ENERGY networks

IFI / RPZ Report

April 2008 to March 2009 Inclusive

For the licensed companies:

EDF Energy Networks (EPN) plc
EDF Energy Networks (LPN) plc
EDF Energy Networks (SPN) plc

Contents

Foreword

Welcome to EDF Energy Networks' Innovation Funding Incentive (IFI) activity report for the regulatory year 2008/09. The content of this report illustrates our continued commitment to the Innovation Funding Incentive, which has given us the opportunity to increase our activity in research, development and demonstration. I am also excited by the new Low Carbon Preparation Fund announced by Ofgem in May 2009. We as network operators, have a key role in the development of future sustainable energy networks.

In June 2008 the CIRED "SmartGrids for Distribution 2008" seminar enabled us to showcase, with our project partners some of our projects, for example Aura NMS, ADDRESS and FENIX. The individual project reports provide additional information. I am personally convinced that those projects in particular and "Smart grids" more generally will create new opportunities and significant benefits for our customers.

After four years of building the IFI project portfolio there are several projects now being actively demonstrated, proving new technologies and realising the business benefits that we expected to see at their inception. The focus in the coming year is to increase the realisation of such benefits from these and new projects.

Laurent Ferrari
Managing Director
EDF Energy Networks

1. Introduction

During the development of the Distribution Price Control Review (DPCR) that took effect on 1 April 2005, Ofgem proposed two new incentives: the Innovation Funding Incentive (IFI) and Registered Power Zones (RPZs).

1.1 Context

As part of the DPCR and Transmission Price Control Review (TPCR), Ofgem has introduced the IFI mechanism. IFI was consulted on as an integral part of the DPCR and TPCR proposals and was widely supported by a large majority of consultees. The primary aim of the incentive is to encourage the network operators to apply innovation in the technical development of their networks. Ofgem recognises that innovation has a different risk/reward balance compared with a network operator's core business. The incentives provided by the IFI mechanism are designed to create a risk/reward balance that is consistent with research, development, demonstration and deployment.

The IFI is intended to provide funding for projects primarily focused on the technical development of the networks, to deliver value (e.g. financial, quality of supply, environmental, safety) to end consumers.

The detail of the DNO IFI mechanism is set out in the Special Licence Condition C3 and Standard Licence Condition 46. It can be summarised as follows:

- A network operator is allowed to spend up to 0.5% of its combined distribution network revenue or its combined transmission network revenue (subject to a minimum of £500,000), as the case may be, on eligible IFI projects. The good practice guide provides guidance on the required characteristics of such projects;
- Network operator IFI expenditure, that is internal expenditure, will be allowed as part of the total IFI expenditure accrued by the network operator;
- The network operator is allowed to recover 80% of its eligible project expenditure via the IFI mechanism within the network operator's licence;
- Ofgem will not approve IFI projects but network operators will have to openly report their IFI activities on an annual basis. These reports will be published on the Ofgem website; and
- Ofgem reserves the right to audit IFI activities if this is judged to be necessary in the interests of customers.

In Ofgem's review of IFI and subsequent open letter response of 14 February 2007, the Authority agreed:

- A commitment to extend the DPCR4 IFI scheme until the end of DPCR5 with a flat pass through rate of 80%;
- The removal of the 15% cap on internal IFI expenditure for both distribution and transmission licences when requested to do so by a licensee; and
- To work with the industry to review and revise the guidance documents by means of which IFI is controlled and managed.

1.2 IFI

Projects will be judged as eligible within the IFI provided that:

- The project satisfies the eligibility criteria described in the ENA Engineering Recommendation G85, Issue 2, Innovation Good Practice Guide for Energy Networks;
- The project has been well managed; and
- Reporting requirements have been met.

Work that has been approved within an industry recognised (or national/governmental) programme (e.g. Department for Business Enterprise and Regulatory Reform (BERR) or European Commission Funding under Research, Development, Demonstration & Deployment Frameworks), whose terms of reference clearly address innovation in the networks, may be considered eligible within IFI if it meets the defined criteria. Co-operation between network operators and other organisations to pursue IFI projects is encouraged. In such cases the overall project would be expected to meet the IFI eligibility criteria; it would then be acceptable for each participating network operator to use the eligibility case for the overall project. IFI projects that secure additional funding from outside agencies, such as BERR or the European Commission, will not trigger any clawback of IFI funding by Ofgem. Engagement with industry engineering committees is not considered eligible as this does not constitute a project with a specific target or deliverable.

In the event that a network operator provides resources to contribute to an eligible IFI project which is led or managed by a third party then those costs incurred by the network operator, that are not recovered from the third party will be considered to be eligible IFI expenditure. Where supporting such projects results in a net cost to the network operator, the network operator should demonstrate, at a level appropriate to the costs involved, that the expected benefits to the network operator exceed the costs involved.

IFI projects, by their nature, involve risk. It is understood, therefore, that not all IFI projects will meet their aims and objectives and deliver net benefits. However, it is expected that the benefits from those that do succeed will significantly exceed the overall costs of a network operator’s IFI programme.

1.3 RPZ

An RPZ is a zone of network where innovative practices, that allow distributed generation to connect more easily, are demonstrated. RPZs are intended to encourage DNOs to develop and demonstrate new, more cost-effective ways of connecting and operating generation that will deliver specific benefits to new distributed generators (DG) and broader benefits to consumers generally. A DNO will receive additional income (over and above the main DPCR4 DG incentive) which will be recovered by the Generator Distribution Use of System (GDUoS) charge. The DNO must demonstrate that an innovative solution could offer material advantages to DG customers compared to a conventional solution.

Although an RPZ requires the connection of a new generator, RPZs are not restricted to greenfield sites. The RPZ may contain existing generators, although only new generators will attract the RPZ premium. Where an RPZ is commissioned in stages, the DNO’s entitlement to the five-year period of the RPZ premium will be triggered by the commissioning date of each generating unit. The total MW of installed capacity cannot exceed the registered capacity. An individual generating unit forming part of staged development of an RPZ must be commissioned by 31 March 2012 to qualify for the RPZ premium.

Each RPZ is defined as a collection of contiguously connected distribution system assets (i.e. which provide an electrical path for the distribution of electrical energy) having one or more terminal points which together describe in full the RPZ's boundary with the total system. These terminal points will be selected such that any system components or connected customers (existing demand and generation) that may be affected by the RPZ project are included within them.

The definition of an RPZ allows flexibility and will need to be applied differently depending on the project. For example, if a number of small generators are involved, it may be useful to define the limits of the RPZ in terms of geography as well as electrically, as this will be a boundary that the stakeholders can identify. On the other hand, if an RPZ involves, for example, the innovative connection of a wind farm in a remote area, defining the boundary in terms of a circuit may be sufficient. The boundary may need to be adjusted if new DG is connected on the edge of an RPZ, provided that it is judged appropriate to include the new DG in the demonstration of innovative practices.

1.4 This Report

This report contains a summary of EDF Energy Networks' IFI activities for the period April 2008 to March 2009 inclusive. Following the publication of the ENA Engineering Recommendation G85 Innovation Good Practice Guide for Energy Networks, issue 2, December 2007 similar to last year's IFI activity report, this report continues to use the new individual project report template. The guide introduced a measure of a project's benefits rating, residual risk and an overall project score. These measures have been calculated for new projects that started since April 2007. The measures are blank for projects that started before the updated guide was published.

1.5 Company Structure

EDF Energy owns and operates the licensed distribution networks serving the East of England, London and the South East of England. The licensees managed by EDF Energy Networks Ltd are:

- EDF Energy Networks (EPN) plc for the East of England, referred to as 'EPN' in the rest of this report;
- EDF Energy Networks (LPN) plc for London, referred to as 'LPN' in the rest of this report; and
- EDF Energy Networks (SPN) plc for the South East of England, referred to as 'SPN' in the rest of this report.

These licensed areas are shown in the map overleaf.

Research, Development and Demonstration activities are conducted by EDF Energy Networks for the benefit of our customers on behalf of the three licensed area operators named above. This year (as with previous years), we have continued to allocate expenditure to each licensed area in proportion to the major asset associated with each individual project. Section 2.4 provides a tabulated summary of expenditure and a graphical representation comparing expenditure with the IFI allowance.

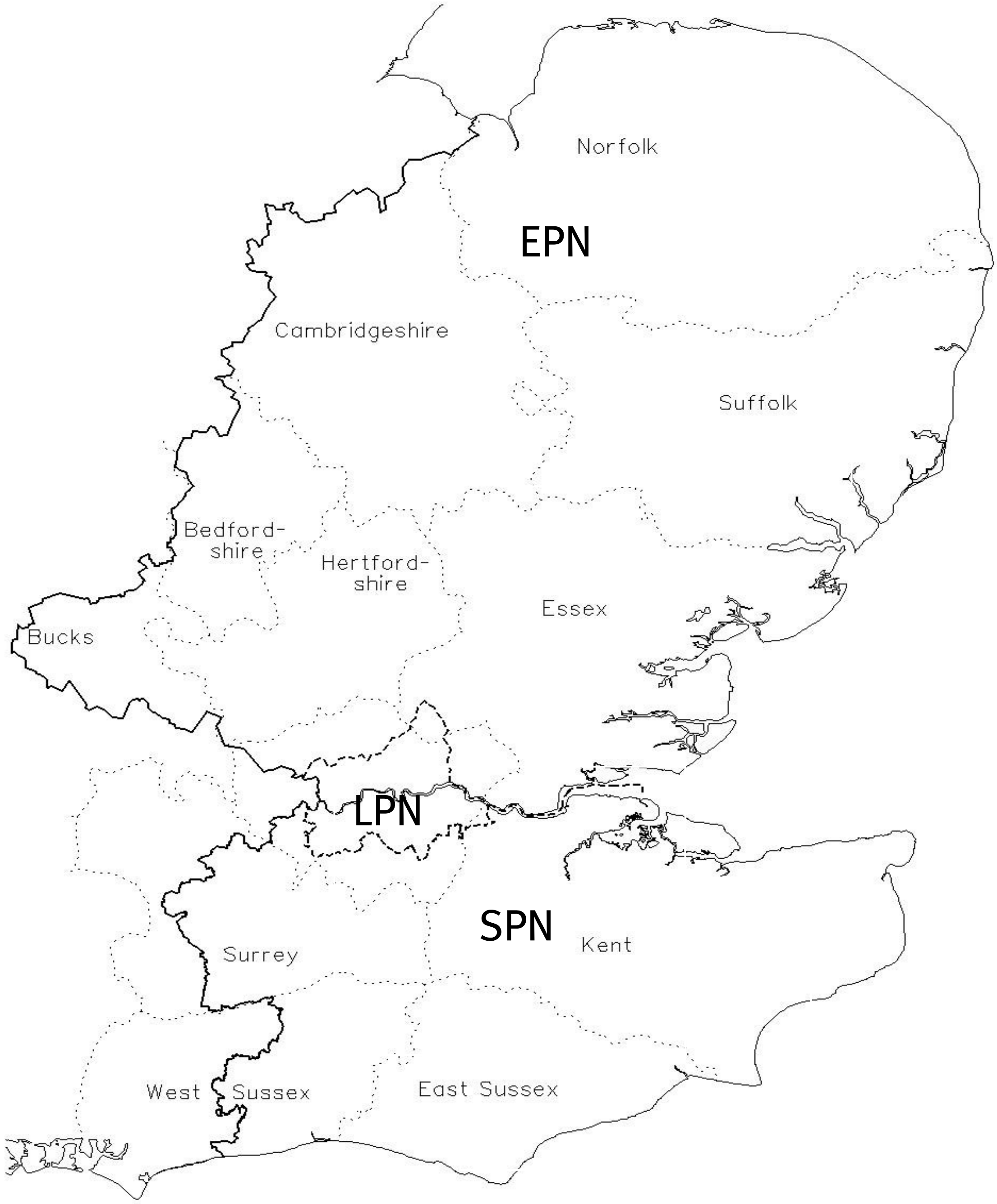


Figure 1 Licensed areas of EDF Energy Networks

1.6 The Evolution towards Future Networks

In the 2007/08 IFI activity report our strategy was described detailing the four work programmes: Sustainability and Environment; Network Operations; Asset Management and Future Networks. EDF Energy Networks believes that the projects funded through the Innovation Funding Incentive will deliver the benefits necessary to manage the networks of the future.

In our existing networks, monitoring of the lower voltages ends at the 33/11kV primary substations. The Intelligent Distribution Network Monitoring project (section 3.3) demonstrated that there is potential value in developing an intelligent distribution network to monitor voltages and currents at a number of 11kV/LV distribution substations, along a radial 11kV distribution feeders. The information from these monitoring points may be fed into the distribution system state estimator developed by Imperial College (section 4.10).

The Autonomous Regional Active Network Management System (AURA NMS) (section 4.2) is in its final year of academic research. Control hardware from ABB, installed with the software agents developed by our university partners, is being installed in demonstration primary substations. The benefits of distributed control will be reported at future conferences such as CIRED. The electrical energy storage device is expected to be installed on the distribution network supplied from Martham primary substation. We aim to demonstrate that storage will be a valuable tool to manage and support future distribution networks.

The FENIX project (Flexible Electricity Networks to Integrate the eXpected 'energy evolution') (section 4.9) will conclude in September 2009. The EU commission review of the demonstration at Woking Borough Council and Imperial College London was positive. Project ADDRESS (Active Distribution networks with full integration of Demand and distributed energy RESourceS) (section 4.29) which started in June 2008, complements and builds on the work of FENIX by exploring the opportunities of Active Demand provided by small commercial and domestic customers.

Transformer Condition Monitoring (section 4.19) and On-line Partial Discharge Monitoring (section 4.1) technologies are being trialled and are already delivering benefits. Future networks will be a combination of new and legacy assets, and these technologies will provide EDF Energy Networks with real time performance and historical trends, which will enable optimal asset management decisions to be taken.

The automation algorithm work reported by Central Networks in its 07/08 IFI Activity report, is being considered for integration into the EDF Energy Networks' ENMAC control system. As old switchgear is being replaced with remotely-controllable equipment and the number of remote control sites increase, so does the potential to reduce the number of customers affected by a network fault. The experience of Central Networks, supported by modelling, shows an increase in the number of successful restorations using this new algorithm compared with the existing hard coded scripts.

1.7 Project Partners

In this report each individual project report details the research and collaborative partners.

2. Summary of IFI Project Activities

2.1 Number of Active IFI Projects

There are a total of 36 active IFI projects. Eleven new projects were started this year and five were closed. The closed projects are reported in section 3 and details of the next steps and the benefits being realised are provided. The four EA Technology Ltd (EATL) Strategic Technology Programme (STP) modules are also reported.

2.2 Net Present Value (NPV) of Costs and Anticipated Benefits from Committed IFI Projects

It is estimated that the current EDF Energy Networks' IFI portfolio will deliver benefits of £39million. The Project NPV benefit of each project in the IFI programme is calculated by taking the present value of the estimated benefits and applying a probability of success. Estimated costs are netted off the anticipated year of occurrence. A discount rate of 6.9% has been used.

Each project undertaken in an STP module falls below the de-minimis level set in the Good Practice Guide. It is recognised that, as each project has variable benefits and different start/completion timeframes, it is not possible to give a specific figure for the benefits achieved against a given financial year. The benefits will be across a range of areas including construction, maintenance, refurbishment and operation.

2.3 Summary of Other Benefits Anticipated from Active IFI Projects

Other benefits anticipated from active IFI projects include:

- An improvement in the security of supply and quality of service received by our customers;
- A reduction in the cost of DG connections; and
- Environmental and safety benefits.

2.4 Total Expenditure to Date on IFI Projects

Regulatory year	Total expenditure
This regulatory year 08/09	£3,922.6k
Regulatory year 07/08	£4,993.5k
Regulatory year 06/07	£3,575.8k
Regulatory year 05/06	£2570.9k
Early start report 04/05	£ 275.8k
Total	£15,338.6k

Table 1 Total Expenditure

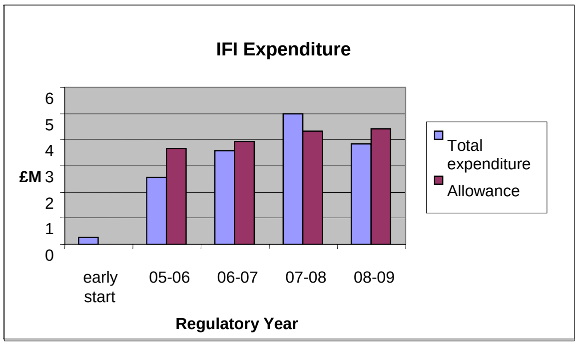


Figure 2 IFI Expenditure

2.5 Tabular Summary

	EPN	LPN	SPN	TOTAL
IFI carry forward from 07/08	£4.7k	0	0	£4.7k
Eligible IFI expenditure 08/09	£1,483.5k	£1,387.1k	£1,052.0k	£3,922.6k
Eligible IFI internal expenditure 08/09	£220.4k	£194.6k	£147.3k	£562.3k
Combined distribution network revenue	£395.10M	£278.74M	£210.73M	£884.57M
The IFI carry forward to 2009/10	£492.0k	£6.6k	£1.7k	£500.3k

Table 2 Tabular summary

2.6 Registered Power Zones

RPZ Name	Steyning Primary RPZ
RPZ DG Capacity (MW)	1.5MW
RPZ starting year	06/07

Table 3 RPZ summary

Further details about Steyning RPZ can be found in Section 5.

2.7 Highlighted Projects

Each year, we highlight projects that will be of particular interest to readers of this report. This year we have included two case studies and information about a software cable ratings application.

- On-line Condition Monitoring: Preventive cable replacement (Whiston Road substation);
- On-line Condition Monitoring: Switchgear failure prevention (Merton substation); and
- Crater - Cable ratings application.

Further details about On-line Condition Monitoring can be found in Section 4.1.

On-line Condition Monitoring: Preventive cable replacement in Whiston Road substation

A high voltage cable, equipped with partial discharge monitoring equipment, was showing signs of incipient failure with significant trends in partial discharge (PD) activity. It was prevented from becoming an actual failure by early detection and replacement of the discharging section. Cable replacement was carried out on the 17 December 2008, and the load restored two days later. The section of cable extracted was sent to a leading cable research laboratory for forensic analysis.

Stage 1: Detection

A high level of partial discharge was detected by the advanced substation monitor (ASM), and automatically highlighted by the automated web based analysis software.

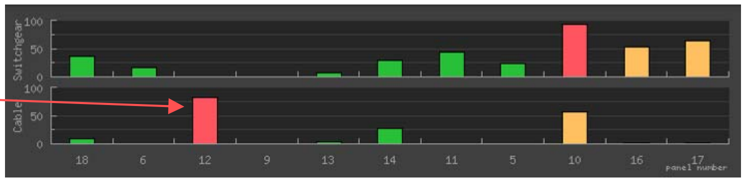


Figure 3 Summary graph highlighting discharging feeders

Stage 2: Incipient Fault Location and Repair

The fault was located on-line and a repair was subsequently planned. The repair proved successful as no PD could be detected following the repair.

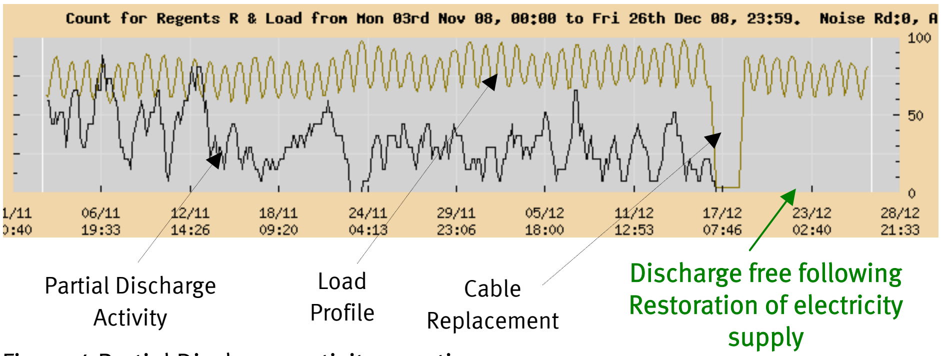


Figure 4 Partial Discharge activity over time

Stage 3: Recovery of Faulted Section

The section extracted was sent to a leading cable research laboratory and the partial discharge activity was traced to gas bubbles forming in a cable joint.

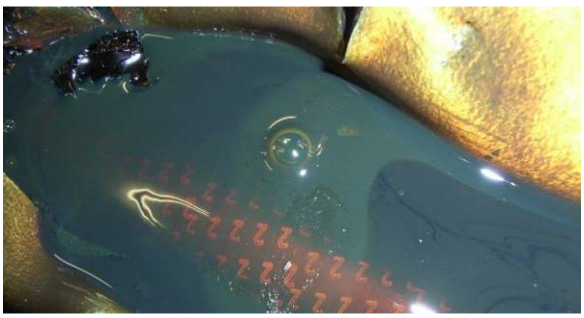



Figure 5 and 6 This defect would have eventually led to a failure if no action had been taken.

Conclusion:

EDF Energy Networks is currently monitoring more than 1000 feeder cables. More than 40 incipient cable faults are currently being assessed and might be considered for preventive replacement. A shift from reactive to proactive cable management strategy will eventually lead to improved security of supply and better service for EDF Energy Networks' customers.

On-line Condition Monitoring: Switchgear failure prevention
Merton substation

A substation switchgear panel equipped with partial discharge monitoring equipment was showing signs of an incipient failure with high Partial Discharge (PD) activity. Preventive maintenance activity was conducted in order to avoid a potential catastrophic failure and unnecessary premature replacement of the switchboard.

Stage 1: Detection

A PD monitoring system equipped with Transient Earth Voltage and Airborne Acoustic transducers was used.
A problem was automatically detected by the acoustic sensors and an operational restriction imposed on the site.

Figure 7 Switchgear equipped with sensors

Stage 2: Incipient Fault Location and Repair

The front busbar was made dead and the Front Bus-section circuit breaker isolated. The discharge was traced to the breaker bushings.
The bushings were carefully cleaned, as they were found to have a greasy surface on which dust had settled.

Figure 8 Bushings showing signs of discharges

Stage 3: Monitoring following re-energisation

Following the cleaning of the switchgear, a significant reduction in PD activity was observed.
Over the following months, the PD activity remained low and action was taken to improve the environmental conditions of the switchroom, as temperature and humidity are often linked to the level of PD activity.

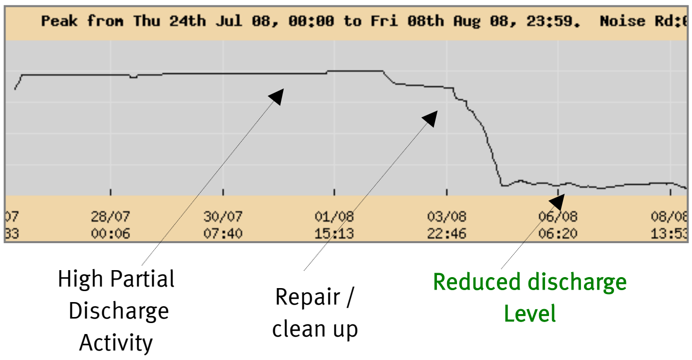


Figure 9 Partial Discharge activity over time

Conclusion:
More than 700 switchgear panels are currently monitored by EDF Energy Networks. Partial discharge detected on switchgear is usually investigated promptly, as it is a potential safety risk and could lead to a failure affecting many customers.
Monitoring and understanding the condition of ageing assets and critical infrastructures is expected to increase over the coming years. It will lead to a better management of the network and more robust asset management decisions.

CRATER – Cable Ratings application

The CRATER software project delivered a suite of tools to determine the current rating of cable circuits. The application is dedicated to the whole range of cable types currently used in the UK. Included are modules for individual cable types, arrays of mixed cable types, cables crossing and dynamic ratings, allowing ratings to be established for a wide variety of cable laying scenarios.

The benefits of CRATER include:

- Simple and complex rating calculations easily and accurately carried out;
- Reduction of engineering design time;
- Standardization of ratings;
- Rapid assessment of contractors' specifications;
- Prevention of over-rating of adjacent circuits at substation bottlenecks;
- Determination of admissible emergency overloads;
- Assessing network reinforcement requirements; and
- Correct estimation of operational cable losses.

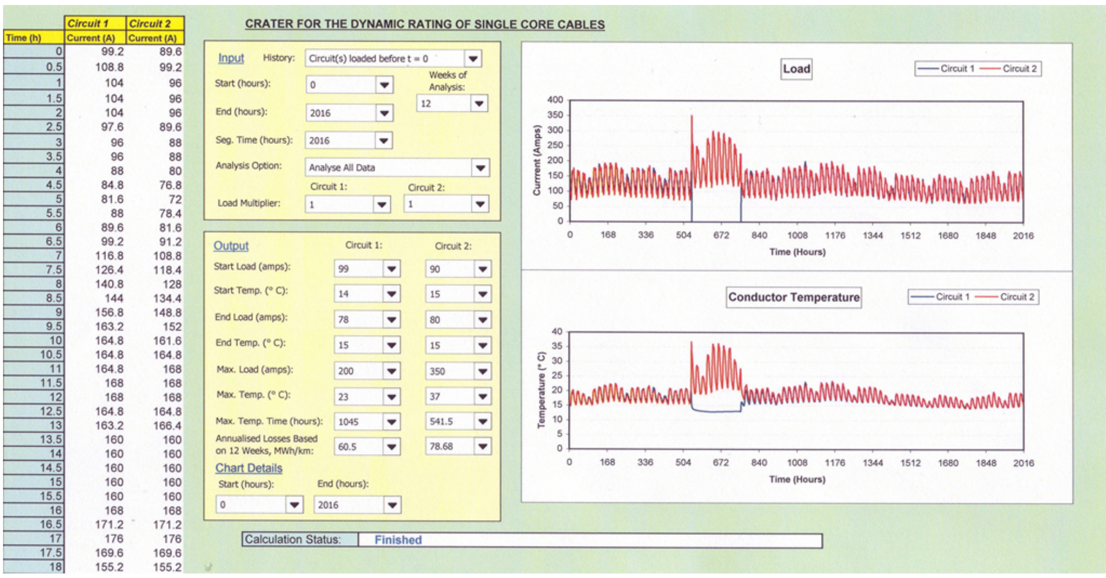


Figure 10 Conductor temperature and losses for a dual 33kV circuit.

Benefits that have been realised include:

- A reduction in engineering design time to determine the correct size of cable required;
- Reducing risk of over-loading cable networks, especially in tunnels where it is easy to install an additional cable without considering the consequences of the new cable's load; and
- Reducing cable losses by increasing cable size can now be assessed on economic grounds.

Benefits also accrue to the customer by reduction in electricity tariffs and to society as whole because of reduced CO_2 emissions.

3. Completed IFI Projects

(Projects ordered by expenditure)

- Vulnerable Customer UPS
- Risk Management of Assets
- Intelligent Distribution Network Monitoring
- DG Connection Planner
- Advanced Forensic Methods

3.1 Vulnerable Customer UPS

Description of project	This project aims to develop solutions that provide continuity of electrical power to customers who are highly dependent on continuous electricity supply (e.g. for medical equipment, heating). Ceres Power has developed the capabilities and specialist expertise to deliver a solid oxide fuel cell solution.				
Expenditure for financial year		EPN	LPN	SPN	
	External	£79,274	£50,447	£50,447	
	Internal	£11,057	£7,036	£7,036	
	Total	**£90,331**	**£57,483**	**£57,483**	
	The costs have been allocated in proportion to the number of customers in each licensed area.				
Expenditure in previous (IFI) financial years	External	£449,755			
	Internal	£48,672			
	Total	**£498,427**			
Total Project Costs (Collaborative + external + EDF Energy Networks)	£ 1,200,000	Projected 2009/10 costs for EDF Energy Networks	Awaiting a decision to proceed to Phase 2.		
Technological area and / or issue addressed by project	Hybrid fuel cell – battery for customers medically dependent on electricity.				
Type(s) of innovation involved	Radical	Project Benefits Rating	Project Residual Risk	Overall Project Score	
Expected Benefits of Project	Provides EDF Energy Networks with the means of reassuring vulnerable customers that the impact of a power cut can be reduced. Provides long-duration power continuity to allow support services to get to a vulnerable customer in the event of a power failure.				
Expected Timescale to adoption	Year 2012	Duration of benefit once achieved	20 Years		
Probability of Success	25%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£ 200,000		
Potential for achieving expected benefits	The demonstration showed that a commercial product could be developed.				

Project Progress March 2009	Phase 1 was split in three main parts: • A study to identify the needs of vulnerable customers. This study was used as a design input to the development of the unit. The output of this study was a product specification. • An indoor battery component that provides continuous supply of power for a period of approximately two hours depending on energy usage following an interruption; and • An outdoor fuel cell module that provides an extended supply of energy, lasting several days or even weeks, depending on the size of the gas bottle. An engineering demonstrator has been delivered and demonstrated that the outline performance specification could be achieved using the hybrid battery and fuel cell technology. The development of a commercial product is being considered.
Collaborative Partners	
R&D Provider	CeresPower

3.2 Risk Management of Assets

Description of project	Two studies were carried out to manage the risk posed by assets close to our customers using RCM techniques.			
Expenditure for financial year		EPN	LPN	SPN
	External	£67,230	£42,783	£42,783
	Internal	£9,334	£5,940	£5,940
	Total	**£76,564**	**£48,723**	**£48,723**
	The costs have been allocated in proportion to the number of connected customers.			
Expenditure in previous (IFI) financial years	This project was started in this reporting year.			
Total Project Costs (Collaborative + external + EDF Energy Networks)	**£ 174,010**	This project is closed.		
Technological area and / or issue addressed by project	Risk posed by assets close to our customers, e.g. service terminations, including cut-outs and lead-ins.			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
		14.4	0	14.4
Expected Benefits of Project	The expected benefits of this project are a more targeted maintenance regime that could result in lower asset failure risk.			
Expected Timescale to adoption	Year 2010	Duration of benefit once achieved	10 Years	
Probability of Success	75%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£ 100,000	
Potential for achieving expected benefits	Being able to target maintenance activities before they result in asset failure.			
Project Progress March 2009	A report has now been delivered following a RCM type study. EDF Energy Networks is now formulating an implementation plan.			
R&D Provider	Schlumberger Business Consulting			

3.3 Intelligent Distribution Network Monitoring

<table>
<tr><td>Description of project</td><td colspan="4">The Intelligent Distribution Network Monitoring study set out to investigate the viability of increased monitoring of the 11kV and LV networks, and to evaluate the cost benefit case associated with the deployment of a specific monitoring technology based on optical current sensors. Existing monitoring and control devices in the networks were taken into consideration, and a high level model for the costs and benefits associated with different levels of monitoring was developed. This study focused mainly on the business benefits associated with Network Planning and Network Operations. Using this model, an optimal level of monitoring has been identified.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£48,544</td><td>£30,891</td><td>£30,891</td></tr>
<tr><td>Internal</td><td>£8,193</td><td>£5,214</td><td>£5,214</td></tr>
<tr><td>Total</td><td>£56,737</td><td>£36,105</td><td>£36,105</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the length of installed HV cable.</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="4">This project was started in this reporting year.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 129,000</td><td colspan="3">This project was completed this year.</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The monitoring of the 11kV and LV networks.</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>1</td><td>12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits of this project are:
• Awareness of power-flows and voltage profiles away from the primary substations and confirmation of planning assumptions;
• Deferred network reinforcement costs;
• Reduced time for fault finding – manpower;
• Reduced time for fault finding – CML;
• Improvement in automation schemes;
• Faster rectification of LV intermittent faults; and
• Faster customer voltage investigations.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2010</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£ 200,000</td></tr>
</table>

Potential for achieving expected benefits	The feasibility study report showed that monitoring the 11kV and LV networks would deliver many of the benefits stated above.
Project Progress March 2009	The main results of the study were: • The optimal level of monitoring for the networks of today has been estimated to be 40% for LPN, 15% for SPN and 15% for EPN; • That a strategy needs to be developed to cover a wider area of Smart grid technology implementation; and • That IT systems should be enhanced to enable optimal use of the information from the current and future monitoring and control devices. The main outputs are: • The optical sensors have been installed in two secondary stations and are providing data on the 11kV and LV networks; • An outline technical solution architecture and target functionalities have been defined; A larger scale trial is being considered.
Collaborative Partners	
R&D Provider	IBM UK Ltd and Powersense (Denmark).

3.4 DG Connection Planner

Description of project	This project builds on the work reported in the study "Internet Services for Planning Distributed Generation connections" funded by the DTI. The project aims to provide DG developers access to suitable connection locations and estimated connection costs. The system uses an OS map background to allow users to position a proposed generator connection, DNO Long Term Development Statement (LTDS) data to derive suitable connection scenarios and costing information for the provision of budget estimates.			
Expenditure for financial year		EPN	LPN	SPN
	External	£13,213	£4,663	£8,031
	Internal	£1,835	£647	£1,115
	Total	**£15,048**	**£5,310**	**£9,146**
	The costs have been allocated in proportion to the amount of connected distributed generation.			
Expenditure in previous (IFI) financial years	External	£146,809		
	Internal	£14,471		
	Total	£161,280		
Total Project Costs (Collaborative + external + EDF Energy Networks)	£ 277,700	This project was completed this year.		
Technological area and / or issue addressed by project	• Location of areas where cost-efficient DG connections can be realised; • Visualisation of connection costs and network capacity; and • Visualisation of DG activity.			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
Expected Benefits of Project	Location of areas where the network is likely to be sufficiently robust to support generation connections can be identified by developers, prior to making formal contact with the DNO. This could reduce the need for significant reinforcement in support of generation connections, by providing visibility of the more suitable locations.			
Expected Timescale to adoption	Year 2011	Duration of benefit once achieved	20 Years	
Probability of Success	25%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£ 167,000	

Potential for achieving expected benefits	This research has already had a positive impact. The cost mapping technology, developed by this project, was specifically referenced as a desirable development for all DNOs in Ofgem's policy review document for DPCR5. The most promising route to implementation may be to offer a service free of charge to developers on behalf of all DNOs. There has also been interest from other DNOs in extending the use of cost and capacity mapping down to smaller schemes, which would connect to the 11kV distribution network.
Project Progress March 2009	A final demonstration and review of the software was delivered in March 2008. All work was completed in September 2008 and the project closure meeting was held on 22 October 2008.
Collaborative Partners	
R&D Provider	IMASS Ltd. and Senergy Econnect.

3.5 Advanced Forensic Methods

Description of project	This project aims to assess the average residual life of power transformers taken out of service (by examining aged insulation papers), and improve transformers replacement strategies.			
Expenditure for financial year		EPN	LPN	SPN
	External	£16,659	£9,024	£9,024
	Internal	£2,641	£1,430	£1,430
	Total	**£19,300**	**£10,454**	**£10,454**
	The costs have been allocated in proportion to the number of installed power transformers.			
Expenditure in previous (IFI) financial years	This project was started in this reporting year.			
Total Project Costs (Collaborative + external + EDF Energy Networks)	£ 40,000	This project was completed this year.		
Technological area and / or issue addressed by project	Residual life of power transformers			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
		9.4	1	8.4
Expected Benefits of Project	The expected benefits of this project are: • The ability to extend transformer life by having detailed knowledge of insulating paper condition; and • Deferred replacement of power transformers.			
Expected Timescale to adoption	Year 2010	Duration of benefit once achieved	10 Years	
Probability of Success	75%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£500,000	
Potential for achieving expected benefits	Further work is required to develop a non-destructive assessment method.			
Project Progress March 2009	A power transformer was recovered from site and moved to the University of Surrey. The tank was cut open, windings split and innovative sensor methods were used to scan the winding.			
R&D Provider	University of Surrey			

4. Individual IFI Projects

(Projects ordered by expenditure)

- Online Condition Monitoring
- AURA NMS
- Earthing Information System
- Advanced Harmonics Monitoring
- Improved Fluid Filled Cable Leak Location System
- Bankside Heat Transfer
- Growth in City Centres
- Overhead Line Fault Location
- FENIX
- Distribution System State Estimation
- Optimal Transformer Utilisation Model
- Network Risk Management
- Application of Storage and DSM
- Network Technical Losses Reduction
- Condition Monitoring of Composite Insulators
- LV Underground Cable Fault Management
- Lone Working Risk Management
- Recycling Excavated Material
- Grid Transformer Monitoring
- Understanding Ageing Mechanisms in XLPE Cable
- 33kV Voltage Control
- Evaluation of the Characteristics of Alternative Oils
- Activ Project
- ZEFAL
- Power Networks Research Academy
- Supergen 1 – FlexNet
- Collaborative ENA R&D Programme
- Transformer Design for FR3
- ADDRESS
- Vacuum Tap Changer
- Supergen V – Amperes
- Vegetation Management

EATL Strategic Technology Programme
- STP Module 2 : Overhead Network
- STP Module 3 : Cable Networks
- STP Module 4 : Substations
- STP Module 5 : Networks for Distributed Energy Resources

As most DNOs subscribe to all four Strategic Technology Programme Modules, these four reports have been written by EA Technology Ltd to provide consistent reporting.

4.1 On-line Condition Monitoring

Description of project	The use of partial discharge measurement is a well known method of checking the condition of electrical insulation. Over the past 10 years, EDF Energy Networks has been actively involved in the development of "on-line" partial discharge monitoring and mapping techniques. Opportunities to improve the existing technology have been identified. This project has taken the laboratory into the distribution network to monitor underground cables and switchgear.			
Expenditure for financial year		EPN	LPN	SPN
	External	£42,540	£439,581	£226,880
	Internal	£6,041	£62,421	£32,217
	Total	**£48,581**	**£502,002**	**£259,098**
	The costs have been allocated in proportion to the length of installed HV cable that is directly earthed.			
Expenditure in previous (IFI) financial years	External	£1,706,140		
	Internal	£162,559		
	Total	**£1,868,699**		
Total Project Costs (Collaborative + external + EDF Energy Networks)	£ 3,000,000	Projected 2009/10 costs for EDF Energy Networks	External £ 500,000 Internal £ 43,000 Total £ 543,000	
Technological area and / or issue addressed by project	The issues being investigated by the project are: • On-line fault detection and location; • Pre-emptive fault repairs; • Cable replacement & maintenance strategy; and • Quality of supply improvement.			
Type(s) of innovation involved	Radical	Project Benefits Rating	Project Residual Risk	Overall Project Score
Expected Benefits of Project	Benefits are expected to include: • Ability to target the replacement of cable; and • Ability to identify faults (cable & switchgear) before they occur, carry out repairs and reduce the number of customer interruptions. • Improved asset management.			
Expected Timescale to adoption	Year 2010	Duration of benefit once achieved	20 Years	
Probability of Success	75%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£4,800,000	
Potential for achieving expected benefits	Although necessary research work is still in progress, benefits are being realised which include avoidance of major incidents, improved safety for EDF Energy Networks' staff, improved asset management by monitoring the condition of switchboards and avoiding premature replacement.			

Project Progress March 2009

Overall progress:
EDF Energy Networks has now started to deploy and benefit from the on-line condition monitoring technology:

- The partial discharge detection algorithms and processes have been improved;
- Several preventive actions (cable replacements and repairs to switchboards) have been carried out, and the number of repairs is expected to increase as on-line condition monitoring is further embedded into asset management processes;
- A number of on-line condition monitoring systems have been purchased by EDF Energy Networks (outside the Innovation Funding Incentive scheme) and larger scale deployments are being considered; and
- Discussions are underway with manufacturers to integrate partial discharge monitoring capability into new high voltage equipment. This will avoid future (potentially expensive) retrofit costs.

Switchgear monitoring (see Merton case study):
Several switchgear incipient defects were detected (e.g. Merton, Tunbridge Wells Town and Brighton Town substations). These defects have been investigated and repairs carried out or planned.

Benefits delivered:

- Avoidance of major incidents, improved safety for EDF Energy Networks' staff; and
- Improved asset management by monitoring the condition of switchboards and avoiding premature replacement.

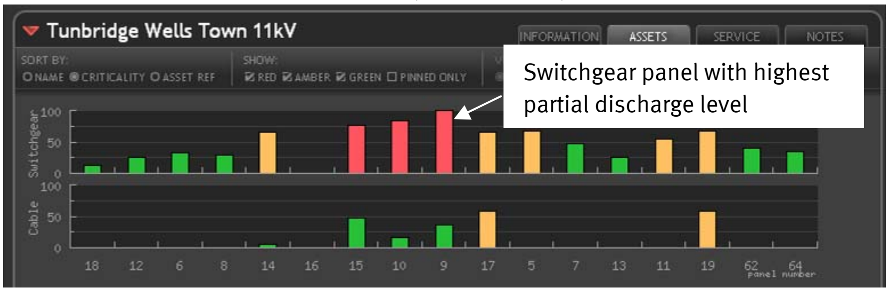


Figure 11 Remote identification of discharging switchgear

Cable monitoring (See Whiston Road case study):
The online condition monitoring system now enables approximately 1000 feeder cables to be ranked according to their partial discharge level and risk of failure. Several cable replacement schemes are currently in progress.

Figure 12 Remote identification of discharging cables

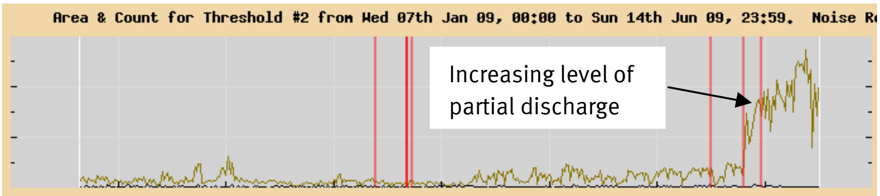


Figure 13 Associated partial discharge level

A ring main unit partial discharge monitor (Figure 14) has been developed. This equipment has limited functionalities, but can easily be deployed beyond the detection range of the main substation monitor in order to provide early indication of partial discharge activity, further along the feeder.

Figure 14 Mini monitor

On-going activities:

- Research is currently taking place in the following areas: time to failure prediction, noise reduction, partial discharge trend analysis and recognition, defect type classification, cable degradation process analysis, failure modes analysis, fault location and improved sensor development;
- Complete solution validation: desk study, spot testing, monitoring, mapping, repairs, forensic analysis;
- Integration with network control system (demonstration); and
- Integration of network information (cable type, number of customers, automation, etc.) to improve risk management.

Selected list of publications:

- CIRED 2009: Influence of network events on partial discharge activity and cable health (Session1, EDF Energy Networks & IPEC Ltd).
- CIRED 2009: Avoidance of MV Switchgear Failure: Case studies of On–Line Condition Monitoring (Session1, EDF Energy Networks, IPEC & PPA Energy).
- CIRED 2009: Integrated solution to target MV cable replacement (Session1, EDF Energy Networks & EDF R&D).

Collaborative Partners	
R&D Providers	IPEC Ltd, EDF R&D (France), PPA Energy, HVPD, ERA Technology and Glasgow Caledonian University.

4.2 AURA NMS – Autonomous Regional Active Network Management System

<table>
<tr><td>Description of project</td><td colspan="6">The project aims to develop a distributed control system to deliver:
• Real-time automated reconfiguration to a regional network of up to four primary substations;
• Economic, efficient and effective integration of large amounts of small scale distributed generation, taking into account legacy infrastructure and renewal programmes; and
• Network optimisation considering DG and electrical energy storage.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td colspan="2">EPN</td><td colspan="2">LPN</td><td>SPN</td></tr>
<tr><td>External</td><td colspan="2">£198,518</td><td colspan="2">£70,065</td><td>£120,668</td></tr>
<tr><td>Internal</td><td colspan="2">£39,040</td><td colspan="2">£13,779</td><td>£23,730</td></tr>
<tr><td>Total</td><td colspan="2">£237,558</td><td colspan="2">£83,844</td><td>£144,398</td></tr>
<tr><td colspan="6">The costs have been allocated in proportion to the amount of distributed generation connected.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="5">£1,595,620</td></tr>
<tr><td>Internal</td><td colspan="5">£143,711</td></tr>
<tr><td>Total</td><td colspan="5">£1,739,331</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td colspan="2">£ 5,760,000</td><td colspan="2">Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 1,100,000
Internal £ 50,000
Total £ 1,150,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">The scoping and development of three major areas.
• Distributed Generation and demand side management to facilitate the connection of DG to the network;
• Develop a controller that will monitor electricity networks, isolate faults quickly and allow distributed generation to remain connected and operating; and
• Optimise the network with respect to losses.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td colspan="2">Project Benefits Rating</td><td colspan="2">Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">Benefits are expected to include:
• Maximisation of the contribution of DG to the electricity network;
• Reduction in carbon emissions and help towards the UK government's climate change targets;
• Reduction in network losses by having the source of generation close to the load;
• Improvement in quality and security of supply;
• Improvement in network resilience; and
• Reducing the current market failures to increase network capacity for DG.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Year 2015</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">This project is expected to deliver benefits in the order of millions of pounds. As part of the project the real value will be calculated.</td></tr>
</table>

Potential for achieving expected benefits	The progress with software implementation on the target hardware (ABB, COM600), and the testing against the real time simulator is encouraging. A high confidence can be ascribed to having the three core algorithms (voltage constraint management, thermal constraint management and restoration) verified by the development team. The communications infrastructure required is minimal and will not impede the realisation of benefits. The use of the target hardware in the field as a communication device will raise confidence in its suitability for UK substations. The hardware will not perform control actions as part of this project.
Project Progress March 2009	The three core algorithms have been further developed and run on the target hardware within satisfactory execution times. Some of these algorithms have been tested against the real time network simulation and tests for the others are being prepared. This testing is performed by an independent team. Further features have been added to the simulator to support the range of tests. The communications infrastructure required to support the Aura-NMS controller on the example 11kV and 33kV networks has been analysed and proposals made for Aura-NMS implementation. The cost-benefit case for the restoration and distributed generation integration has been formulated and cases explored. The installation of the electrical energy storage device has been delayed due to planning permission and various consents issues. Installation plans by ABB in Sweden are well developed.
Collaborative Partners	This project is a Strategic Partnership between the EPSRC, ABB, EDF Energy Networks and SP Energy Networks.
R&D Providers	Aura NMS is led by Imperial College London and supported by the Universities of Bath, Cardiff, Durham, Edinburgh, Loughborough, Manchester and Strathclyde.

4.3 Earthing Information System

<table>
<tr><td>Description of project</td><td colspan="4">The Earthing Information System project will develop a Geographical 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. Rods are usually driven by pneumatic tools or by hand. Where hard ground restricts the depth of installation either an array of rods is installed at shallower depth, or an earthing system is installed some distance from the substation to achieve the required resistance.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£142,485</td><td>£28,980</td><td>£70,035</td></tr>
<tr><td>Internal</td><td>£20,589</td><td>£4,188</td><td>£10,120</td></tr>
<tr><td>Total</td><td>£163,074</td><td>£33,168</td><td>£80,155</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of distribution substations.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£0</td></tr>
<tr><td>Internal</td><td colspan="3">£2,300</td></tr>
<tr><td>Total</td><td colspan="3">£2,300</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£450,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £20,000
Internal £ 1,000
Total £21,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">A network-wide information system that will help network planners 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></td><td></td><td></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; and
Improved employee safety.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2012</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 (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£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 March 2009	The project is progressing well and a map has been produced for the EDF Energy Networks and Central Networks trial 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 a 10 ohm earth. An interim report has also been produced covering the methodology, processing of the data and the output of the model. Activities included in the project are: the construction of the spatial framework, attribution with resistivity and strength characteristics, calculations to determine the 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 Networks 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 further confidence. The resistivity data will also be used within EDF Energy Networks to support other earthing design work.
Collaborative Partners	Central Networks
R&D Provider	British Geological Survey and Cranfield University

4.4 Advanced Harmonic Monitoring

<table>
<tr><td>Description of project</td><td colspan="4">The purpose of the harmonic monitoring project is to establish a framework for the management of harmonics which will focus on:
A quantification of the current level of harmonics;
A quantified analysis of consequences (losses, life expectancy, accelerated ageing);
The development of a system and strategy to manage the increasing level of harmonics; and
Maximising the output of the on-going power quality programme.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="4"><table><tr><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr><tr><td>External</td><td>£70,336</td><td>£21,531</td><td>£51,675</td></tr><tr><td>Internal</td><td>£14,230</td><td>£4,356</td><td>£10,454</td></tr><tr><td>Total</td><td>**£84,566**</td><td>**£25,887**</td><td>**£62,139**</td></tr></table>The costs have been allocated in proportion to the number of primary substations.</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="4">This project was started in this reporting year.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 469,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 190,000
Internal £ 60,000
Total £ 250,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Identify and understand the impact of harmonics on the network:
Cost: establish whether reducing total harmonic distortion reduces losses and frees up capacity;
Evaluate the impact of harmonics on the life expectancy of assets;
Evaluate the current level of third harmonic in the neutral; and
Sustainability: reduction of carbon footprint due to the reduction of losses.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11.2</td><td>-1</td><td>12.2</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits are:
quantification of the impact of harmonics on the network in terms of cost and safety to the DNO;
potential financial benefits due to: reduction of losses, increased capacity available, increased life expectancy of assets;
development of a robust system to measure and analyse and harmonics data;
development of a methodology to take action when the G5/4 levels have been exceeded; and
better understanding of the current level of harmonics and its evolution. Fully assess the impact of DG on harmonics.</td></tr>
</table>

Expected Timescale to adoption	Year 2010	Duration of benefit once achieved	10 Years
Probability of Success	75%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£200,000
Potential for achieving expected benefits	Power Quality Monitoring equipment has been installed, but it is too early to carry out any detailed analysis.		
Project Progress March 2009	A number of multi-functional power quality monitoring equipment units have been installed. Data has started to be collected and a high level analysis has been carried out. We have been able to provide some customers with information on the levels of harmonics at their points of connection.		
Collaborative Partners	EDF R&D		
R&D Provider			

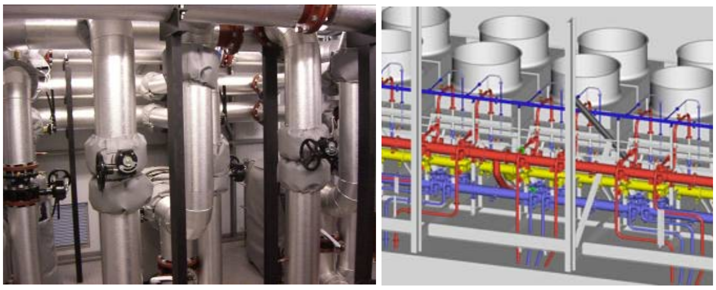
4.5 Improved Fluid Filled Cable Leak Location System

<table>
<tr><td>Description of project</td><td colspan="4">This project is to evaluate the suitability of using PFT tracer technology to determine fluid-filled cable leak locations and reduce the number of excavations required. The technology was developed by NASA.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£59,749</td><td>£52,960</td><td>£23,085</td></tr>
<tr><td>Internal</td><td>£15,999</td><td>£14,181</td><td>£6,181</td></tr>
<tr><td>Total</td><td>£75,748</td><td>£67,140</td><td>£29,266</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the existing lengths of fluid filled cables.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£831,301</td></tr>
<tr><td>Internal</td><td colspan="3">£123,637</td></tr>
<tr><td>Total</td><td colspan="3">£954,938</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 1,100,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £16,049
Internal £25,373
Total £41,422</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">PFT tracer technology to determine cable leak location and reduce the number of excavations required.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Benefits are expected to include:
• Faster and more accurate oil leak locations;
• Operational cost savings with fewer and smaller excavations;
• Positive impact on environment;
• Improved relationship with Environmental Agency through demonstration of a pro-active and world's best practice leak location technique.
• Reduction in Network Risk because the process can be used without switching out the leaking circuit; and
• Better Asset Management of fluid-filled cable condition monitoring associated with the leak location process.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2010</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£5,000,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Between October 2008 and February 2009 the cost of locating seven leaks were collected and compared against the traditional methods previously employed. It was estimated that approximately £135k was saved on these seven jobs alone.</td></tr>
</table>

Project Progress March 2009	Designing and trialling a robust repeatable method for introducing the PFT material into de-gassed cable fluid has been finalised. It became apparent that even with the modifications developed with Femtotrace in 2007/08, the READ unit was never going to be able to perform as originally expected. This coupled with concerns over the continued viability of Femtotrace, forced EDF Energy Networks to look for an alternative instrument. Following a meeting with our collaborative partner Con Edison, and a subsequent visit to their facilities, it was decided that a replacement device, manufactured by Wasson ECE should be purchased. Delivery of this new unit is expected in May 2009. Benefits delivered: It is estimated that £150,000 has been saved in the first 6 weeks of 2009. This is expected to increase as the technology is being integrated into business practices.
Collaborative Partners	Con Edison.
R&D Provider	Femtotrace Inc. Prochem H & R Chempharm Ltd and Wasson ECE Instrumentation.

4.6 Bankside Heat Transfer

<table>
<tr><td>Description of project</td><td colspan="4">Substation transformers produce waste heat which is usually lost to the environment. The re-planted substation at Bankside, adjacent to the Tate Modern, will use transformers with water cooled heat exchangers. It is proposed that the waste heat from the transformers will be used by the Tate Modern to assist with their building heating process. This will benefit EDF Energy Networks, as less energy will need to be expended within cooler fans at the substation, and lower maintenance and replacement cost will be incurred.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£0</td><td>£145,622</td><td>£0</td></tr>
<tr><td>Internal</td><td>£0</td><td>£26,140</td><td>£0</td></tr>
<tr><td>Total</td><td>£0</td><td>£171,762</td><td>£0</td></tr>
<tr><td colspan="4">The costs have been allocated to LPN as the trial is being carried out at Bankside substation in London.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£443,669</td></tr>
<tr><td>Internal</td><td colspan="3">£52,944</td></tr>
<tr><td>Total</td><td colspan="3">£496,613</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£750,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 250,000
Internal £ 4,500
Total £254,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Environmentally friendly cooling of transformers</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></td><td></td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Benefits are expected to include:
• Waste heat will be used by a third party;
• Fewer maintenance interventions for cooling;
• Less auxiliary electricity consumption; and
• Lower noise level from coolers.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2010</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£200,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The Tate Modern is likely to be able to utilise the heat within the next year. Transformer coolers are quiet in operation, even when they are required to provide additional cooling.</td></tr>
</table>

Project Progress March 2009	The control system and the third party heat exchanger have been installed with energy monitoring capability. Cold commissioning and testing is almost complete.  Figure 15 Heat recovery system
Collaborative Partners	
R&D Provider	Wilson Transformers, Arup

4.7 Growth in City Centres

<table>
<tr><td>Description of project</td><td colspan="4">The 'Growth in City Centres' Project is aimed at evaluating innovative ways of dealing with the rapidly increasing load demand in cities in a timely, efficient and cost effective manner.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£0</td><td>£102,015</td><td>£0</td></tr>
<tr><td>Internal</td><td>£0</td><td>£14,164</td><td>£0</td></tr>
<tr><td>Total</td><td>£0</td><td>£116,179</td><td>£0</td></tr>
<tr><td colspan="4">The costs have been allocated to LPN as the research will have the greatest impact in London.</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="4">This project was started in this reporting year.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 289,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 187,000
Internal £ 20,000
Total £ 207,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">• Evolution of 132kV connections
• Power electronics
• Technologies to increase power flows (water cooling, superconductivity, HVDC) and
• DC networks.</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>9.6</td><td>3</td><td>6.6</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The main benefit derived from completion of this part of the project will be the development of technical knowledge and expertise.
Once applied, it will result in improvements in network capacity, performance, better utilisation of space, improved operational resilience, together with potential environmental benefits.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2012</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£200,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">This project has shortlisted a number of ideas and concepts likely to help EDF Energy Networks tackle the issue of increasing load in cities.
The development of timely and cost-effective technical solutions to connect large point loads and reinforce the network will provide better security of supplies, improved reliability, enhanced system resilience and improved customer service.</td></tr>
</table>

Project Progress March 2009	A series of workshops have been held with a number of internal and external specialists. The main issues, problem areas and matters of concern that have been identified to date are:- • Lack of 132kV/11kV capacity in certain areas; • Little likelihood for open cut routes for 132kV and 11kV circuits thereby creating a need for more tunnels; • Insufficient space to accommodate physical size of plant and equipment; • Heat generated by multiple cable circuits in tunnels; and • Insufficient technology progress over past 10 years.
Collaborative Partners	
R&D Provider	PPA Energy

4.8 Overhead Line Fault Location

<table>
<tr><td>Description of project</td><td colspan="6">This project aims to develop an integrated, non-invasive solution to locate and characterise faults, based on a waveform analysis and information provided by other sensors installed on the HV overhead network. The objectives are:
• To help identify the section that contains the fault;
• To detect weak points on the network by long-term waveform analysis, and so optimise maintenance and/or investments;
• Predict and accurately locate a potential fault on the system before it occurs;
• Introduce of innovative monitoring and test equipment that can pinpoint a fault.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td colspan="2">EPN</td><td colspan="2">LPN</td><td>SPN</td></tr>
<tr><td>External</td><td colspan="2">£58,895</td><td colspan="2">£0</td><td>£17,592</td></tr>
<tr><td>Internal</td><td colspan="2">£8,177</td><td colspan="2">£0</td><td>£2,442</td></tr>
<tr><td>Total</td><td colspan="2">£67,072</td><td colspan="2">£0</td><td>£20,034</td></tr>
<tr><td colspan="6">The costs have been allocated in proportion to the length of overhead line.</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="6">This project was started in this reporting year.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td colspan="2">£380,000</td><td colspan="2">Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £100,000
Internal £ 10,000
Total £110,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">To develop a prototype integrated solution which will enable the automatic waveforms analysis to inform network management.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td colspan="2">Project Benefits Rating</td><td colspan="2">Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td colspan="2">17</td><td colspan="2">0</td><td>17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">The expected benefits of this project are:
• Develop a proactive approach towards decreasing interruption duration;
• Reduce switching required to locate the fault; and
• Provide a map of the weak points of the network, for the justification of the investment and maintenance plans.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Year 2010</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">75%</td><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£2,300,000</td></tr>
</table>

Potential for achieving expected benefits	New data compression algorithms are available and enable recording waveforms for long periods of time (6 months to 1 year) with great accuracy. Therefore, having longer recording makes it possible to detect more focused events than when the waveform recording is only triggered on an event trigger.
Project Progress March 2009	Progress to date include: • Power quality devices are installed at the primary substations to measure current and voltage waveforms; and • The communication and information system to download and store data has been installed. • Initial signal measurements on overhead lines have been carried out. • A consortium of project partners has been identified.
Collaborative Partners	eRDF
R&D Provider	EDF R&D, PPA Energy

4.9 FENIX

Flexible Electricity Networks to Integrate the eXpected 'energy evolution'

Description of project	The objective of FENIX is to boost Distributed Energy Resources (DER) by maximizing their contribution to the electric power system, through aggregation into Large Scale Virtual Power Plants (LSVPP) and decentralized management. The project is organised into three phases: • Analysis of the DER contribution to the electrical power system, assessed in two future scenarios (Northern and Southern) with realistic DER penetration; • Development of a layered communication and control solution validated for a comprehensive set of network use cases, including normal and abnormal operation, as well as recommendations to adapt international power standards; and • Validation through two large field deployments, one focused on domestic Combined Heat and Power (CHP) aggregation, and the second aggregating large DER in LSVPPs (wind farms, industrial cogeneration), integrated with global network management and markets.			
Expenditure for financial year		EPN	LPN	SPN
	External	£32,310	£11,403	£19,639
	Internal	£4,942	£1,744	£3,004
	Total	**£37,252**	**£13,147**	**£22,643**
	The costs have been allocated in proportion to the amount of connected distributed generation.			
Expenditure in previous (IFI) financial years	External	£80,918		
	Internal	£41,881		
	Total	**£122,799**		
Total Project Costs (Collaborative + external + EDF Energy Networks)	**€14,700,000**	Projected 2009/10 costs for EDF Energy Networks	Internal £ 10,000 External £ 100,000 Total **£ 110,000**	
Technological area and / or issue addressed by project	To conceptualise, design and demonstrate a technical architecture and commercial framework that would enable DER based systems to become the solution for the future cost efficient, secure and sustainable EU electricity supply system.			
Type(s) of innovation involved	Radical	Project Benefits Rating	Project Residual Risk	Overall Project Score
Expected Benefits of Project	Benefits are expected to include: • Maximise the contribution of DG to the electricity network; • Reduce carbon emissions and help towards the UK governments climate change targets; and • Reduce network losses by having the source of generation close to the load.			
Expected Timescale to adoption	Year 2015	Duration of benefit once achieved	20 Years	
Probability of Success	25%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£2,000,000 This estimate will be refined in the WP3 to assess the	

			economic impact of this architecture.
Potential for achieving expected benefits	The two scenarios to demonstrate the FENIX benefits are proceeding well. Various Stakeholders have had regular contact with the project to understand the commercial and regulatory issues.		
Project Progress March 2009	The first two years of the project were focused on theoretical and conceptual issues. During year 3, the emphasis of WP1 "System Solutions for DER Integration and Demand Response through LSVPP" has been on design and development of specific hardware and software components that will enable the large-scale integration of DER in a way foreseen by FENIX. Areva and Siemens have designed and developed new DMS and EMS modules, that will be demonstrated in the EDF Energy Networks and Iberdrola sites (Northern and Southern scenario respectively). The cost benefit analysis and comparison of the business as usual and the FENIX scenarios were carried out by WP3. The Northern Scenario demonstrator took place at the Imperial College Labs and integrated with intelligent metering devices and Fenix Boxes installed to monitor the Woking Borough Council DER. The Southern Scenario demonstrator has been prepared , by developing each individual components and advancing in agreements with the third parties taking part in the demonstration. The control system of the Urkilla Wind Farm has been installed & validated. WP5 produced several newsletters, disseminating different aspects of the project. In parallel to CIRED Seminar 2008: SmartGrids for Distribution, the Fenix project held its first workshop of the project Stakeholders' Advisory Group. The consortium produced several presentations on the FENIX results in International Conferences (CIRED, IEEE, CIGRE, etc.).		
Collaborative Partners	FENIX is an Integrated Project supported by the European Commission under the 6th framework programme. www.fenix-project.org		
R&D Providers	Iberdrola SA, Electricité de France, EDF Energy Networks, Red Eléctrica de España SA, National Grid Transco, SIEMENS Aktien-gesellschaft Österreich PSE, Korona Inzeniring DD, Areva T&D Energy Management Europe, ZIV PmasC SL, ScalAgent Distributed Technologies, ECRO SRL, Pöyry Energy Consulting, Fundación LABEIN, Energy Research Centre of the Netherlands, Groupment pour inventer la distribution électrique de l'avenir, Institut für solare energieversorgungstechnik verein an der universität Kassel E.V. (ISET), The University of Manchester, Vrije Universiteit Amsterdam, Imperial Collage London and Gamesa Innovation and Technology.		

4.10 Distribution System State Estimation

Description of project	To develop prototype algorithms for distribution system state estimation (DSSE), taking into account the greater use of active components in future distribution networks. The effectiveness of the new algorithms will be evaluated using a suitable section of EDF Energy Networks' network model. This will provide a useful demonstration of the algorithms' ability to facilitate new approaches for the operation and control strategies of future active distribution networks.			
Expenditure for financial year		EPN	LPN	SPN
	External	£31,110	£10,980	£18,910
	Internal	£4,319	£1,524	£2,625
	Total	**£35,429**	**£12,504**	**£21,535**
	The costs have been allocated in proportion to the number of primary transformers supplying the distribution network.			
Expenditure in previous (IFI) financial years	External	£184,000		
	Internal	£14,147		
	Total	**£198,147**		
Total Project Costs (Collaborative + external + EDF Energy Networks)	**£ 396,000**	Projected 2009/10 costs for EDF Energy Networks	External £ 128,000 Internal £ 50,000 Total **£ 178,000**	
Technological area and / or issue addressed by project	The overall research objective will be achieved through two parallel work streams, to be completed in a coordinated manner. One work stream will focus on DSSE methodologies and the other on the implementation issues.			
Type(s) of innovation involved	Radical	Project Benefits Rating	Project Residual Risk	Overall Project Score
Expected Benefits of Project	Benefits are expected to include: • Establishing the difference between the investment reinforcement costs associated with traditional, passive network operation based solutions, and the costs of the system within the context of an active distribution network operation that uses DSSE. • It can be expected that a DSSE will play a similar role to the state estimators used in transmission systems, enabling the release of untapped network capacity, and the provision of network services such as fast flow control and voltage support.			
Expected Timescale to adoption	Year 2010	Duration of benefit once achieved	Years 20	
Probability of Success	25%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£800,000	

Potential for achieving expected benefits	The measurement placement and load modelling tools developed in this project will determine the optimal number of meters and locations for network automation. The load modelling will help utilise untapped capacity of the feeders leading to enhanced network operational efficiency.
Project Progress March 2009	The following project deliverables have been delivered: • Simulation platform compatible with ENMAC for simulation of network operations; • Development of EDF Energy Networks' generic network models and future development scenarios; • Evaluation of performance of conventional state estimator applied to available measurement and network information; • Understanding of the suitability of EDF Energy Networks' data measurement practice to feed in to state estimation function; • Measurement selection and placement tools developed; • Benefits of installing additional measurements established; • DSSE prototype solver; • Application of DSSE solver uncertainties (errors) in estimates and risk of constraint violation; and • Methodology and results of performance validation for improved convergence, prediction error, bad data handling and constraint violation.
Collaborative Partners	
R&D Provider	Imperial College London and EDF R&D

4.11 Optimal Transformer Utilisation Model

<table>
<tr><td>Description of project</td><td colspan="4">EDF Energy Networks currently models emergency/cyclic ratings of power transformers by using a method based on formulae described in CP1010 / BS7735 (a loading guide for oil immersed transformers). This model allows the load-related risk on a substation to be quantified in order to prioritise network reinforcement expenditure. The model predicts the temperature rise within the transformer, in order to determine a maximum rating on a daily basis which each transformer can sustain.

It has become apparent by comparing the output of the EDF Energy Networks' model with the temperatures observed in practice, that there are some differences. The main causes for differences in modelled and observed temperature are over-simplifications of the model, and the absence of effective data for transformer and heat exchanger parameters.

The Cambridge University Engineering Department, in particular the EPEC group, has particular expertise in computer modelling and will be able to significantly improve the EDF Energy Networks' model; this will take the form of a new model for the transformer and a comparison of output with that observed in practice. By using numerical methods, unknown transformer parameters (which cannot easily be measured in practice on an operational transformer) will be determined to produce a model which accurately reflects transformer behaviour. The parameters will be used in the EDF Energy Networks' model, or the Cambridge Model will be used in its entirety to produce accurate results.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£26,739</td><td>£14,484</td><td>£14,484</td></tr>
<tr><td>Internal</td><td>£4,595</td><td>£2,489</td><td>£2,489</td></tr>
<tr><td>Total</td><td>£31,334</td><td>£16,973</td><td>£16,973</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of installed primary transformers.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£85,971</td></tr>
<tr><td>Internal</td><td colspan="3">£9,172</td></tr>
<tr><td>Total</td><td colspan="3">£95,143</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 170,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 20,000
Internal £ 3,000
Total £ 23,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Emergency / cyclic ratings of power transformers</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11.2</td><td>-1</td><td>12.2</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits are:
• Accurate assessment of load related risk on a substation will allow EDF Energy Networks to confidently predict whether there is an unacceptable risk to supplies; and</td></tr>
</table>

	• Optimum timing of reinforcement work programmes (ability to defer spending where appropriate).		
Expected Timescale to adoption	Year 2014	Duration of benefit once achieved	20 Years
Probability of Success	50%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£660,000
Potential for achieving expected benefits	EDF Energy Networks has expressed some concerns with the CUED model, and unless those areas are resolved the expected benefits may not be achieved.		
Project Progress March 2009	Cambridge university have delivered their model for comparison with the EDF Energy Networks' model. A few areas require development and enhancements. Those areas have been highlighted and will continue to be addressed.		
Collaborative Partners			
R&D Provider	Cambridge University Engineering Department		

4.12 Network Risk Management

Description of project	The aim of this project is to develop algorithms for calculating the risk, which the continued use of the components of a distribution system pose, to ongoing satisfactory system operation. It will take into account the significant levels of uncertainty that characterise both the condition of the individual assets and the overall operation of the network. The measurement of risk will characterise network performance in the near future, ensuring that it will reflect the anticipated variability in operation of future distribution networks. The outcome of the project will be new methodologies, enabling a formal understanding of the criticality of different operational conditions and the accuracy with which network parameters must be specified. In addition, it will illustrate the value of an explicitly predictive indicator of the suitability of proposed changes in system operation.			
Expenditure for financial year		EPN	LPN	SPN
	External	£26,574	£14,394	£14,394
	Internal	£3,928	£2,128	£2,128
	Total	**£30,502**	**£16,522**	**£16,522**
	The costs have been allocated in proportion to the number of connected customers.			
Expenditure in previous (IFI) financial years	External	£177,050		
	Internal	£15,549		
	Total	**£192,599**		
Total Project Costs (Collaborative + external + EDF Energy Networks)	£ 454,000	Projected 2009/10 costs for EDF Energy Networks	External £ 100,000 Internal £ 5,000 Total £ 105,000	
Technological area and / or issue addressed by project	This project will address: • The formulation and implementation of algorithms to provide, in near real-time, an assessment of the risk or vulnerability of a section of EDF Energy Networks' distribution system into the near future; • What parameters have most influence on the calculated measure of network risk; and • Provide a comprehensive demonstration of the value of a measure of risk for guiding network operation.			
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	Overall Project Score
Expected Benefits of Project	Benefits are expected to include: • Development tools that will allow the DNO to take into account the explicit uncertainty involved in the distribution system operation; and • Methodologies and tools that can be applied in active distribution networks to optimise the utilisation of the existing network capacity, through the introduction of new devices and/or the modification of network operation strategies in a more informed manner.			

Expected Timescale to adoption	Year 2010	Duration of benefit once achieved	20 Years
Probability of Success	75%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£ 200,000
Potential for achieving expected benefits	A framework has been developed for calculating a measure of risk to which different sections of the EDF Energy Networks' network are exposed to, by considering different approaches to operation within the near future. The framework allows risk to be calculated considering a range of different time horizons, hazards that could lead to supply interruptions, with a reasoned trade-off between computational efficiency and accurate estimation of high impact interruptions. The main focus of the remaining work will be to ensure that the computational process can deliver meaningful and useful results to network operators.		
Project Progress March 2009	An algorithm has been developed and is working satisfactorily when applied to a realistic test network. It is being refined through application to sections of EDF Energy Networks' system. Further developments may include translating the code into a more flexible programming language, to increase the robustness and computational efficiency of the process. Data resources (both generic and network specific) have been identified and processed. The risk algorithm has the facility to include "in-simulation" changes to asset condition, in prediction of failure events but feedback mechanism to customize asset condition must be added. The algorithms developed allow interruptions to be costed using different metrics such as customer interruptions, customer minutes lost, potential worst served customer performance and cost of exceeding regulatory standards for customer supply. Future work will look at valuing risk in terms of energy not served, including the stochastic behaviour of loads. Algorithms have been developed to allow the calculation of operational risk faced by continued (or changing) over time horizons ranging from one hour to one year ahead. This work is supported by analytical models ,for the risk evolution process that can be used to help understand how apparent network vulnerability evolves. A data survey has identified boundaries to the range of asset failure likelihoods, operational effectiveness and the repair and restoration processes that have been used on comparative projects. This is complemented by extensive sensitivity studies conducted on aggregated network models. Limitations in the original risk algorithm that reduced the robustness of sensitivity studies have been resolved and studies are now being conducted with actual system data.		
R&D Provider	Imperial College London		

4.13 Application of Storage and Demand Side Management

<table>
<tr><td>Description of project</td><td colspan="6">The project will investigate and quantify the benefits of integration of electricity storage and Demand Side Management (DSM) technologies in the operation and development of active distribution networks.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td colspan="2">EPN</td><td colspan="2">LPN</td><td>SPN</td></tr>
<tr><td>External</td><td colspan="2">£26,520</td><td colspan="2">£9,360</td><td>£16,120</td></tr>
<tr><td>Internal</td><td colspan="2">£3,703</td><td colspan="2">£1,307</td><td>£2,251</td></tr>
<tr><td>Total</td><td colspan="2">£30,223</td><td colspan="2">£10,667</td><td>£18,371</td></tr>
<tr><td colspan="6">The costs have been allocated in proportion to the amount of connected distributed generation.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="5">£199,000</td></tr>
<tr><td>Internal</td><td colspan="5">£17,275</td></tr>
<tr><td>Total</td><td colspan="5">£216,275</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td colspan="2">£ 460,000</td><td colspan="2">Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 35,000
Internal £ 5,000
Total £ 40,000</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="6">The main areas addressed are:
• Feasibility assessment of alternative applications of DSM and storage to solve network problems;
• Development of techniques for optimisation of the operation of active distribution network, including real time control of storage and load control devices, to manage network voltage and flow profiles in real time; and
• Quantification and optimisation of the multiple value streams of various storage applications and load control management.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td colspan="2">Project Benefits Rating</td><td colspan="2">Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">Benefits are expected to include:
• Quantifying the value of specific storage and DSM technologies; and
• A business case showing whether storage and DSM can deliver value in the performance of the network.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Year - 2015</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">75%</td><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">Only when the methodology proposed in this project is developed, will it be possible to evaluate financial benefits of storage and DSM across various future development scenarios.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="6">The models for Storage and Demand Side Management (DSM) have been developed and validated for the application in distribution network</td></tr>
</table>

	operation and development. A methodology has been devised to assess the technical and financial benefits of these technologies from DNO's perspective. The key drivers that impact the value of storage and DSM are identified and quantified. The optimal operating strategies of Storage and DSM are being devised and examined on various test networks under various future network development scenarios, while successfully managing network constraints. The remaining work will be focused on the analysis of business cases for Storage and DSM technologies within the present regulatory environment.
Project Progress March 2009	Progress within the work packages in work Phase 1 and Phase 2 are summarised below: WP 1 - Characterisation and modelling of storage and DSM systems A generic storage model was developed and covers all essential features of the real storage. Several DSM models (both thermal load and shifting load), taking into account consumers' comfort constraints were implemented and successfully tested on several test cases. Both storage and DSM models can be incorporated into power system analysis tools. WP 2 - Viability assessment of Storage and DSM technologies A set of metrics has been introduced in order to assess the financial benefits of Storage and DSM, and examined through extensive simulations and sensitivity analyses. This has led to the identification of the key drivers for storage and DSM that can be created within distribution networks. WP 3 - Optimisation of active network operation including control capabilities of storage and DSM The network analysis model developed enables both power flow and voltage profiles to be managed in the distribution network using storage and DSM, within operation time scales. The model allows the impact of the application of storage and DSM on the power and energy losses in the network to be evaluated, as a result of higher network utilisation. The algorithms developed are also suitable for the control of active distribution networks in real time. The remaining efforts will focus on modelling uncertainties in the driving parameters such as electricity prices, demand and DG output profiles. WP4 - Development of distribution investment planning tool to determine network reinforcement, investment in storage and DSM technologies A new active distribution network planning methodology is being developed to study optimal network reinforcements, while taking full advantage of the control capabilities enabled by storage and DSM. The model is based on a co-ordination of network investment (such as circuit reinforcement), and operation with enabling technologies (including penetration of DG). Further work will focus on practical implementation

	of the model and testing on a wide range of system conditions. WP5 - Development of business cases for Storage and DSM technologies Developed network operation and planning algorithms are used to assess the value of Storage and DSM when applied to distribution networks. However, the commercial viability will also depend of the design of regulatory framework.
Collaborative Partners	
R&D Provider	Imperial College

4.14 Network Technical Losses Reduction

Description of project	The purpose of the project is to establish a framework for the management of network technical losses. It will demonstrate a proactive approach towards economic, social and environmental sustainability, through EDF Energy Networks management of electrical distribution efficiency.			
Expenditure for financial year		EPN	LPN	SPN
	External	£26,000	£10,000	£14,000
	Internal	£3,610	£1,388	£1,944
	Total	**£29,610**	**£11,388**	**£15,944**
	The costs have been allocated in proportion to the total length of distribution circuits.			
Expenditure in previous (IFI) financial years	This project was started in this reporting year.			
Total Project Costs (Collaborative + external + EDF Energy Networks)	**£400,000**	Projected 2009/10 costs for EDF Energy Networks	External £50,000 Internal £ 5,000 Total **£55,000**	
Technological area and / or issue addressed by project	Techniques to reduce network technical losses.			
Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	Overall Project Score
		13.8	2	11.8
Expected Benefits of Project	This project is expected to suggest ways to minimise losses by: • Maximising the available capacity of plant and equipment to deliver useful energy; and • Minimising losses also minimises the amount of generation required purely to supply network losses.			
Expected Timescale to adoption	Year 2010	Duration of benefit once achieved	10 Years	
Probability of Success	75%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£2,000,000	
Potential for achieving expected benefits	A distribution circuit will be selected, changes will be made, and the before and after performance will be evaluated.			

Project Progress March 2009	Progress and findings include the following: • Urban, suburban and rural circuits have been modelled and tested in order to optimise the position of normal open points. • Primary substations can be operated with busbar switches open. Another solution is to leave the standby transformer de-energised. • Copper and iron losses and the consequences on quality and security of supply have been evaluated. • Voltage level and losses are closely linked. The two following subject have been studied: - Consequences of voltage increasing (LV and MV) on losses; and - Consequences of capacitors on MV or LV networks. For cables, the resistance of conductors is taken into account to evaluate the losses. The impact of others parameters has been estimated (temperature of conductors, cable screens, connections, etc.). Strategic planning information on distribution system and distribution equipment efficiency has been provided. Research results have included annual technology assessments and strategic intelligence reports. A consistent process for integrating energy efficiency, and demand response resources as part of the distribution planning process has been developed.
Collaborative Partners	eRDF
R&D Provider	EDF R&D

4.15 Condition Monitoring of Composite Insulators

<table>
<tr><td>Description of project</td><td colspan="4">Composite insulators are now deployed throughout the world and are steadily replacing traditional ceramic and glass insulators. Low weight and physical robustness are two properties which have led to an increasing market share for composite insulators over the last 20 years. However, there is concern over the long-term ageing of these insulators.

This work will characterise the millimetre-scale arcing activity between water droplets, and develop an experimental knowledge and theoretical understanding of how this leads to macroscopic behaviour. In particular, it will identify the local service conditions on the millimetre scale which cause the ageing of hydrophobic material surfaces.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£28,752</td><td>£0</td><td>£8,588</td></tr>
<tr><td>Internal</td><td>£11,533</td><td>£0</td><td>£3,445</td></tr>
<tr><td>Total</td><td>£40,285</td><td>£0</td><td>£12,033</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the length of 11kV overhead line.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£37,600</td></tr>
<tr><td>Internal</td><td colspan="3">£4,521</td></tr>
<tr><td>Total</td><td colspan="3">£42,121</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 120,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 26,000
Internal £ 2,000
Total £ 28,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Develop reliability models for hydrophobic insulators, recommend test schedules for type approval and product development, and identify condition monitoring techniques for existing 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>10.4</td><td>3</td><td>7.4</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits include:
An improved understanding of insulation ageing;
A better understanding of risk associated with ageing insulation;
Reduced operational costs through extended times between insulator replacement;
Reduced outages as a result of reduced, unforeseen insulation failure;
Improved methods for testing of new products; and
Stronger management of suppliers.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2011</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£ 100,000</td></tr>
</table>

Potential for achieving expected benefits	Several of benefits likely to be achieved soon include: • An improved understanding of insulation ageing; and • Improved methods for testing new products.
Project Progress March 2009	11 kV field-aged MV EPDM Insulators: • The last group of insulators was recovered in September 2008. Four different locations are under study. • All the electrical tests, under dry and wet conditions have been finished. • Leakage current versus frequency tests are concluded. • Fourier transform infrared spectroscopy (FTIR) has been carried out for the last group of insulators. • Microscopy images of surfaces have been taken. • Evaluation of hydrophobicity is complete. Water droplets under electric field analysis: • The unique test facility is now completely built and synchronized; • A study of the influence of the electrode configuration and shape is complete; and • Behaviour (movement, contact angle change, leakage current and flashover) of a single water droplet (tap water, low conductivity) on a polymer surface has been examined.
Collaborative Partners	
R&D Provider	University of Manchester

4.16 LV Underground Cable Fault Management

<table>
<tr><td>Description of project</td><td colspan="4">EDF Energy Networks has identified opportunities from intermittent fault detection & location on LV underground cables.
This project combines the use of an intermittent cable fault location device (T-P22) with an improved re-energisation device (REZAP Fault Master) so that LV intermittent faults can be better managed and customer interruptions reduced.
The project is also supporting the development of a “modular REZAP”.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£20,649</td><td>£11,931</td><td>£13,307</td></tr>
<tr><td>Internal</td><td>£2,867</td><td>£1,656</td><td>£1,848</td></tr>
<tr><td>Total</td><td>£23,516</td><td>£13,587</td><td>£15,155</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the length of installed LV cable.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£306,752</td></tr>
<tr><td>Internal</td><td colspan="3">£29,295</td></tr>
<tr><td>Total</td><td colspan="3">£336,047</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 450,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £0
Internal £10,000
Total £10,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The project is developing the following techniques:
• Time reflection to determine fault location;
• Transient impedance fault location;
• Travelling wave fault location; and
• An auto reclosing device.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>16.2</td><td>-11.00</td><td>27.20</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Benefits are expected to include:
• Reduction in number of site visits to replace fuses
• Reduction in repeated customer interruptions due to intermittent faults being re-energised;
• Reduction in customers minutes lost; and
• Reduction in worst served customers.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2009</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£1,200,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Work is currently on-going to modify EDF Energy Networks’ LV fault management strategy. A number of operational restrictions are currently delaying the deployment of the technologies developed as part of this project.</td></tr>
</table>

Project Progress March 2009	T-P 22 (Intermittent fault location equipment): Following successful trials of the device, a business wide deployment of the T-P 22 equipment is currently in progress (not IFI funded). The following developments were carried out: • A modified low voltage fuse carrier has been designed in collaboration with relevant manufacturers, in order to provide a safer method of connection for the device; and • Improved protection for the equipment. REZAP Fault Master (LV auto-reclosing equipment): The trial of the REZAP Fault Master devices has been delayed due to operational restrictions on the EDF Energy Networks' LV network. The following developments were carried out: • Load profiler and Modular REZAP Feasibility study; and • Fault differentiation algorithms to prevent reclose on high current and improve safety.
Collaborative Partners	Electricity North West. SP Energy Networks
R&D Provider	Kehui Ltd, Kelvatech (formerly Kelman), Nortech Management Ltd

4.17 Lone Working Risk Management

<table>
<tr><td>Description of project</td><td colspan="6">Two incidents involving lone workers recently occurred. A linesman fell into a disused well (concealed by long grass), whilst carrying out line patrol and sustained multiple injuries.

The other incident involved a linesman who fell into a concealed ditch full of slurry whilst carrying out line patrol and was unable to call for immediate help.

As part of EDF Energy's Zero Harm programme, an investigation into potential solutions for the welfare monitoring and management of Health and Safety incidents involving lone workers is being carried out.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td colspan="2">EPN</td><td colspan="2">LPN</td><td>SPN</td></tr>
<tr><td>External</td><td colspan="2">£21,000</td><td colspan="2">£7,560</td><td>£13,440</td></tr>
<tr><td>Internal</td><td colspan="2">£2,916</td><td colspan="2">£1,050</td><td>£1,866</td></tr>
<tr><td>Total</td><td colspan="2">£23,916</td><td colspan="2">£8,610</td><td>£15,306</td></tr>
<tr><td colspan="6">The costs have been allocated in proportion to the length of installed circuits.</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="6">This project was started in this reporting year.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td colspan="2">£ 238,000</td><td colspan="2">Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 107,000
Internal £ 84,000
Total £ 196,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">Managing lone worker risk using technological solutions.
Improved asset management processes.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td colspan="2">Project Benefits Rating</td><td colspan="2">Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td colspan="2">7</td><td colspan="2">-3</td><td>10</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">Expected Benefits of Project are expected to be:
Warning system to check the welfare of lone workers; and
Location of lone workers.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Year 2010</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">75%</td><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£200,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="6">Managed service providers are likely to be able to provide the necessary services to reduce lone worker risk.</td></tr>
</table>

Project Progress March 2009	The focus of the project has been to : • Identify and document current processes and measures for lone worker safeguards; • Identify gaps and inadequacies in these; and • Develop a proposed set of processes and associated requirements for an improved solution. This work laid the foundations for specifying solution proposals. It has now been approved and provide the basis for the pilot implementation.
Collaborative Partners	
R&D Provider	EDF Energy's BI&T will select a third party service provider to supply technology and external management processes.

4.18 Recycling Excavated Material

Description of project	This project will identify ways in which excavated ground works material, resulting from jointing, maintenance and project work, can be recycled and how the change to the use of recycled materials can be managed both internally and with local authorities. Currently, over 500,000 tonnes per annum of excavated material is sent to landfill. Disposal costs are rising and are in the order of £20 per tonne. Equal amounts of aggregate (approximately £16 per tonne) are excavated to produce virgin "type one" material required by the Highways Authorities to backfill utility excavations. The impact of sending excavated material to landfill sites is not sustainable and demonstrates that EDF Energy Networks takes the challenge of corporate responsibility seriously.			
Expenditure for financial year		EPN	LPN	SPN
	External	£18,244	£11,195	£12,024
	Internal	£2,533	£1,554	£1,669
	Total	**£20,776**	**£12,749**	**£13,694**
	The costs have been allocated in proportion to the length of installed underground cable.			
Expenditure in previous (IFI) financial years	External	£24,681		
	Internal	£6,463		
	Total	**£31,144**		
Total Project Costs (Collaborative + external + EDF Energy Networks)	**£ 80,000**	Projected 2009/10 costs for EDF Energy Networks	External £ 24,681 Internal £ 8,000 Total **£ 32,681**	
Technological area and / or issue addressed by project	The innovative part of this project is to show that the recycled material can meet the requirements of the Highway Authorities and can be approved as an alternative to virgin type one material. It will also contribute to achieving the "45% of material recycled" government target. This will be carried out alongside a full product and process life cycle analysis. Any recommendations will be backed up by scientific evidence (comparison between recycled material properties and reinstatement specification) and a cost benefit analysis.			
Type(s) of innovation involved	Radical	Project Benefits Rating	Project Residual Risk	Overall Project Score
Expected Benefits of Project	Benefits are expected to include: • Reduction in the amount of material sent to landfill by 136,000 tonnes per year; • Reduction in excavated virgin material from around the world by 136,000 tonnes; • Less vehicle movement to landfill sites and gravel yards; and • Less pollution on roads caused by vehicle movement.			

Expected Timescale to adoption	Year 2010	Duration of benefit once achieved	20 Years
Probability of Success	75%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£1,900,000
Potential for achieving expected benefits	The project has the potential to identify the most sustainable ways in which to reinstate the highway. By creating a model based on the PAS 2050 standard, the Greenhouse Gases (GHG) emissions from street works will be identified, depending on the method of reinstatement used. By looking at the GHG emissions from the various methods, the most sustainable method can then be selected depending on the situation (i.e. how far away the waste management plant is, what materials are available, etc). The model will also be able to monitor the associated economic costs.		
Project Progress March 2009	The local councils in the LPN and EPN region have been visited. The results of other trials in the London area are being monitored. The EPN region is now using recycled materials in the majority of the area. The resource usage data collection is now homogenised and reported in all regions. Recycled material has been developed in the LPN area and is undergoing final testing and councils have been approached with the view to roll out the recycled material in the next three months. The change management culture within the street works team has been analysed, in order to ensure effective take-up of any new processes. The local councils have been interviewed to analyse their attitude towards a change of process and materials, and create a best practice guide when the changes are implemented. The construction of the PAS 2050 model has begun and is in the data collection phase.		
Collaborative Partners			
R&D Provider	University of Surrey		

4.19 Grid Transformer Monitoring

<table>
<tr><td>Description of project</td><td colspan="4">This project will evaluate the benefits of deploying the Intellix MO150 transformer monitoring system. Devices will be installed on four typical grid transformers at two sites. Full installation involves the integration of alarms/monitoring data with existing EDF Energy Networks' SCADA (ENMAC and possibly one CORGIS site) and historic data acquisition into LIMES data historian for strategic analysis.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£13,873</td><td>£7,514</td><td>£7,514</td></tr>
<tr><td>Internal</td><td>£3,238</td><td>£1,754</td><td>£1,754</td></tr>
<tr><td>Total</td><td>£17,111</td><td>£9,268</td><td>£9,268</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of primary transformers supplying the distribution network.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£98,600</td></tr>
<tr><td>Internal</td><td colspan="3">£7,764</td></tr>
<tr><td>Total</td><td colspan="3">£106,364</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 170,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 40,000
Internal £ 10,000
Total £ 50,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Grid transformer monitoring.</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></td><td></td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits include the following:
• Optimisation of the lifespan of power transformers;
• Monitoring and performing real-time, online transformer diagnostics can help reduce the risk of unexpected and sometimes catastrophic failures, thus avoiding expensive replacement, clean-up costs and unplanned downtime; and
• Permit short time overloading with online realtime monitoring.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2009</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>100%</td><td>Project NPV
(Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£200,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The Intellix MO150 devices do appear to be able to monitor transformers effectively and provide useful information.
GE Energy can routinely plug and play these devices with ENMAC. This will be proved at the forthcoming deployment at Sheerness Grid.</td></tr>
</table>

Project Progress March 2009	This IFI project has enabled EDF Energy Networks to benefit from the practical experience of first deployment of these devices in the UK. The first units deployed were incorrectly sited too close to an overheating transformer and failed, as temperatures exceeded design specification. There have also been some difficulties with SCADA communications which have now been resolved.
Collaborative Partners	
R&D Provider	GE Energy, MW Test Equipment Ltd and Drallim Ltd

4.20 Understanding Ageing Mechanisms in XLPE cables

<table>
<tr><td>Description of project</td><td colspan="4">This project will study the performance of the materials used for cable design and in particular:
The oxygen penetration index of the outer sheath, coupled with water and oxygen diffusion factors; and
The corrosion mechanisms of aluminium screens.
The aim is to determine the effects of water and oxygen penetration through High Voltage cable outer sheath/screen combinations on the expected life.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£13,200</td><td>£8,400</td><td>£8,400</td></tr>
<tr><td>Internal</td><td>£1,833</td><td>£1,166</td><td>£1,166</td></tr>
<tr><td>Total</td><td>£15,033</td><td>£9,566</td><td>£9,566</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the length of 11kV cable.</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="4">This project was started in this reporting year.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£390,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £30,000
Internal £ 3,000
Total £33,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Current IEC cable standards do not have a long term corrosion tests, because there is no scientifically proven evidence suggesting a problem exists;
Influence cable specifications; and
EDF Energy Networks is particularly interested in keeping water out of cables for as long as possible because some UK design cables have a copper wire / aluminium foil screen combination.</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>10.6</td><td>-2</td><td>12.6</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Improvement of security/quality of supply and a better understanding of the failure mechanism.
Better planning of investments for the replacement of 132kV and 66kV cables.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2010</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£200,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The project is progressing according to plan. Several cable samples have been collected in order to carry out long term corrosion tests.</td></tr>
<tr><td>Project Progress March 2009</td><td colspan="4">PhD work started in October 2008.
The first dissemination event took place on the26th March 2009.
A literature search has been carried out.
The cable sample collection activity is ongoing.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">RTE and eRDF</td></tr>
<tr><td>R&D Provider</td><td colspan="4">ENSAM Paris, EDF R&D</td></tr>
</table>

4.21 33kV Voltage Control

<table>
<tr><td>Description of project</td><td colspan="4">This project proposes a study to evaluate active voltage control and reactive power flow management of interconnected 33kV systems (via SCADA), to minimise losses whilst accommodating embedded generation.
With the provision of real and reactive power measurements, generator outputs and tap changer positions, the project will develop voltage control strategies taking into the account DG contributions and co-ordination with various EDF Energy Networks and National Grid strategies</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£14,065</td><td>£4,964</td><td>£8,549</td></tr>
<tr><td>Internal</td><td>£1,953</td><td>£689</td><td>£1,187</td></tr>
<tr><td>Total</td><td>£16,018</td><td>£5,653</td><td>£9,736</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of primary transformers.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td colspan="2">External</td><td colspan="2">£22,052</td></tr>
<tr><td colspan="2">Internal</td><td colspan="2">£2,534</td></tr>
<tr><td colspan="2">Total</td><td colspan="2">£24,586</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 118,000</td><td>Projected costs for EDF Energy Networks 2009/10</td><td colspan="2">External £ 6,000
Internal £ 1,000
Total £ 7,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Co-ordinated 33kV voltage control strategies taking into the account DG contributions.</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></td><td></td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits are:
Enhanced software tools and techniques for mathematical modelling and analysis of AVC schemes in distribution networks
Expertise and knowledge transfer between R&D provider (Brunel University) and collaborative partners (EDF Energy Networks and Fundamentals)
Increased headroom to allow more DG to connect to lower voltage networks; and
Reduced network losses caused by reactive power flow.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2013</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£ 100,000</td></tr>
</table>

Potential for achieving expected benefits	Based upon the progress to March 2009 there is considerable potential for achieving expected benefits. The following benefits are close to realisation: • Increased headroom to allow more DG to connect to lower voltage networks; • Software assessment tool for SuperTAPP n+ relay operation and settings; • Improved performance of SuperTAPP n+; • Reduced network losses by appropriate transformer tap position control; • Knowledge, experience and confidence with installation, settings and performance of SuperTAPP n+ scheme; and • Assessment criteria for appropriate voltage control scheme selection and settings.
Project Progress March 2009	The following have been carried out: • Rigorous investigation, implementation, testing and comparison of existing modelling and analysis tools for AVC schemes in distribution networks • Theoretical demonstration of benefits of SuperTAPP AVC scheme in distribution networks using enhanced software tools and techniques. • Practical demonstration of the potential benefits of SuperTAPP AVC scheme using EDF Energy Networks' network case study and data. • Installation of SuperTAPP n+ on the EDF Energy Networks' network. Performance analysis and validation of SuperTAPP n+ during the network trial. Validation of software simulation results based on network trial data. • Evaluation of new generator output estimation algorithm based on dynamic load ratio using network trial data. Investigation and analysis of coordinated active voltage management schemes in distribution networks with distributed generation. Five technical papers have been accepted at peer reviewed international conferences: UPEC 2007, PSCC 2008, UPEC 2008, CIRED 2009, IEEE PES GM 2009.
Collaborative Partners	Fundamentals Ltd
R&D Provider	Brunel University

4.22 Evaluation of the Characteristics of Alternative Oils for retro-filling power transformers and for use in new transformers, Phase 2

<table>
<tr><td>Description of project</td><td colspan="4">To assess various alternative materials that could be used as the insulating medium for power transformers and to undertake electrical tests on insulation materials to validate the advantages claimed.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£11,200</td><td>£6,067</td><td>£6,067</td></tr>
<tr><td>Internal</td><td>£2,922</td><td>£1,583</td><td>£1,583</td></tr>
<tr><td>Total</td><td>£14,122</td><td>£7,650</td><td>£7,650</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of installed primary transformers.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£21,199</td></tr>
<tr><td>Internal</td><td colspan="3">£11,667</td></tr>
<tr><td>Total</td><td colspan="3">£32,866</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 350,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £22,000
Internal £ 2,200
Total £24,200</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Evaluation of the characteristics of alternative oils for retro-filling power transformers and for use in new transformers.</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></td><td></td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The benefits of using alternative oils in transformers are based around two main points:
• Safety/environment; and
• Lifetime ageing performance.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2014 Year</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 (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£ 50,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Electrical and Mechanical characteristics have been determined. Usage of the alternative oil is dependent on the final cost benefit analysis.</td></tr>
<tr><td>Project Progress
March 2009</td><td colspan="4">Validation of previous research has been completed.

Further investigation of fluid characteristics is being carried out.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">Areva T&D, M & I Materials,
National Grid, SP Energy Networks,
Electricity North West and EDF Energy Networks.</td></tr>
<tr><td>R&D Provider</td><td colspan="4">University of Manchester</td></tr>
</table>

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4.23 Activ Project

<table>
<tr><td>Description of project</td><td colspan="4">This project will investigate active voltage control in order to increase the efficiency of the network and facilitate the connection of distributed generation. More specifically, it will undertake field trials of the "Fundamentals" SuperTAPP n+ automatic voltage control (AVC) relay and develop associated modelling criteria for network planners.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£22,856</td><td>£0</td><td>£0</td></tr>
<tr><td>Internal</td><td>£4,802</td><td>£0</td><td>£0</td></tr>
<tr><td>Total</td><td>£27,658</td><td>£0</td><td>£0</td></tr>
<tr><td colspan="4">The costs have been allocated to EPN where the demonstration of this project will take place.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£6,906</td></tr>
<tr><td>Internal</td><td colspan="3">£ 854</td></tr>
<tr><td>Total</td><td colspan="3">£7,760</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£254,206</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 47,000
Internal £ 10,000
Total £ 57,000</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</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td></td><td></td><td></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; and
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>Year 2010</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£ 223k</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The voltage control scheme is operating as expected over a range of operating conditions. It is likely that the expected benefits will be achieved.</td></tr>
</table>

Project Progress March 2009	Three of the four trial sites are now installed and generating data that will be used for validation. The sites include: • A simple landfill generator on an 11kV radial network; • A 33kV lightly interconnected network with wind generation; • An 11kV radial network with Load Drop Compensation and large amount of generation and varying load types. Over 10,000 operational hours have been recorded. A number of issues have been discovered and addressed. Desktop studies have been completed on two of the sites, indicating that more voltage headroom for generation can be created with little requirement for additional operator intervention.
Collaborative Partners	CE Electric UK, Central Networks, EDF Energy Networks and SP Energy Networks
R&D Provider	EA Technology Ltd Fundamentals Ltd

4.24 ZEFAL

The Zefal Generator for Active Urban Networks

<table>
<tr><td>Description of project</td><td colspan="4">Development of a proof of concept prototype generator that is optimised for network connectivity, including networks with fault level constraints.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£0</td><td>£19,000</td><td>£0</td></tr>
<tr><td>Internal</td><td>£0</td><td>£8,407</td><td>£0</td></tr>
<tr><td>Total</td><td>£0</td><td>£27,407</td><td>£0</td></tr>
<tr><td colspan="4">The costs have been allocated to LPN licensed area where the Zefal generator would be expected to deliver benefits.</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="4">This project was started in this reporting year.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 430,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £12,000
Internal £ 7,200
Total £ 19,200</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Network connection of distributed generation.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>7</td><td>3</td><td>4</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Reduced cost, network impact and man-hours involved in providing distributed generation connections.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2013</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£ 500,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The proposed design could be patentable and provide competitive advantage over existing products.</td></tr>
<tr><td>Project Progress March 2009</td><td colspan="4">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. The issues have now been resolved and the project is proceeding as planned.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">E.On UK Plc,
Yorkshire Electricity Distribution Plc
EDF Energy Networks</td></tr>
<tr><td>R&D Provider</td><td colspan="4">NaREC Development Services Ltd,
PPA Energy Ltd,
University of Nottingham and
Imperial College London.</td></tr>
</table>

4.25 Power Networks Research Academy

<table>
<tr><td>Description of project</td><td colspan="4">Power Networks Research Academy has been established through a strategic partnership agreement between the Engineering and Physical Sciences Research Council (EPSRC), Network operators and electricity supply industry related manufacturers and consultants. They will fund PhD researchers in power industry-related projects, help maintain, as well as improve, the research and teaching capacity in power engineering subjects.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£9,068</td><td>£5,771</td><td>£5,771</td></tr>
<tr><td>Internal</td><td>£1,417</td><td>£902</td><td>£902</td></tr>
<tr><td>Total</td><td>£10,485</td><td>£6,673</td><td>£6,673</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of customers in each licensed area.</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="4">The PNRA has not been reported in previous years.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 1,540,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 40,000
Internal £ 4,000
Total £ 44,000</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; and
• 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>9.4</td><td>0.0</td><td>9.4</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>
</table>

Expected Timescale to adoption	Year 2012 onwards	Duration of benefit once achieved	20 Years
Probability of Success	25%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£ 200,000
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 a 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,)** 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.		

Project Progress March 2009	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 Networks has provided technical guidance on the use of OHMS for optimising performance on the 11kV networks. Initial modelling of PLC systems on the 11kV 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, 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) 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 National Grid), 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, The IET, National Grid, Scottish and Southern Energy, Central Networks, EDF Energy Networks and EA Technology Ltd.
R&D Providers	Universities of Cardiff, Manchester, Queens (Belfast), Southampton, Strathclyde and Imperial College London.

4.26 Supergen 1 - FlexNet

<table>
<tr><td>Description of project</td><td colspan="4">FlexNet will put in place a substantial body of work that will build on the achievements of 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 rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£8,800</td><td>£5,600</td><td>£5,600</td></tr>
<tr><td>Internal</td><td>£1,222</td><td>£778</td><td>£778</td></tr>
<tr><td>Total</td><td>£10,022</td><td>£6,378</td><td>£6,378</td></tr>
<tr><td colspan="4">The costs will be allocated in proportion to the number of customers in each licensed area .</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="4">The programme started in this regulatory year.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 7,600,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 20,000
Internal £ 3,000
Total £ 23,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Some key questions to be 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">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>7.2</td><td>-2</td><td>9.2</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Each work stream is expected to deliver benefits.
Shape and Size of Future Electricity Networks will continue to build on the FutureNet scenarios.

Markets and Investments will investigate some of the 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 power electronic systems currently being restricted to voltage control.

Smart, Flexible Controls will help network operators to understand the benefits of changing the network operation philosophy and the requirements for its implementation.

Customers, Citizens and Loads will analyse potential contributions that</td></tr>
</table>

	customers and responsive demand can make towards enabling a more flexible energy system, to identify barriers to this participation and their possible remedies, and to analyse the place-related factors shaping public acceptance of a more flexible network infrastructure. Validation and Showcase will provide the basis for testing the research outcomes in a representative environment and demonstrating their effectiveness in addressing problems central to the realisation of flexible power networks. Future Energy Mix will consider possible changes in (UK) energy systems to 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 and Public Acceptance of Future Network will inform many of the social issues and engagement.		
Expected Timescale to adoption	Year 2012 onwards	Duration of benefit once achieved	20 Years
Probability of Success	25%	Project NPV (Present Benefits – Present Costs) x Probability of Success	£2,000,000
Potential for achieving expected benefits	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" work stream 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.		
Project Progress 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 work stream supported the LENS report with techno-economic appraisals and that work is now disseminated.
Collaborative Partners	EPSRC, National Grid, Scottish and Southern Energy, Central Networks, EDF Energy Networks, SP Energy Networks, CE Electric UK, and Electricity North West.
R&D Provider	Universities of Bath, Birmingham, Cambridge, Cardiff, Edinburgh, Manchester, Strathclyde and Imperial College London.

4.27 Collaborative ENA R&D Programme

<table>
<tr><td>Description of project</td><td colspan="4">The Energy Networks Association (ENA) represents all the UK network operators. The projects listed below have been initiated by the ENA R&D Working Group and have been funded through the IFI.

The fault level monitor and earthing project reported last year have not incurred any costs this year. A new project to develop guidance for long underground cable harmonic impedance modelling is the main topic of this report.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£3,959</td><td>£2,519</td><td>£2,519</td></tr>
<tr><td>Internal</td><td>£550</td><td>£350</td><td>£350</td></tr>
<tr><td>Total</td><td>£4,509</td><td>£2,869</td><td>£2,869</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to length of installed 11kV cables.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£32,125</td></tr>
<tr><td>Internal</td><td colspan="3">£2,749</td></tr>
<tr><td>Total</td><td colspan="3">£34,874 (previous years' collaboration)</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 65,000 (for the harmonic impedance modelling)</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 5,000
Internal £ 1,000
Total £ 6,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The harmonic impedance modelling project addresses the detailed modelling of cable and overhead line components, to develop cable models appropriate for distribution networks.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental innovation</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>6.2</td><td>-10</td><td>16.2</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The objective of the study 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.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2010</td><td>Duration of benefit once achieved</td><td colspan="2">10 – 20 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£ 100,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The frequency dependent behaviour of overhead lines and cables was assessed. A sensitivity analysis has shown that simplified 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.</td></tr>
</table>

Project Progress March 2009	An interim report for the harmonic impedance modelling project 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. A final report is expected shortly. The findings of the Earthing project were so new and unexpected that further work is planned to verify and publish the results.
Collaborative Partners	National Grid, SP Energy Networks, Scottish and Southern Energy, Electricity North West, Western Power Distribution, Central Networks, CE Electric UK and EDF Energy Networks.
R&D Providers	TNEI

4.28 Transformer Design for FR3

<table>
<tr><td>Description of project</td><td colspan="4">This project will design and build two transformers that will be filled with FR3 vegetable oil manufactured by Coopers Power system. This requires considerable design work and evaluation of the various components used in the manufacture of the transformer. Techniques to manage a clean up, should a spill of FR3 occur, will also be developed.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£4,155</td><td>£0</td><td>£0</td></tr>
<tr><td>Internal</td><td>£1,773</td><td>£0</td><td>£0</td></tr>
<tr><td>Total</td><td>£5,928</td><td>£0</td><td>£0</td></tr>
<tr><td colspan="4">The costs have been allocated to EPN as this transformer will be installed in the EPN licensed area.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£1,076,510</td></tr>
<tr><td>Internal</td><td colspan="3">£96,021</td></tr>
<tr><td>Total</td><td colspan="3">£1,172,531</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 1,200,000</td><td colspan="2">Projected 2009/10 costs for EDF Energy Networks</td><td>External £ 23,000
Internal £ 2,000
Total £ 25,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The demonstration will:
• Evaluate the possibility of the use of FR3 as the initial fluid to be used in a transformer with 132kV as the primary voltage;
• Assess the reaction of the components used in the manufacture of a transformer with the fluid; and
• In particular, assess the fluid use in the tap-changer and other components.
The transformer will be equipped with a comprehensive monitoring system to enable data to be obtained regarding the performance of the transformer and compare with another, similar transformer filled with mineral oil.</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></td><td></td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Benefits are expected to include:
• Longer life of the transformer;
• Lower disposal costs for the fluid;
• Higher rating from the same transformer; and
• The fluid is highly biodegradable.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2009</td><td colspan="2">Duration of benefit once achieved</td><td>20 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td>£ 1,500,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The monitoring system is now live and assessing the performance of the transformer.</td></tr>
</table>

Project Progress March 2009	A transformer equipped with a comprehensive monitoring system has been installed and is in service. The monitoring will continue for the next 2 years to determine whether the use of the vegetable oil should be considered for future projects.
Collaborative Partners	
R&D Provider	Areva T&D, University of Manchester, Coopers Power Systems, Monash University, Australia and Brush transformers.

4.29 ADDRESS

Active Distribution networks with full integration of Demand and distributed energy RESourceS

<table>
<tr><td>Description of project</td><td colspan="4">ADDRESS is a European Commission funded FP7 project which aims to deliver a comprehensive commercial and technical framework for the development of “Active Demand” (AD) in the smart grids of the future. ADDRESS is investigating how to effectively stimulate the participation of domestic and small commercial consumers in the power system markets and the provision of services to different power system participants.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£0</td><td>£0</td><td>£0</td></tr>
<tr><td>Internal</td><td>£525</td><td>£334</td><td>£334</td></tr>
<tr><td>Total</td><td>£525</td><td>£334</td><td>£334</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of customers connected to each licensed area.</td></tr>
<tr><td>Expenditure in previous (IFI) financial years</td><td colspan="4">This project was started in this reporting year.</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>€ 16,000,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 0
Internal £ 10,000
Total £ 10,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Develop new concepts, strategies and architectures for a full integration and a market-based exploitation of the flexibilities and services provided by Demand and Distributed Energy Resources (DG, RES and storage) on distribution grids.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11.2</td><td>-2</td><td>13.2</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">ADDRESS will develop technical solutions both at the consumers’ premises, and at a power system level to enable AD, and to allow real-time response to requests from markets and/or from other power system participants.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2010</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">This project is expected to deliver benefits in the order of millions of pounds. As part of the project the real value will be calculated.</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">This project builds on the results from a number of other European Commission funded projects e.g. FENIX and EUDeep.</td></tr>
</table>

Project Progress March 2009	ADDRESS has identified some possible barriers against AD deployment, and is proposing solutions to remove these barriers. Moreover, a scalable and open communication architecture is needed to deal in real time with large numbers of consumers (hundreds of thousands and above). ADDRESS will identify the possible benefits of AD for the different power system participants, and will develop appropriate contractual and market mechanisms for the exploitation of these benefits. In addition to the technical and economic questions, ADDRESS will deal with regulatory, societal and cultural aspects and, in particular, the project will define recommendations to lower possible regulatory barriers. It will also study accompanying measures in dealing with small consumers' socio-cultural and behavioural factors. The concepts and solutions will be validated in three different field test sites, with different demographic and electricity supply characteristics in Spain, Italy and on a French island.
Collaborative Partners	ADDRESS is an Integrated Project, supported by the European Commission under the 7th framework programme. www.addressfp7.org
R&D Providers	ENEL Distribuzione S.p.A. Electricité de France Iberdrola. Distribución S.A.U. ABB Switzerland Ltd. Corporate Research Universidad Pontificia Comillas University of Manchester VTT, Technical Research Centre of Finland VITO NV ERICSSON ESPAÑA, S.A.U. ALCATEL Italia S.p.A. KEMA Nederland B.V. VATTENFALL EDF Energy Networks Enel Produzione Landis & Gyr, Fundación Labein RLtec Electrolux Home Products Corporation N.V. Università degli studi di Cassino Universita` degli studi di Siena ZIV Pmas C S.L. Current Technologies International GmbH Dobrogea Philips Consentec

4.30 Vacuum Tap Changer

<table>
<tr><td>Description of project</td><td colspan="4">This project will develop a vacuum bolt-on type tap-changer based on the design of the ATL - AT type. A conceptual design is already in place. It will include the design, manufacture, KEMA type testing and fitting of a prototype on a new transformer for field service. The tap-changer will be based on the AT type design, a proven reliable product with many advantages over the in-tank type. In essence, the existing DNO transformer design should remain unchanged. It is also envisaged the tap-changer could be retrofitted to older transformers.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£0</td><td>£0</td><td>£0</td></tr>
<tr><td>Internal</td><td>£556</td><td>£301</td><td>£301</td></tr>
<tr><td>Total</td><td>£556</td><td>£301</td><td>£301</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of primary transformers supplying the distribution network.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£184,000</td></tr>
<tr><td>Internal</td><td colspan="3">£19,040</td></tr>
<tr><td>Total</td><td colspan="3">£203,040</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£870,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 150,000
Internal £ 15,000
Total £ 165,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Bolt-on type vacuum insulated on-load tap-changer for a power transformer.</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>17.6</td><td>2</td><td>15.6</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits include:
• Maintenance free; and
• Provides an alternative to in-tank type tap-changers.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2014</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 (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£100,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">IEC type tests are planned prior to attaching the tap changer to the transformer and carrying out in service tests.</td></tr>
<tr><td>Project Progress March 2009</td><td colspan="4">Software models of the new mechanism have been carried out.
Prototype parts have been built.
The vacuum bottles for the tap changer have been selected.
A prototype build has started.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4"></td></tr>
<tr><td>R&D Provider</td><td colspan="4">Brush Transformers</td></tr>
</table>

4.31 Supergen V - AMPerES

Asset Management and Performance of Energy Systems

<table>
<tr><td>Description of project</td><td colspan="4">This is a 4 year major multi-party collaborative project. The research programme is split into 6 work packages & 25 activities. Most of the research is carried out by the universities. An EDF Energy Networks' representative has been identified for each work package so that research can be steered towards delivering benefits to the DNO's.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£0</td><td>£0</td><td>£0</td></tr>
<tr><td>Internal</td><td>£183</td><td>£116</td><td>£116</td></tr>
<tr><td>Total</td><td>£183</td><td>£116</td><td>£116</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of connected customers.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£ 50,000</td></tr>
<tr><td>Internal</td><td colspan="3">£ 4,172</td></tr>
<tr><td>Total</td><td colspan="3">£ 54,172</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 2,800,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 25,000
Internal £ 5,000
Total £ 30,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The research programme is split into 6 work packages namely:
WP 1: Programme delivery, outreach and implementation;
WP 2: Enhanced network performance and planning;
WP 3: New protection and control techniques that adapt to changing networks;
WP 4: Infrastructure for reducing environmental impact;
WP 5: Ageing mechanisms; and
WP 6: Condition monitoring techniques.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td></td><td></td><td></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; and
• To develop models and recommendations for network operation and management.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2013</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£150,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Asset management is core to the business. The appropriate use of the emerging opportunities for condition monitoring is key to optimising</td></tr>
</table>

	performance, both financially and in terms of quality of supply. A number of technologies are being developed as part of this programme; however, it also gives a broader window to the global research community. Through demonstration, the true value of condition monitoring can be identified, enabling appropriate business decisions on adoption of technologies.
Project Progress March 2009	The project has been running for over three years and will end on schedule, in January 2010. Overall progress has been very good. • 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 was held in November 2008, which allowed access to 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. Reports include: • 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; and • 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 employed a real-time phasor measurement system. • Optimized design of existing overhead lines is being demonstrated by Manchester through analysis of a SP Energy Networks' 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 Energy Networks and one for National Grid by Liverpool University. • Strathclyde and Liverpool have been applying knowledge-based partial discharge analysis and chromatic analysis to data from EDF Energy Networks' cable monitoring systems. These will be used to prove data acquisition technology and develop interpretation tools.
Collaborative Partners	National Grid, SP Energy Networks, Scottish and Southern Electric, Electricity North West, Western Power Distribution, Central Networks, CE Electric UK, NIE, Advantica & EDF Energy Networks.
R&D Provider	Universities of Edinburgh, Liverpool, Manchester, Queens (Belfast), Southampton and Strathclyde.

4.32 Vegetation Management

<table>
<tr><td>Description of project</td><td colspan="4">This project proposes to:
Monitor vegetation growth at 1650 sites across the UK network; and
Develop a software model which will take into account factors such as tree species, bioclimatic area, and the effect of climate change, in order to estimate the speed of vegetation growth at different sites.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£0</td><td>£0</td><td>£0</td></tr>
<tr><td>Internal</td><td>£311</td><td>£0</td><td>£93</td></tr>
<tr><td>Total</td><td>£311</td><td>£0</td><td>£93</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the length of 11kV overhead line.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£172,000</td></tr>
<tr><td>Internal</td><td colspan="3">£18,555</td></tr>
<tr><td>Total</td><td colspan="3">£190,555</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 1,740,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 0
Internal £ 3,000
Total £ 3,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Rate of vegetation growth</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>9.8</td><td>-3</td><td>12.8</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The expected benefits include a software tool, that will enable EDF Energy Networks and other DNOs to predict whether areas are high or low growth, and hence allow two-fold savings:
In high growth areas, proactive cutting can be carried out, thus reducing the number of outages (by cutting before the vegetation enters the live zone) and cost to DNOs; and
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>Year 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 (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£400k</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 benefits.</td></tr>
</table>

Project Progress 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	Electricity North West, EDF Energy Networks, SP Energy Networks, Central Networks and National Grid.
R&D Provider	ADAS

4.33 Strategic Technology Programme Overhead Network Module

<table>
<tr><td>Description of project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£33,118</td><td>£0</td><td>£9,892</td></tr>
<tr><td>Internal</td><td>£6,016</td><td>£0</td><td>£1,797</td></tr>
<tr><td>Total</td><td>£39,134</td><td>£0</td><td>£11,689</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the length of installed overhead line.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£141,451</td></tr>
<tr><td>Internal</td><td colspan="3">£15,719</td></tr>
<tr><td>Total</td><td colspan="3">£157,170</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 360,200 annually</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 45,600
Internal £ 4,500
Total £ 50,100</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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 requiring technical investigation and development.

Completed Projects (March 09):
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; and
S2159_1 LV shrouding - review of current practices and standards.</td></tr>
</table>

<table>
<tr>
<td></td>
<td colspan="4">Projects Still In Progress (March 09):-

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 Aluminium OHL conductors - Stage 3 Instrument Development;
S2147_2 Increasing vibration limit of CCs to 20%UTS using multiple std or single Hi-mass SVDs;
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; and
S2157_1 Novel conductors for 132kV wood pole lines;

Updated information can be found at https://www.stp.uk.net</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>10.2</td>
<td>-6</td>
<td>16.2</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 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 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; and
Give a better understanding of novel conductors for new build or re-conductoring 132kV wood pole lines that gives lower capital cost, minimum visual impact, greater environmental acceptance than other methods of improving power transfer.
</td>
</tr>
</table>

Expected Timescale to adoption	Range 2-5 years - dependent on project	Duration of benefit once achieved	Range 2-10 years - dependent on project
Probability of Success	Range 10-50% - dependent on project	Project NPV (Present Benefits – Present Costs) x Probability of Success	£ 64,600
Potential for achieving expected benefits	A number of STP Projects are at an early stage and the project costs may not always reflect the likely full costs of implementation. These will be identified providing the outcome of the early stage is positive.		
Project Progress March 2009	Most projects or project stages started in the module during 08/09 have been completed, but some projects span for more than one year.		
Collaborative Partners	CE Electric UK, Scottish & Southern Energy, Central Networks, SP Energy Networks, EDF Energy Networks, Electricity North West, Northern Ireland Electricity and Western Power Distribution.		
R&D Provider	EA Technology Limited		

4.34 Strategic Technology Programme Cable Networks Module

<table>
<tr><td>Description of project</td><td colspan="4">The STP cable networks 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.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£23,620</td><td>£14,494</td><td>£15,567</td></tr>
<tr><td>Internal</td><td>£3,437</td><td>£2,109</td><td>£2,266</td></tr>
<tr><td>Total</td><td>£27,057</td><td>£16,603</td><td>£17,833</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the length of installed underground cable.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£152,351</td></tr>
<tr><td>Internal</td><td colspan="3">£15,355</td></tr>
<tr><td>Total</td><td colspan="3">£167,706</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 436,000 annually</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 55,300
Internal £ 5,500
Total £ 60,800</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Completed Projects:

• 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 cable systems: Study to assess work carried out on thermo-mechanical forces in cable systems;
• S3152_1 Separable connectors and cable compartments in 11kV switchgear;
• S3153_1 & 2: Economics and environmental impacts of distribution cable losses: Model development including CO2 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; and
• S3171_1: Jointing onto wet cables.

Projects Still In Progress:
• 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</td></tr>
</table>

<table>
<tr><td></td><td colspan="4">forces in cable systems;
S3155_1 Trial testing of triplexed cable in plastic ducts;
S3157_1 Partial discharge testing of MV cable systems to provide asset risk management data;
S3164_1: Develop fluid filled cable design tool;
S3165_1: Performance ageing tests on polymeric terminations; and
S3166_1 & 2: Performance of cold and heat-applied accessories under resin: Assessing interaction between resin and semi-conducting layer.
Updated information can be found at: https://www.stp.uk.net</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>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 are implemented, the projects will potentially deliver the following benefits:
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 reduce outage times;
Reduce cable purchase costs;
Reduce design costs; and
Increase safety of staff and public by reducing the number of accidents / incidents.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-3 years - 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 (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£ 87,318</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Some projects within the programme are at an early stage, whilst others are complete. Issues have been identified relating to both operational and capital expenditure which, if successfully addressed, would enable the expected benefits to be achieved.</td></tr>
<tr><td>Project Progress 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 for more than one year.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">CE Electric UK, Scottish & Southern Energy, Central Networks, SP Energy Networks, EDF Energy Networks, Electricity North West and Western Power Distribution.</td></tr>
<tr><td>R&D Provider</td><td colspan="4">EA Technology Limited</td></tr>
</table>

4.35 Strategic Technology Programme Substations Module

<table>
<tr><td>Description of project</td><td colspan="4">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.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£21,494</td><td>£6,580</td><td>£15,792</td></tr>
<tr><td>Internal</td><td>£3,828</td><td>£1,172</td><td>£2,812</td></tr>
<tr><td>Total</td><td>£25,322</td><td>£7,752</td><td>£18,604</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the number of primary substations.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£141,451</td></tr>
<tr><td>Internal</td><td colspan="3">£13,488</td></tr>
<tr><td>Total</td><td colspan="3">£154,939</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 313,784 (2008/9)</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 40,400
Internal £ 4,000
Total £ 44,400</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The majority of projects have not only resulted in essential knowledge transfer, but have also 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.

Completed Projects (March 09):
• 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 and Methods; and
• S4244_1: Review of methods to dissipate pressure in Substations during equipment failure.

Projects Still In Progress (March 09):
• S4164_5: Tap changer monitor stage 5;
• S4178_2: Impedance Testing of Substation Batteries;
• S4185_4: European AM Forum Membership 08/09;</td></tr>
</table>

<table>
<tr><td></td><td colspan="4">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; and
S4245_1: Switchgear – Effect of Low Power Factor Switching (Joint Investigation with STP5: S5181_1).
Updated information can be found at: https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Significant, 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>-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, 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, tap-changers, earth switches increasing safety and avoiding unnecessary scrapping of serviceable components will alleviate environmental impact.
Liaison with European Utilities to share new technology and failure modes; and
Increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-5 years - dependent on project</td><td>Duration of benefit once achieved</td><td colspan="2">Range 2-8 years - dependent on project</td></tr>
<tr><td>Probability of Success</td><td>Range 10-100% - dependent on project</td><td>Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£ 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.</td></tr>
<tr><td>Project Progress 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.</td></tr>
</table>

Collaborative Partners	CE Electric UK, Scottish & Southern Energy, Central Networks, SP Energy Networks, EDF Energy Networks, Electricity North West, ESB Networks and Western Power Distribution.
R&D Provider	EA Technology Limited

4.36 Strategic Technology Programme Networks for Distributed Energy Resources Module

<table>
<tr><td>Description of project</td><td colspan="4">The projects, undertaken through budget year 08/09 were aimed at enabling cost effective connections and ensuring techniques are in place to plan, operate and manage networks with significant amounts of generation. Most projects also had positive impacts on safety and environmental performance. The projects all addressed real problems that had been identified by the module steering group members as significant and which required technical investigation and development.</td></tr>
<tr><td rowspan="5">Expenditure for financial year</td><td></td><td>EPN</td><td>LPN</td><td>SPN</td></tr>
<tr><td>External</td><td>£25,091</td><td>£9,932</td><td>£17,250</td></tr>
<tr><td>Internal</td><td>£3,750</td><td>£1,484</td><td>£2,578</td></tr>
<tr><td>Total</td><td>£28,841</td><td>£11,416</td><td>£19,828</td></tr>
<tr><td colspan="4">The costs have been allocated in proportion to the length of installed distributed generation.</td></tr>
<tr><td rowspan="3">Expenditure in previous (IFI) financial years</td><td>External</td><td colspan="3">£141,451</td></tr>
<tr><td>Internal</td><td colspan="3">£13,372</td></tr>
<tr><td>Total</td><td colspan="3">£154,823</td></tr>
<tr><td>Total Project Costs (Collaborative + external + EDF Energy Networks)</td><td>£ 480,000</td><td>Projected 2009/10 costs for EDF Energy Networks</td><td colspan="2">External £ 54,400
Internal £ 5,400
Total £ 59,800</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">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 microgrids. Most of the projects aim to increase network performance and reduce risk whilst having a positive impact on DNOs' environmental performance.

Completed Projects:
• 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 Microgrids - Feasibility study;
• S5200_1 LV Fuse Reach; and
• S5201_1 Distribution Network Losses – Loss Reduction</td></tr>
</table>

<table>
<tr><td></td><td colspan="4">Initiatives.

Projects Still In Progress:
S5147_8 Microgenerator 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; and
S5205_1 Fault level management - Feasibility Study.
Updated information can be found at: https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Significant, Technological substitution</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="4">Projects within this module have been cost effective and have led to improved 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 deliver 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 greenhouse gases emissions; and
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 1-7 years - dependent on project</td><td>Duration of benefit once achieved</td><td colspan="2">Range 1-15 years - dependent on project</td></tr>
</table>

Probability of Success	Range 5-60% - dependent on project	Project NPV (Present Benefits – Present Costs) x Probability of Success	£ 89,367
Potential for achieving expected benefits	A number of STP Projects are at an early stage and the project cost may not always reflect the likely full costs of implementation.		
Project Progress 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.		
Collaborative Partners	CE Electric UK, Scottish & Southern Energy, Central Networks, SP Energy Networks, EDF Energy Networks, Electricity North West, ESB Networks and Manx Electricity Authority.		
R&D Provider	EA Technology Limited		

5. Steyning Primary RPZ

Description of project and technical details	The DG operator at Horton Quarry (a landfill gas generator) wished to increase its generation output to make use of an excess of landfill gas which could not be stored. However, during times of low demand, the operator already experienced nuisance trips due to voltage rise. GenAVC has been developed by Econnect Ventures Ltd to manage voltage rise issues associated with the connection of distributed generation (DG) into 11kV networks. Following a positive outcome from studies carried out using the GenAVC assessment tool (see 07/08 activity report), EDF Energy Networks installed GenAVC at Steyning Primary to demonstrate that GenAVC is an appropriate solution to: • Manage voltage rise issues; • Avoid the occasional disconnections of the generator; and • Provides the least-cost connection for DG when additional generation capacity is sought.
Expenditure for financial year	£4,251 has been spent this year in maintaining the control system. When communications have been operational, the system has allowed the generator to increase its output.
Type(s) of innovation involved	The assessment tool did show that GenAVC is an appropriate solution to a voltage rise problem. GenAVC takes into account the voltage contribution from DG connected to the network, and biases the target voltage of the primary substation tap changers to allow additional generation to be connected and the output of the generators to be maximised.
Status (planned, under construction, operational) and operational starting year	Operational
Connection cost	Connection costs using GenAVC were reduced when compared to the traditional network reinforcement methods which would have involved the installation of 4.5km of underground cable.

Benefit to customers compared to those envisage when project was registered	This RPZ was registered to allow the generator operator to utilise its additional gas supply to generate energy, as opposed to flaring the excess gas into the environment. It already operates two 1MW of landfill gas generators connected to distribution network supplied from Steyning Primary substation. The assessment tool estimated that approximately 1.5MW of additional generation could be connected without infringing statutory voltage or power flow limits. All connected customers benefit from improved voltage control, especially during periods of light load when higher volts were experienced.