used for many years and have evolved from simple blinking light indications to the latest devices that include an array of communications and sensor technology. The Polestar FPI was selected for a trial with the aim of gathering data and developing communications protocols to allow the FPI to communicate with the control room management system.

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

The objective of this project is:
• Trial the device and prove the concept.
• Develop load monitoring algorithms
• Evaluate the potential replacement for existing dumb fault passage indicators (FPIs) and power outage devices (PODs) on OHL networks
• Obtain real-time fault/load data to improve fault location response times
Obtain historical load data for planning network reinforcement or development</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental / Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>12</td><td>-5</td><td>17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits are:
• Reduction in CMLs and CIs

Improved quality of supply - On-line load monitoring to assist in network management , gathering fault data and outage data, can be used with automation schemes in helping to determine which NOP to close and what load would be picked up, gathering of historical load data for planning or network development and faster restoration</td></tr>
</table>

Expected Timescale to adoption	2012	Duration of benefit once achieved	10 years
Probability of Success	75%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 151,000
Potential for achieving expected benefits	This project stems from a strategy of developing our infrastructure to allow greater visibility of the network loads in the control room at any instant in time. The Pole Stars can be installed without any outage making them an attractive device. Once the results are calibrated they will provide another means to better manage issues such as DG connections.		
Project Progress at March 2009	• Following the installation of the initial six prototype devices during the 2007/08 period, a further 30 demonstration units were purchased and installed. • Problems associated with voltage field fluctuations have occurred at several sites requiring POD functionality to be upgraded. • Site information from units has confirmed transformer magnetising inrush is being successfully mitigated for. • Installed units are awaiting more real fault information to occur to allow further analysis.		
Collaborative Partners	Electricity North West and Scottish & Southern Energy		
R&D Provider	Nortech		

<table>
<tr><td>Project Title</td><td colspan="4">Earthing Information System</td></tr>
<tr><td>Description of project</td><td colspan="4">The project will develop a GIS Information System to assist the installation of rural ground earthing systems, by providing a graphical presentation of ground conditions and the likelihood of a suitable earthing resistance being met.

Earthing rural substations can be very labour intensive, with the need to drive earthing rods vertically downwards into the ground to a depth of 12 metres to achieve the necessary 10 ohm resistance. Usually rods are driven by pneumatic tools or by hand and where hard ground restricts the depth of installation an array of rods are installed at shallower depth, or an earthing system is installed some distance from the substation to achieve the required resistance.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 4,504
External £ Nil
Total £ 4,504</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 229,380</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 465,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 5,000
External £ Nil
Total £ 5,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">A network-wide information system that will help them to improve planning and costing of new and replacement earthing installations.</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>9</td><td>-4</td><td>13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits are:
• Accurate estimation of the cost of installation of rural ground earthing systems
• Advice on the number and technique of installation
• Increased employee safety</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2012</td><td colspan="2">Duration of benefit once achieved</td><td>20 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>£ 110,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The potential for achieving expected benefits is as originally stated. However the resistivity data being provided may also be used for other design work and will therefore provide additional benefits.</td></tr>
</table>

Project Progress at March 2009	The project is progressing well and a map has been produced for the trial areas in both the EDF Energy and Central Networks areas demonstrating the final output. The map uses a traffic light system to show the type of earthing installation (single earth rod, multiple earth rods, horizontal conductor or special) required to provide 10 ohm earth. An interim report has also been produced covering the methodology, the processing of the data and the output of the model. The data processing included: the construction of the spatial framework, attribution with resistivity and strength characteristics, calculations to determine likely earthing-resistance results, comparison of the earth-resistance results with the proposed installation scenarios, final assessment of installations, adjustments for lithological variability and the export of the data to a single layer of 'traffic light' attribution. The final map covering the complete EDF Energy and Central Networks areas is on schedule to be completed by June 2009. However there are still some concerns about the underlying resistivity data and further research work may be required to provide some further confidence. The resistivity data will also be used within Central Networks to support other earthing design work.
Collaborative Partners	EDF Energy
R&D Provider	British Geological Survey and Cranfield University

<table>
<tr><td>Project Title</td><td colspan="4">Demand Side Management Demonstration</td></tr>
<tr><td>Description of project</td><td colspan="4">Research into all aspects of Demand Side Management.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,897
External £ 70,922
Total £ 72,819</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 581,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 3,000
External £ 127,000
Total £ 130,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Previous investigations have identified the potential for medium sized Heating, Ventilation and Air Conditioning (HVAC) loads to provide active demand side management at times of peak loading.

This work will now be extended into a widescale demonstration, which will aggregate the loads from several sites and control them in real time.

This will enable the development of a scalable and flexible framework for Distribution Demand Side Management that will:
• Provide geographical control to alleviate thermal congestion issues and other stresses on networks.
• Enable an increase in the uptake of intermittent renewable generation and micro-generation.
• Include the physical electrical systems, communications and control aspects.
• Etc.</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>11</td><td>-1</td><td>12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The demonstration will prove that it is technically possible to control significant amounts of load in response to a signal at times of peak demand, reduced generation capacity or network constraint.

Systems to develop active demand side management will be explored and routes to commercialisation investigated, with an emphasis placed on releasing the true value.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2015</td><td colspan="2">Duration of benefit once achieved</td><td>25</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>£ 795,000</td></tr>
</table>

Potential for achieving expected benefits	The project is in its initial stages, but is expected deliver.
Project Progress at March 2009	• Planning stage has been completed and project management organised. • Recruitment of an Engineering Doctorate student has been completed.
Collaborative Partners	Technology Strategy Board, EPSRC and E.ON Engineering
R&D Provider	Imperial College in London, Centre for Renewable Energy Systems Technology (CREST) at Loughborough University and E.ON Engineering

<table>
<tr><td>Project Title</td><td colspan="4">Networks to Improve Power Quality</td></tr>
<tr><td>Description of project</td><td colspan="4">Power quality and reliability continue to grow in importance with deregulation of the electric power industry. Computer technology, automated processes and sensitive electronic equipment are in widespread use across all sectors and there is a requirement on DNOs to provide a high quality of supply and service to its customers.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 1,783
External £ 38,305
Total £ 40,088</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ 125,932</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 179,320</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 2,000
External £ 11,300
Total £ 13,300</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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 frequent mal-operation of equipment.

The disruption of an industrial process, due to a supply interruption or voltage sag, can result in very substantial costs to the operation ranging up to millions of pounds attributed to a single disruption of the process, whereas the costs to commercial customers (e.g. banks, data centres, customer service centres, etc.) can be just as high if not higher.</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>Overall Project Score</td></tr>
<tr><td>9</td><td>-3</td><td>12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Mesh distribution networks can reduce the number of short duration interruptions, but can also increase the potential for voltage sags. Understanding the feasibility of modifying existing networks and how any undesirable consequences for customers can be mitigated or eliminated is therefore an important element in improving distribution network design.

The two key areas of research in this project are:

• Investigation of the performance benefits, economics and the technical restrictions of modifying existing radial networks into mesh distribution networks with the aim of reducing short duration customer outages.

• Investigation into the potential and available alternatives for a distribution company to provide a cost effective, enhanced electricity supply, which will limit the effects of voltage sags on the network to either individual or clustered groups of customers.</td></tr>
</table>

Expected Timescale to adoption	2012	Duration of benefit once achieved	20 years
Probability of Success	25%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 66,113
Potential for achieving expected benefits	This project is on track and is expected to deliver the intended benefits. An additional task to produce a tool for assessing financial loss to individual customers due to long interruptions has been added to the project, which will now finish in early 2010.		
Project Progress at March 2009	• Improved customer plant models for studies of process sensitivity to voltage sags and short interruptions with implementation of the effects of process immunity time constant (PIT) and process dependence matrix (PDM). • Established methodology for assessing potential financial losses to individual customer due to inadequate reliability of electricity supply. • Established methodology for load segregation in a generic distribution networks by minimising customer lost due to voltage sag and short interruption. Genetic algorithm based on 10 year customer loss is used. • Continuing Investigation into the techno-economic effects of backfeed arrangement, busbar and feeder configurations on the quality of electricity supplied to individual/groups of customers. • Work in this period has resulted in 1 IEEE journal publication, 1 IEEE journal submission and 4 international conference publications.		
Collaborative Partners	None		
R&D Provider	Manchester University and E.ON Engineering		

<table>
<tr><td>Project Title</td><td colspan="4">Power Communications Meter</td></tr>
<tr><td>Description of project</td><td colspan="4">Development and demonstration of a cost effective remote monitoring device for small embedded generation sites connected at 11kV.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 3,181
External £ 30,825
Total £ 34,006</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 77,000</td><td colspan="2">Projected 2009 – 2010 costs for Central Networks</td><td>Internal £ 8,000
External £ 30,000
Total £ 38,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Small scale embedded generation sites connected on the 11kV Distribution Network are increasing in number, but these sites are not normally monitored. Without data from these sites, the quantity of real demand on a feeder is effectively masked by the generation and this presents difficulties for both; real time operational decision making, and for network design.

A traditional SCADA RTU could be installed but this is not considered to be a cost effective solution.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental / Technical Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>14</td><td>-4</td><td>18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Real time information (Voltage, current, power factor and alarms) displayed on the control System diagram will enhance network visibility when operating and will impact on network performance and safety.
• This functionality will facilitate future Smart Grid development allowing the connection of more embedded generation.
• Historic ½ hourly load information will improve the quality of network design and provide power quality information.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2011</td><td colspan="2">Duration of benefit once achieved</td><td>25 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>£114,606</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The initial trial has proven that the equipment can remotely monitor sites and operates correctly. Several other uses of the equipment are under consideration.</td></tr>
</table>

Project Progress at March 2009	• Specification of functionality and technical requirements of the equipment, including interface with Control System. • Identification of suitable 3phase power meter and communications options. Development and testing of communication interfaces and device functionality. • Five trial units designed and built. One trial unit installed on site and communications / data transfer proven.
Collaborative Partners	None
R&D Provider	Nortech and Schneider Electric

<table>
<tr><td>Project Title</td><td colspan="5">Sensor Networks (Smart Dust)</td></tr>
<tr><td>Description of project</td><td colspan="5">"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 has been scoped between Central Networks and Scottish Power to develop a product based on this principle for the remote signalling of fault passage indication on OH networks.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 5,074
External £ 154,231
Total £ 159,305</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td colspan="2">£ 462,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 4,000
External £ 57,500
Total £ 61,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">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).</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>13</td><td>-2</td><td colspan="2">15</td></tr>
</table>

Expected Benefits of Project	Sensor Networks implemented as a method of fault passage indication (FPI) could have an enormous effect on how faults on the overhead network are located. They could have a huge impact on CI/CML figures as the technology would be effectively pin pointing faults on the network. This results in a significant financial saving.		
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 is on track to deliver the expected benefits but additional development following alterations to the scope of the communication strategy has introduced a 3 month delay in the project.		
Project Progress at March 2009	Communication Strategy • The strategy has been agreed and signed off. Gateway • The gateway PCB production board has been delivered and is being built and tested. GSM Module • GSM module development is ongoing; work has been focused on establishing a reliable GPRS connection. • Power cycling and battery charging software is complete • Plain text log file entries enable status of GSM module and connection to be tracked • GSM module development is now 50% complete wFPI • PCB layout has been fully designed (ready for production) • Housing has been selected • Work has begun on the radio communications core software Other • Development has begun on the PC configuration application		
Collaborative Partners	Scottish Power		
R&D Provider	Willow Technologies and E.ON Engineering		

<table>
<tr><td>Project Title</td><td colspan="5">Helicopter mounted Partial Discharge detection</td></tr>
<tr><td>Description of project</td><td colspan="5">To fit the Elimpus Partial Discharge (PD) locator onto a helicopter to enable an aerial survey to be undertaken to reliably detect and locate PD for air insulated high voltage equipment.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 2,201
External £ 6,393
Total £ 8,594</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td colspan="2">£ 207,400</td><td colspan="2">Projected 2009 – 2010 costs for Central Networks</td><td>Internal £ 3,000
External £ 30,000
Total £ 33,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Detection of incipient faults using partial discharge location equipment mounted on a helicopter.</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>10</td><td>-3</td><td colspan="2">13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Detection of partial discharge from a helicopter will enable proactive measures to prevent faults occurring leading to an improvement in CI/CML performance and a reduction in equipment costs.

The ability to scan open terminal substations during routine overhead line patrols means a low incremental cost will be incurred.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2012</td><td colspan="2">Duration of benefit once achieved</td><td>10 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 27,505</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">The University of Strathclyde and the spin-off company Elimpus, have developed ground based systems for locational detection of partial discharges using time of flight systems. One of these utilises an array of aerials contained within a van mounted ″roof box″; a size compatible with the aerial separation that might be achieved between the skids of a typical Jet Ranger or Squirrel helicopter employed by DNOs for overhead line patrols. A small feasibility trial was undertaken to assess the viability of a larger IFI project that would entail development of equipment suitable for CAA flight certification.</td></tr>
<tr><td>Project Progress at March 2009</td><td colspan="5">The feasibility study has shown that it is practical to fit the Elimpus equipment to a helicopter and a flight trial has demonstrated the ability to detect ground based discharge activity.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="5">Western Power Distribution and Scottish & Southern Energy</td></tr>
</table>

R&D Provider	Elimpus

<table>
<tr><td>Project Title</td><td colspan="4">Power Networks Research Academy</td></tr>
<tr><td>Description of project</td><td colspan="4">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.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 4,438
External £ 20,610
Total £ 25,048</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 1,555,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 2,500
External £ 35,628
Total £ 38,128</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The projects for the first cohort of Academy scholars are:
• Overhead Lines Measurement System
• System Impacts and Opportunities of HVDC Upgrades
• Application of Artificial Immune System Algorithm to Distribution Networks
• Circuit Breaker Condition Monitoring (No scholar recruited)</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; and
• deliver research output that is industrially relevant.
See online for further information at
http://www.theiet.org/about/scholarships-awards/pnra/</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2012</td><td colspan="2">Duration of benefit once achieved</td><td>20 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>£ 200,000</td></tr>
</table>

Potential for achieving expected benefits	**Overhead Lines Measurement System (Cardiff University)** The OHMS project aims to develop an on-line measurement system of voltage and current to be set up on the high voltage conductors. This will include development of specialised transducers, data acquisition and recording systems and a two-way communication system. It is envisaged that such overall system will be housed in purpose-built unit. Once fully developed the OHMS system will have applications in fault location, protection and control and will be particularly suitable for enhancing Smart Grids objectives. **System Impacts and Opportunities of HVDC Upgrades (Imperial College, London)** The HVDC project aims to establish how HVDC links and networks inset in AC systems could contribute to AC-system stability and enhanced transfer capacity beyond the simple added capacity of the links. The project will offer detailed assessment and quantification of the benefits of supplementary control in raising stability limits and will specifically address robustness to outages of lines and other equipment. **Application of Artificial Immune System Algorithm to Distribution Networks (Manchester University)** The AIS project aims to understand the feasibility of using AIS techniques to assist the detection of weak areas and faults within distribution networks. AIS based techniques will be compared with other techniques (for example neural networks and fuzzy logic) to evaluate any niches for AIS in power systems analysis. The AIS algorithm or methodology developed will assist with the diagnosis of a series of health criterion within the power network. The research will also use AIS data mining techniques to analyse real data to unearth previously hidden correlations, which may assist in the maintenance or operation of distribution networks. In 2008 four projects for the first cohort of Academy scholars were 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 three of these projects and a brief summary of the progress achieved to date are detailed below: **Overhead Lines Measurement System (Cardiff University)** A comprehensive survey has been carried out and was used to produce an initial design of the Overhead Lines Measurement System (OHMS) concept. This was summarised in a paper and presented in a poster at the 2nd UHVnet colloquium in January 2009. EDF Energy has provided technical guidance on the use of OHMS for optimising performance on the 11 kV networks. Initial modelling of PLC systems on the 11 kV network has also been carried out using ATP/EMTP software. Laboratory testing of PLC is ongoing and following advice from the magnetics group at Cardiff University group,

Project Progress at March 2009 (continued)	the simple inductive couplers are being replaced by couplers exhibiting more desirable properties for narrowband PLC. Development of a suitable processing unit to integrate different sub-systems (multiple sensors, ADCs and PLC MODEM chips) into one stand-alone device working in real time is a challenge requiring both the development of the microelectronics and laboratory testing taking place concurrently with the sensor and PLC testing. **System Impacts and Opportunities of HVDC Upgrades (Imperial College, London)** The initial phase of the HVDC project has concentrated on developing understanding of the fundamental analysis techniques and tools. Using Power Factory DIgSILENT software (used by NG), a two-area AC system of 4-generators with an embedded HVDC link was modelled. The small signal stability was analysed by evaluating a series of non-linear simulations and modal analysis under various contingencies. Due to the limitations of the software, alternative methods using system identification are being explored to obtain the state-space matrices which will allow for designing controllers to improve the damping of inter-area oscillations. A larger power system with 14-generators, consisting of 5 areas has been developed for similar analysis. **Application of Artificial Immune System Algorithm to Distribution Networks (Manchester University)** A comprehensive survey of research on artificial immune systems (AIS) and their application to power systems problems has been completed. An AIS algorithm to cluster arbitrary data sets and detect groupings has been designed and its performance evaluated using a variety of initialisation methods. An AIS based methodology for detection of overloaded lines and voltage weak buses within power system networks has been designed, while a basic negative selection algorithm to detect critical loading in small power systems has been designed and built. The AIS algorithms have been hybridised with other techniques such as support vector machines to produce a classification algorithm and the performance of AIS algorithms compared with neural networks. Power system network data has been obtained from Central Networks to use for a knowledge discovery experiment, where this will be mined using AIS techniques to find patterns. A paper entitled "Application of AIS Based Classification Algorithms to Detect Overloaded Areas in Power System Networks" has been written and submitted to the 8th International Conference on Artificial Immune Systems 2009 (ICARIS) to be held in York, UK in August 2009.
Collaborative Partners	EPSRC, National Grid, Scottish and Southern Energy and EDF Energy Networks
R&D Provider	Universities of Cardiff, Manchester, Queens (Belfast), Southampton, Strathclyde, and Imperial College London.

<table>
<tr><td>Project Title</td><td colspan="4">Environmental Monitoring Fluid Filled Cables</td></tr>
<tr><td>Description of project</td><td colspan="4">Demonstration of how remote cable pressure monitoring equipment and Control System load information can be used to monitor the integrity of Fluid Filled Cables.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 4,119
External £ 18,140
Total £ 22,259</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 95,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 7,000
External £ 25,500
Total £ 32,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The potential environmental harm caused by leaks from fluid filled cables is of concern to Central Networks and methods to detect small leaks from distribution assets are necessary. Self contained equipment for calculating the volume and pressure of a fluid filled cable system is available for transmission systems, but this is not considered to be an effective solution for distribution networks.

Information about cable and ambient temperatures in addition to pressure readings and system parameters are needed to calculate the cable fluid volume. While the cable temperature depends upon a number of fixed and variable parameters (including the changes in circuit load, which is already available in our Control System).

Obtaining real time pressure and temperature data from some fluid filled cable systems can be challenging due to their remote or extreme locations, which can include buried, in partially flooded roadway pits and exposed, on raised electricity tower platforms.

This project attempts to integrate available monitored information to calculate changes in the cable fluid volume in a cost effective manner.</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>16</td><td>-3</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Environmental
• Identifying leaks sooner, so less cable fluid is leaked

Financial and Safety
• Remote monitoring will reduce need to visit remote or restricted gauge locations

Operational
• Improved condition monitoring of cable assets
• Aid to identification of leak position
• Monitored information could support Dynamic Ratings of Cables</td></tr>
</table>

Expected Timescale to adoption	2011	Duration of benefit once achieved	25 years
Probability of Success	50%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ 116,986
Potential for achieving expected benefits	Project is on track with remote monitoring of pressure gauges in restricted and extreme locations proving successful.		
Project Progress at March 2009	• Analysis of available equipment and project requirements. • Information obtained for Central Networks' fluid filled cable systems and water source protection zones. • Demonstration of robust cost effective pressure monitoring and communications units at typical conditions.		
Collaborative Partners	None		
R&D Provider	Nortech and Central Networks		

<table>
<tr><td>Project Title</td><td colspan="5">ZEFAL – Zero Fault Level Generation for Active Urban Network</td></tr>
<tr><td>Description of project</td><td colspan="5">Development of a proof of concept prototype generator that is optimised for network connectivity, including networks with fault level constraints.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £ 2,145
External £ 33,770
Total £ 35,915</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td colspan="2">£ 430,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 2,000
External £ 25,000
Total £ 27,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Network connection of distributed generation.</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>-3</td><td colspan="2">10</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Reduced cost, network impact and man-hours involved in providing distributed generation connections.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2013</td><td colspan="2">Duration of benefit once achieved</td><td>10 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">75%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 500,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">The proposed design seems to be patentable and to provide competitive advantage over existing products.</td></tr>
<tr><td>Project Progress at March 2009</td><td colspan="5">The project has developed a feasible design and is progressing with simulations and the construction of a prototype. There were some delays in the design phase, however these have been resolved and the project is proceeding as planned.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="5">EDF Energy, CE Electric and E.ON Engineering</td></tr>
<tr><td>R&D Provider</td><td colspan="5">NaREC Development Services Ltd,
PPA Energy Ltd,
University of Nottingham,
Imperial College London</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4">PV Solar for Substation Supplies</td></tr>
<tr><td>Description of project</td><td colspan="4">Feasibility Study into use of Solar Energy to provide an adequate 'back-up' power supply to essential auxiliary equipment at times of loss of normal LV supply.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 2,058
External £ 13,210
Total £ 15,268</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 26,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 1,500
External £ 9,000
Total £ 10,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Determine the feasibility of providing an adequate secure DC supply by using solar PV panels that are capable of powering all the essential site supplies at a switching site for a predetermined specified period in the event of the loss of the existing LV supplies.
The solar panels must be designed to provide their maximum output in the winter months and capable of operating in both 'Islanded' and 'parallel' modes.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technical Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>0</td><td>11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Despite the negative financial benefit an environmental-friendly method of providing additional security for essential supplies is an attractive solution as enables the switching site to be completely self contained in the event of the loss of LV supplies and access being restricted.
• Energy generated under normal conditions could also be used to reduce the technical losses associated with the LV supply.
• A successful project would justify this method of providing 'back-up' supplies to be incorporated into other operational sites.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2011</td><td colspan="2">Duration of benefit once achieved</td><td>20 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>- £ 42,612</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Initial indications are that a PV installation sufficient to provide the required back-up power will exceed the justifiable financial threshold of this project.</td></tr>
</table>

Project Progress at March 2009	All LV and DC power supplies at operational switching site have been individually monitored to determine essential supply load. Existing battery capabilities in the event of LV loss have been calculated. Typical power output of commercial available PV panels calculated for winter day. Optimum panel orientation for site building determined and maximum output during winter period calculated. Discussions with suppliers regarding equipment necessary to support potential operation modes. Alterative connection options evaluated and scheme designed and costed.
Collaborative Partners	None
R&D Provider	Wind and Sun Ltd and E.ON Eng

<table>
<tr><td>Project Title</td><td colspan="3">Urban Heat Island Study (KTP)</td></tr>
<tr><td>Description of project</td><td colspan="3">Understand the impact of urban heat island effects on distribution network assets. In particular the increased ageing and reduced rating of transformers.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 73
External £ 3,770
Total £ 3,843</td><td>Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 230,500</td><td>Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 7,000
External £ 66,500
Total £ 73,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">According to the Government's 'UK Low Carbon Transition Plan - 2009', without a reduction in emissions, summer average temperatures in the West Midlands could increase by almost five degrees.

Within urban areas this increase is exasperated by the natural thermal storage effect of the infrastructure, which significantly reduces the diurnal cooling. At the same time the expected increase in air conditioning load will increase network asset utilisation and at times of high load, transformers are particularly susceptible to external thermal conditions as their life is dependent upon their operating temperature.

This project will identify the impact of urban heat islands and climate change on transformers through the following activities:

1. Instrumentation of transformers across Birmingham to measure ambient and asset temperatures.

2. Development / adaptation of a GIS based heat island model. This model will form the basis of input data for a weather generator and will allow initial calculations of the financial savings to be made.

3. Modelling of asset temperatures. This is likely to be a neural network containing data pertaining to ambient temperatures, transformer loadings and other environmental variables.

4. Incorporation of a climate change weather generator within heat island model so that climate change scenarios can be analysed.

5. Production of probabilistic climate change / heat island scenarios for the Birmingham area. This will lead to mapping of temperature variations / usage and therefore, the aging rates of assets.

6. Consideration of how the nature of the heat island may change in line with climate change.

7. Development of final documentation and training of personnel to implement the technology. The Birmingham scenarios will be summarised along with various mitigation / adaptation strategies for Birmingham and other urban areas.</td></tr>
</table>

<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>17</td><td>0</td><td>17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Increased knowledge of the predicted climate change factors affecting the distribution network assets
• Increase efficiency of network assets from increased knowledge of asset behaviour under high temperature conditions
• Reduced cost of operation and maintenance costs by more accurate prediction techniques
• Reduced disruption and increased quality of supply to customers, allowing targets for consistent performance to be achieved
• Reduced risk of environmental or safety incidents from failed assets</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2013</td><td>Duration of benefit once achieved</td><td colspan="2">40 years</td></tr>
<tr><td>Probability of Success</td><td>50%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td colspan="2">£ 719,822</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The University of Birmingham has extensive expertise in the field of applied climatology and climate change including the NERC URGENT grant focused on the Birmingham Heat Island. They are also working closely with Birmingham City Council on a project identifying ways of adapting to climate change.</td></tr>
<tr><td>Project Progress at April 2009</td><td colspan="4">• Project scope has been defined and proposal approved.
• Project management team has been put in place.
• Recruiting for suitable research associate has commenced.
• Assessment of suitable monitoring equipment</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">Technology Strategy Board (TSB) KTP</td></tr>
<tr><td>R&D Provider</td><td colspan="4">Birmingham University and E.ON Engineering</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4">Black Start Study</td></tr>
<tr><td>Description of project</td><td colspan="4">System model studies of Central Networks' primary assets to determine the feasibility of using remote network interconnection to provide substation power requirements in the event of a Black Start Scenario.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 353
External £ 18,190
Total £ 18,543</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 42,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 1,000
External £ 18,500
Total £ 19,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Under Black Start conditions, substations are dependent upon their back-up batteries to power the equipment necessary to enable a safe restart of the system.

The increased quiescent load on these batteries from modern electronic equipment means that these batteries will run-down during an extended blackout situation.

Conventional options for extending this period are larger batteries or diesel generators, but they will incur additional capital and an ongoing revenue cost.

This project looks at the feasibility of arranging the network to enable restoration of substation essential supplies from Black Start Generation prior to the restoration of customers' loads.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>0</td><td>13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Reduced cost of providing and maintaining extra facilities for restarting the network in the event of a Black Start.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2010</td><td colspan="2">Duration of benefit once achieved</td><td>40 years</td></tr>
<tr><td>Probability of Success</td><td>33%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 59,179</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Initial Studies have proved that it is possible to supply the majority of CN(e) substation auxiliaries from the nominated Black Start Generation.</td></tr>
</table>

Project Progress at March 2009	• System Demand requirements have been obtained for all substations taking in to account the means of supplying the essential supplies at each site. Options for minimising this demand have been investigated. • The CN(e) Network system model has been modified to represent the network under Black Start conditions. With interconnection to substations in isolated groups considered. • Generator limitations have been assessed and where these impose additional restrictions these have been incorporated into the model. Where necessary methods to mitigate these restrictions have been considered. • Load flows, Voltage Profiles and Fault Levels have been calculated using the Network system model to determine if these will be acceptable.
Collaborative Partners	None
R&D Provider	E.ON Engineering

<table>
<tr><td>Project Title</td><td colspan="4">Power Line Carrier Demonstration</td></tr>
<tr><td>Description of project</td><td colspan="4">Assessment of Power Line Carrier technology on a typical urban LV Network to quantify the technology's opportunities and limitations.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 3,155
External £ 8,000
Total £ 11,155</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 42,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ 6,500
External £ 8,000
Total £ 14,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Power Line carrier technology has the potential to enhance Distribution LV Network applications and could become an integral part of future Smart Grid technology. As a communications medium it has several advantages over other mediums:
• Lowest operational cost and lowest power consumption.
• Intrinsically knows electrical network connectivity model (even to phase connection detail). This feature could be critical for Smart Grid applications
• Less susceptible to third party interference
• Not limited by poor reception areas
However, although PLC has been proven as a technology and there are applications throughout Europe and USA, little is known about its limitations on UK distribution networks.
This demonstration will determine PLC performance on a typical urban UK network and also monitor any effects on the network power quality. Determining the effects on power quality is increasingly important as third parties are starting to use PLC to communicate over distribution networks.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>8</td><td>-1</td><td>9</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Understanding of PLC technology and its suitability as a Smart Grid Communications medium.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2012</td><td colspan="2">Duration of benefit once achieved</td><td>25 years</td></tr>
</table>

Probability of Success	40%	Project NPV = (PV Benefits – PV Costs) x Probability of Success	£ Not Available
Potential for achieving expected benefits	Although the advantages of PLC produce significant financial benefits over other communication options, the adoption costs cannot be estimated with any degree of confidence until the trail has been completed, so Project NPV has not been included at this point.		
Project Progress at March 2009	Review of available PLC systems. Selection of Substation Site for trial and installation of back haul communications equipment to facilitate the connection and monitoring of the LV Network. Identification of several sites where a third party is using PLC over Central Networks assets for their own purposes. Risk assessment of PLC connection options in standard LV equipment cabinets.		
Collaborative Partners	Current Communications		
R&D Provider	E.ON Engineering		

<table>
<tr><td>Project Title</td><td colspan="4">Harmonics issues on Distribution Networks</td></tr>
<tr><td>Description of project</td><td colspan="4">Report on the harmonic problems due to converter plant and the development of planning guidelines.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £ 738
External £ 38,000
Total £ 38,738</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Total £ Nil</td></tr>
<tr><td>Total Project Costs (Collaborative + external + Central Networks)</td><td>£ 40,000</td><td colspan="2">Projected 2009 - 2010 costs for Central Networks</td><td>Internal £ Nil
External £ Nil
Total £ Nil</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Embedded generators and flexible AC transmission system devices are set to become more prevalent on distribution networks and planning constraints mean that long cable connections are likely to be installed to connect them.

As a result there is a belief that harmonic distortion on distribution networks will increase, which can reduce power quality and damage conventional distribution equipment.

The project will address the harmonics generated, or absorbed, by different converters as used by some typical embedded generation plant; (In particular Doubly fed induction generators (DFIG) and Full converter wind generators (FCWG)) and will also consider high speed reactive plant, such as Static Power Compensation (STATCOM) devices.

The project will study the effects of capacitance of different designs of EHV cable with various reactive compensation options to determine if there are design limits.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-1</td><td>11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Understanding the issues associated with new equipment and their connection will ensure other distribution assets and customers' supplies are not jeopardised.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2010</td><td colspan="2">Duration of benefit once achieved</td><td>10 years</td></tr>
<tr><td>Probability of Success</td><td>80%</td><td colspan="2">Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£ 59,473</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The report on the Harmonic problems due to converter plant is complete.</td></tr>
</table>

Project Progress at March 2009	• Survey of harmonic emissions generated from seven different models of wind turbine manufactured by two different companies. • Theoretical assessment of the voltage distortions produced from each wind turbine and from STATCOM devices. • A six step method for deriving the harmonic voltage distortions of new applications for network connections has been determined and these guidelines can be used to ensure new plant will comply with EA ER G5/4-1 planning levels.
Collaborative Partners	None
R&D Provider	E.ON Engineering