CE Electric UK

2007/08 IFI Annual Report

July 2008

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Executive summary

1. This report has been prepared by CE Electric UK Funding Company Ltd (CE) to inform interested parties of the activities of its licensees, Yorkshire Electricity Distribution plc (YEDL) and Northern Electric Distribution Ltd (NEDL), on innovation. It has been prepared in accordance with standard condition 51 of the electricity distribution licence, the associated regulatory instructions and guidance (published by Ofgem) and the Energy Networks Association (ENA) Engineering Recommendation (ER) G85, issue 2, 2007 (the Good Practice Guide). It also informs our returns under standard condition 50.

2. The key projects in CE Electric during the reporting period are:
   - projects dedicated to local CE needs:
     - Loss of mains protection (ROCOF), phase 2;
     - an innovative fault passage indicator for cable systems;
     - network risk
     - GM Fault passage indicator
     - LV AVC feasibility study
     - a remote indicating fault flow indicator; and
     - technology road-mapping.
   - collaborative projects, including:
     - ASL superconducting fault limiter;
     - Supergen V; and
     - ACTIV project;
     - EA Technology STP.

3. In terms of commitment to the development of innovation, it is also worth noting that we have committed some **£**7375 of engineering resource to support the activities of the Electricity Networks Steering Group (ENSG). We hold this work to be of national importance and as such have committed resource to the work on an equal basis to our own R&D contracts, inevitably displacing some in-house activity.

4. Qualifying spend for the period has been £362930 and £504869 for NEDL and YEDL respectively, of which £48220 and £67078 respectively relates to internal costs. This total eligible spend of £867799**Error! Reference source not found.** compares to £669028 for the twelve months to 31 March 2007, an increase of over 29%.

5. There remains a delicate balance in taking work forward, between either:
   - exploiting the existing ENA and EATL STP frameworks or alternative collaborative forums, where the need for consensus extends the process but collaborative specification and support will improve the finished product; and
   - proceeding on our own, where we can commission more quickly but would lose some of the up-front benefits of collaboration.

Revision Record

Version	Date	Revision Details	Author
0.1	25 July 2008	First Draft	
1.0	29 July 2008	Final Version	D.Miller C.Goodhand

Introduction

6. This report has been prepared by CE Electric UK Funding Company Ltd (CE) to inform interested parties of the activities of its licensees, Yorkshire Electricity Distribution plc (YEDL) and Northern Electric Distribution Ltd (NEDL), on innovation. It covers the period from 1 April 2007 to 31 March 2008.

7. A single report has been prepared because both licensees are operated under common management, sharing best practice across the whole. Research and development is no exception, and we draw no arbitrary distinction between innovation carried out for the two licensees. Projects and programmes are therefore discussed only once. Finally, the report breaks out the relevant expenditure by licensee to support regulatory reporting requirements.

8. The report focuses upon research and development work eligible for Ofgem's innovation funding incentive (IFI). The IFI is intended to provide funding for projects focused on the technical development of distribution networks, up to and including 132 kV, to deliver value (i.e. financial, supply quality, environmental, safety) to end consumers. IFI projects can embrace any aspect of distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning.

9. In this context, 'technical' requires both that there is a significant engineering intellectual content and that projects involve load-carrying assets or their control and electrical protection.

10. The report has been prepared in accordance with standard condition 51 of the electricity distribution licence, the associated regulatory instructions and guidance (RIGs) and the Energy Networks Association (ENA) Engineering Recommendation (ER) G85 (the Good Practice Guide (GPG)), which states:

    3.4 Annual Regulatory Reporting Requirements for IFI Projects

    Ofgem requires a report to be published annually (i.e. by no later than the 31 July immediately following the end of the reporting year as required by the RIGs) by each distributor on its IFI [Innovation Funding Incentive] project activity…distributors will normally be required to provide the following information at the end of the reporting year and by no later than the immediately following 30 June [sic]:

    • IFI budget carry-forward

    • eligible IFI expenditure

    • eligible IFI internal expenditure

    • combined distribution network revenue

    • the IFI annual report.

    The minimum level of accuracy required when reporting to Ofgem is as follows:

    • IFI carry- forward nearest £1k

    • eligible IFI expenditure nearest £1k

• eligible IFI internal expenditure nearest £1k

• combined distribution network revenue nearest £0.1m

The IFI annual report will describe the IFI projects for which the distributor has incurred expenditure. The report should provide a summary of IFI project activities and details of costs and anticipated benefits of individual projects. A distributor may undertake one or more discrete programmes of IFI projects that are best grouped together to ease administration and reduce overheads. For each such programme a de minimis level of expenditure by an individual distributor of £40k per programme will apply. Individual projects with an annual expenditure below this level may be aggregated and reported as a programme…

11. The programmes and major projects that will be discussed in this report are:

- CE's internal innovation programme;
- externally-driven activities, including the BERR/Ofgem Energy Networks Strategy Group (ENSG) and subsidiary workstreams;
- collaborative projects, including:
  - ASL superconducting fault limiter;
  - Supergen V; and
  - ACTIV project;
- projects led by the Energy Networks Association (ENA) R&D working group, including:
  - ENA P2: fault level monitor;
  - ENA P9: earthing (grids & transfer potentials);
- the EA Technology Limited (EATL) Strategic Technology Programme (STP), including
  - module 2 (overhead networks);
  - module 3 (cables);
  - module 4 (substations);
  - module 5 (distributed energy);
  - protective coatings forum; and
  - partial discharge user group;
- projects dedicated to local CE needs:
  - Loss of mains protection (ROCOF), phase 2;
  - an innovative fault passage indicator for cable systems;
  - network risk
  - GM Fault passage indicator
  - LV AVC feasibility study
  - a remote indicating fault flow indicator; and
  - technology road-mapping.

12. As permitted by the GPG, this report aggregates portfolios of projects under ENA, STP, work for BERR, and internal costs in developing and managing projects.

13. In preparing this year's report, the opportunity has been taken to review the projected benefits of ongoing projects. This has led to some revisions, none of which damage the business case for each project.

Registered Power Zones

14. Registered Power Zones (RPZs) are intended to encourage distributors to develop and demonstrate new, more cost-effective ways of connecting and operating generation that will deliver specific benefits to new distributed generators and broader benefits to consumers generally. The RPZ mechanism provides for an enhanced rate of return for distributors, by extending the general generation funding mechanism introduced by Ofgem at the last periodic review.

15. We remain committed to developing an RPZ in the YEDL or NEDL networks, subject to delivering tangible benefits to customers and shareholders. We have again reviewed a number of opportunities during the year, in the areas of:

    - the potential for active management of constraints on the existing system to facilitate more efficient generator connections by avoiding reinforcement; and
    - the potential for active management of constraints on system extensions to facilitate more efficient generator connections by reducing the amount of new infrastructure required.

16. Each of these opportunities (and we have had several in each basket) has arisen from genuine customer enquiries. None has been developed speculatively, on the basis that an opportunity might arise on the network. However, each has failed, generally due to a combination of lack of customer commitment and unfavourable economics. One application that we pursued with some vigour looks likely to be implemented, but a 'conventional' solution will be more economic than artificially pursuing something sufficiently innovative to clear the RPZ threshold.

Externally-driven activities

17. This section considers those projects driven by bodies outside the distribution sector where, although we have the choice as to whether or not we become involved, they fall outside our direct governance. We are, therefore, effectively unpaid sub-contractors.

18. We have committed significant resource to support projects under the BERR technology programme in previous years, but there has been no material contribution in this reporting year. Therefore, the only area covered in this report is the BERR-Ofgem Electricity Networks Strategy Group (ENSG).

Project Title	**ENSG – DWG**		
Description of project	This is the first expert group to have a remit to look at issues of generation, transmission and distribution in the context of the Government's energy policy.		
Expenditure for financial year	Internal £7375 External £0 Total **£7375**	Expenditure in previous (IFI) financial years	Internal £29,875 External £0 Total **£29,875**
Project Value	Rolling programme	Projected 07/08 costs	Internal £12,000 External £0 Total **£12,000**

<table>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The Electricity Networks Strategy Group (ENSG) provides advice to BERR, Ofgem, Defra, the Scottish Executive and the Welsh Assembly on issues associated with the development of the electricity distribution and transmission networks. The ENSG has a number of sub-groups, specially the Distribution Working Group (DWG), chaired until recently by our President and Chief Operating Officer, and the Transmission Working Group (TWG).
The Distribution Working Group (DWG) continues the work of the earlier Distributed Generation Coordinating Group's (DGCG) Technical Steering Group (TSG), examining the issues to enable the integration of generation onto the distribution network. The DWG manages four work programme areas and CE Electric have been actively involved in three out of four of the current modules, as follows:
Work Programme 01: Horizon Scanning
To assess the current state of technology, likely developments, R&D progress, actual and forecast trends in penetration levels and future scenarios, regulatory and political policy to guide and formulate the programmes of work that would commence in approximately 18-24 months' time, on a rolling basis.
Work Programme 02: Network Design for a Low-Carbon Economy
To evaluate the technology, tools, techniques, processes and standards that would be required to construct power systems compatible with the developing trends in low-carbon energy technology.
Work Programme 03: Enabling Active Network Management
Developing the technologies, protocols, tools, processes, techniques and standards that would be needed to ensure that low-carbon compliant power systems could be operated on an active basis to ensure efficient use of investment and an effective contribution from potential market participants.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="3">Significant though Radical</td></tr>
<tr><td>Expected benefits of project</td><td colspan="3">BERR/Ofgem have not published a PV benefit for the DWG/TSG projects. We have modelled a cost/benefit ratio for the BERR Technology Programme, then assumed that this should also apply to CE Electric investment.</td></tr>
<tr><td>Expected timescale to adoption</td><td>2-10 years, dependent on projects.</td><td>Duration of benefit once achieved</td><td>ongoing</td></tr>
<tr><td>probability of success</td><td colspan="3">Estimated 25%</td></tr>
<tr><td>PV of project costs to date</td><td>£33,320</td><td>PV of anticipated project benefits from work to date</td><td>£62,738</td></tr>
<tr><td>Commentary on project progress and potential for achieving expected benefits</td><td colspan="3">Debates over funding have delayed meaningful work on many projects, although some work has been progressed
The DWG now has 22 substantive projects, representing a total direct cost of approximately £700,000</td></tr>
<tr><td>Collaborative Partners</td><td colspan="3">BERR, Ofgem, TSO, DNOs, generators, energy suppliers, equipment manufacturers and independent consultants</td></tr>
</table>

ENA

19. The tangible outputs of the ENA R&D working group are the major projects described in detail in the following tables. Significant effort was committed to updating ER G85, the IFI GPG, during 2007/08 and this was published in December 2007.

20. In addition to the major projects we also incurred internal costs of £4.625. This was made up from £3,000 incurred attending the ENA R&D steering group and £1,625 on the vacuum bottle end of life project. These costs have been aggregated with our internal R&D working group for reporting purposes.

21. The remaining active projects are, like STP, reported together:

Project Title	**ENA collaborative R&D projects**		
Description of project	Two projects initiated by the Energy Networks Association (ENA) R&D Working Group. The ENA represents all UK DNOs.		
Expenditure for financial year	Internal £1500 External £5191 Total **£13019**	Expenditure in previous (IFI) financial years	Internal £13519 External £9085 Total **£22604**
Project Value	Rolling programme	Projected 08/09 costs	Internal £3,500 External £10,000 Total **£13500**
Technological area and / or issue addressed by project	The projects undertaken through budget year 2006/7 addressed real problems that had been identified by the ENA Working Groups as significant and which required technical investigation and development. • **SG12 Fault Level Monitor** – Develop a Fault Level Monitor (FLM) that can successfully measure fault level on a distribution network with repeatability and reliability. The FLM instrument shall use the underlying methodology proven with EA Technology's existing Extended Supply Monitor and shall measure normally occurring events (e.g. small scale disturbances resulting from tap changer operation), so no customer supply interruption will be required. • **SG14 Earthing Project** – Develop new techniques to assess the impact of lower voltage earth electrodes on higher voltage 'hot zones' and to measure the resistance of distribution substation earth systems.		
Type(s) of innovation involved	Incremental and Significant innovation types are involved.		
Expected Benefits of Project	• **SG12 Fault Level Instrument** • The FLM instrument will allow fault infeed levels to be accurately assessed. This will provide an objective measurement tool that can be used to facilitate both the initial connection of distributed generation and ongoing assessment of its effects. • **SG14** – This project will investigate the effects of LV earth systems on HV systems. The results of this should determine the means to provide cost effective, safe earthing system without the need for expensive separations between HV and LV electrodes which in a PME system may be impractical and costly to achieve and maintain.		

Expected Timescale to adoption	3 years / 2 years	Duration of benefit once achieved	10+ years
probability of success	25% / 75%	Project NPV	£280709
potential for achieving expected benefits	To progress to stage 2 of the project as originally defined the results obtained from stage 1 had to support a statement that it was technically feasible to develop a Fault Level Measuring Instrument capable of deriving answers within ±5% of the actual Source and Motor Infeed values. The Algorithm Validation work has cast some doubt over the achievability of that goal. The good agreement of the existing Fault Level Monitor with expected values does however offer some signs that the results obtained in the algorithm validation phase are not unequivocal. The proposed testing of the existing Fault Level Monitor within a defined third party test network has not been pursued at this time since although this might provide further data supporting the instrument's capabilities it would not answer the question as to why the differences exist between the apparent capability of the existing instrument and the performance of the algorithms implemented in Matlab. As the results of Stage 1 do not support an unequivocal statement that it is technically feasible to develop a Fault Level monitor with the required degree of accuracy this project will conclude at Stage 1. Proposals are being prepared for consideration to carry out further work to resolve questions about the apparent differences in performance of the existing Fault Level Monitor and the Fault Level Monitor Algorithms implemented in Matlab. **SG14 Earthing Techniques** – EA Technology High. The results from tests and simulations can be used to propose a recommended procedure for measuring transfer potential between HV and LV systems, suitable for inclusion in a DNO policy document.		
Commentary on project progress as at 31 March 2008	• **SG12 Fault Level Instrument** – EA Technology and the University of Strathclyde have pursued the following activities 1. **Experiment & Laboratory Investigation** – The performance of the previous Fault Level Monitor was tested against the known parameters of the University of Strathclyde's microgrid. In general a reasonable level of agreement was achieved. 2. **Algorithm Validation** – The algorithms from the Fault Level Montor coded within Matlab were tested using a network model in Matlab/Simulink to provide the sampled data to the algorithm. The results were compared to values of source infeed and motor infeed calculated directly from the parameters of the disturbances used. This resulted in an assessment of the potential accuracy of the instrument under a variety of load and disturbance conditions. At the power factor and load disturbance conditions which were most likely to be experienced in a real power system the results were not within the required accuracy band. 3. **Comparison of Real Site** – In contrast to the results obtained		

	under the algorithm validation section, comparison of measurements made on a real network with the Fault Level Monitor exhibited a much closer agreement with the results expected • **SG14 Earthing Techniques** 1. Project Completed during 2007-2008 2. Part 1 (Investigation at Test Facility) report delivered in 2007. The first stage of the project involved measurements and calculations on a test electrode system and it was found that the transfer potential to a distributed LV electrode is much lower than previously thought. Rather than being the potential picked up from the soil at the closest electrode portion (i.e. as based on the present method of calculation), it is in fact an average of the soil potential picked up by each connected electrode, but accounting also for their relative size and location in relation to the HV electrode source. 3. Part 2 `Investigation at two live substations' completed during 2007/08. Measurements conducted at two substations in WPD area. Complete post-installation analysis including interpretation of results and recommendations for use in DNOs policy documents presented. The substations selected for the study each have an isolated (self-contained) low voltage distribution cable network and are supplied at 11kV via unearthed overhead lines. The low voltage networks use Protective Multiple Earthing and CNE type cables. The computer model was developed so as to represent the actual sites' main electrical characteristics to a reasonable degree of accuracy. The computer model also contains the soil structure, but at this stage, it is used only to enable a comparison with the measured values and cannot be used with the traditional formulae because these are based upon a uniform soil. Both stages of the project have revealed the previously unknown effect that the LV electrode system can have on the shape of the HV voltage contours in the soil, that results in a lower than predicted average transfer potential on the LV neutral/earth. This has important consequences for distribution system design and could result in a reduction in the required HV: LV separation distances. For example, it means that new installations could be situated closer to a HV site than previously thought. It also goes some way towards explaining why there are far fewer reports of damage on LV networks co-incident with an HV fault, when their earthing systems are separate, but not by the 3m to 9m distance required in DNO policies.
Collaborative Partners	ENA member companies
R&D provider	University Of Strathclyde, EA Technology, Strategy & Solutions Ltd

EA Technology Strategic Technology Programme etc.

Project Title	**Strategic Technology Programme Overhead Network Module**		
Description of project	Applied R&D into reducing the costs and risks associated with overhead lines		
Expenditure for financial year	Internal £1875 External £44963 Total **£46838**	Expenditure in previous (IFI) financial years	Internal £4438 External £74091 Total **£78529**
Project Value	rolling programme over seven distributors	Projected 08/09 costs	Internal £5,000 External £45,000 Total **£50,000**
Technological area and / or issue addressed by project	The STP overhead network programme for budget year 2007/8 aimed to reduce costs and improve performance of overhead networks by increasing understanding of issues that have a negative impact on costs and performance. The programme is expected to also have a positive impact on safety and environmental performance. The projects all address real problems that have been identified by the module steering group members as significant and which require technical investigation and development. The projects within the programme aimed to: • S2126_3 – Completion of long-term monitoring of conductor temperature by obtaining and analysing 12 months trial data. • S2126_4 – Monitoring overhead line conductor temperature at two trial sites at constant current. • S2136_3 - Continued participation in European Project COST 727: Measuring and forecasting atmospheric icing on structures. • S2140_2 – Field trials of techniques for checking the foundations of newly installed poles. • S2143_2 – Feasibility study to detect in-situ degradation of aluminium overhead line conductors. • S2146_2 Undertake torsion testing to evaluate possible limits for composite tension insulators. • S2148_1 – Re-appraisal of ACE104, overhead line ratings, methodology. • S2150_1 Evaluation of TDR, time domain reflectometry, for assessment of tower foundations using actual field data. • S2151_1 – Investigate alternatives to wood poles. • S2152_1 – Evaluate performance of ice recording solution at severe weather test site. • S2154_1 – Experimental investigation of ice loading of novel conductors. • S2155_1 – Comparative performance of available pole-top shrouds		
Type(s) of innovation involved	Technical Substitution / Radical		
Expected Benefits	Due to the age profile of system equipment it is inevitable that, unless		

<table>
<tr><td>of Project</td><td colspan="3">significant new technology is used to extend asset life, CAPEX and possibly OPEX will need to increase significantly to maintain the present level of network reliability and safety.
If these projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain benefits including:
- avoid redesign, reconstruction or refurbishment of overhead lines where this is driven by a perceived need to increase ratings or strengthen lines, and is required to conform with existing standards but which may be unnecessary;
- reduce levels of premature failure of assets;
- provide more cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults;
- confidently extend the service life of towers and reduce potential levels of tower failures; and
- reduce lifetime costs by the appropriate use of alternative materials.</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>Range 3-10 years - dependent on project</td></tr>
<tr><td>Probability of success</td><td>Range 2-50% dependent on project</td><td>Project NPV</td><td>£39079</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">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>Commentary on progress as at 31 March 2008</td><td colspan="3">The second phase of monitoring overhead conductor temperatures at steady rated current was carried out during the year. The data have yet to be analysed. In contrast to the first phase, when four different types of conductor, all with similar ratings, were monitored at a single location, phase two monitored two different-sized conductors of the same type (so different design temperatures for the same current) simultaneously at two very different locations, one near sea level and one high up in the Scottish Highlands. Phase 1 found that day time ratings could probably be increased; hopefully analysis of the Phase 2 data will provide confirmation of this and possibly find other location-dependent benefits.

An experimental investigation of live-line jumper cutting was carried out to determine whether or not it was acceptable to cut 11kV jumpers carrying load. Members found the results useful and the work is likely to lead to changes in working practices resulting in time and cost savings for DNOs.

Three projects were carried out at our severe weather site on Deadwater Fell, all concerned with icing of conductors. Two “novel” conductors with higher ratings than conventional conductors (one with a gap between core and conducting strands, the other with a carbon-fibre based composite core) have been monitored for ice loading alongside a conventional aluminium alloy conductor. Preliminary analysis indicates little difference in ice loads but big differences in creep between the three conductors. At the same time, two ice meters have been tested, one as a stand-alone STP2 project and the other as part of a European</td></tr>
</table>

	project on conductor icing. The former performed very well and could provide DNOs with real-time information on ice build-up on exposed conductors. A non-destructive device for detecting defects in concrete has been assessed for its applicability to HV tower foundations. Subsequent excavations of the tested foundations indicated that the device is a useful and sufficiently accurate tool for assessing foundation integrity. Its use could result in time and cost savings for DNOs. A study of alternatives to wood poles for HV OH lines, looking at the advantages and disadvantages, and the practical applicability within UK DNOs, indicated that there were benefits to be gained from using concrete poles in certain situations. A test rig has been designed to investigate the practical problems of erecting and working on lines mounted on concrete poles.
Collaborative Partners	All GB DNOs
R&D Provider	EA Technology

Project Title	**Strategic Technology Programme Cable Networks Module**		
Description of project	Applied R&D into reducing the costs and risks associated with underground cables		
Expenditure for financial year	Internal £1875 External £53637 Total **£55512**	Expenditure in previous (IFI) financial years	Internal £3838 External £74091 Total **£77929**
Project Value	Rolling programme over seven distributors	Projected 2008/09 costs	Internal £5000 External £55000 Total **£60000**
Technological area and / or issue addressed by project	The STP cable network programme for budget year 2007/8 aimed at identifying and developing opportunities to reduce the costs of owning cable networks. The reduction of whole life cost through greater reliability and improved performance of cables and associated accessories comes under the remit of Module 3. Where appropriate, Module 3 worked with other Modules to achieve common goals. The projects undertaken within the programme during 2006-07 aimed to: • S3132_10 – Further development in cable ratings to address gas compression cables. • S3132_12 - Further development in cable ratings • S3140_3 – Develop best practice for the installation of Ducted Cable systems. • S3144_2 & 3 – Comparison of processes for the treatment of redundant fluid filled cables. • S3151_1, 2 & 3 – Understanding and controlling thermo-mechanical forces in cable systems. • S4152 – Separable connectors and cable compartments in 11kV switchgear. • S3159_1 - Investigation of current ratings of triplexed cable in plastic ducts. • S3157_1 – PD testing of MV cable systems to provide asset risk management data. • S3163_1 – On-going testing of sensors for cable fluids		
Type(s) of innovation involved	Incremental		
Expected benefits of project	If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain the following benefits, including: • offset future increases in CAPEX and OPEX; • CI/CML savings per connected customer; increased safety of staff and public by reducing the number of accidents / incidents.		
Expected timescale to adoption	Range 1-3 years - dependent on project	Duration of benefit once achieved	Range 3-5 years - dependent on project
Probability of success	Range 2-50%	Project NPV	£26566

Potential for achieving expected benefits	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.
Commentary on project progress as at 31 March 2008	In 2007/08 projects were completed to allow the calculation of current ratings of crossing cables (S3132_7), gas compression cables (S3132_10) and dynamic ratings (S3132_12). This almost finishes the creation of a comprehensive suite of cable rating tools for network designers and cable engineers. The outputs are of particular benefit in solving difficult multi-circuit problems. Without them there are risks of overloading the circuits. The cable rating work is being extended to the accurate modelling and calculation of technical losses in cable networks. The S3148 project has delivered a tool for comparing the merits of cross-bonding and solid bonding of MV polymeric cable systems, including outputs of annualized energy losses, as well as current ratings, circulating currents and elementary section length. Further work on the economic and environmental impacts of losses is continuing in the 2008/09 STP programme. Work is ongoing to assess the mechanical and thermal integrity of plastic ducts (S3155). This builds on previous experimental work carried out within the STP to underpin conduit specification, vital to ensure that the Electricity Industry is not faced with a serious problem of duct collapse in the future. Trials have been arranged to compare the effectiveness of three different processes for the treatment of oil filled cables at end-of-life. This work (S3144) on oil removal has been held up by difficulties in obtaining suitable sites and persuading all parties to take part, but the problems have now been resolved. The outputs of the project should allow DNOs to select the best and most cost effective process, ensuring that long term impact on the environment of redundant oil filled cables is minimised. Significant progress is being made in determining the most effective system (on-line and off-line) for Partial Discharge (PD) testing of MV cable systems (S3157). When complete it should give the DNOs useful asset risk management data
Collaborative Partners	All GB DNOs
R&D provider	EA Technology

<table>
<tr><td>Project Title</td><td colspan="3">Strategic Technology Programme Substation Module</td></tr>
<tr><td>Description of project</td><td colspan="3">Applied R&D into reducing the costs and risks associated with substation equipment</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2875
External £41558
Total £44433</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £9313
External £74167
Total £83480</td></tr>
<tr><td>Project Value</td><td>rolling programme over seven distributors</td><td>Projected 08/09 costs</td><td>Internal £4000
External £45000
Total £49000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">Issues with the age profile of substation assets within the UK electricity distribution system are well known. Also, both regulatory and shareholder pressures preclude substantial investments of the large scale that was seen in the 1950’s to 1970’s. The challenge is to constantly review and innovate new solutions to monitor and define asset condition thereby allowing risks to be clearly defined and sound investment decisions to be taken

The programme of projects which were approved for funding from the STP substations module budget and were undertaken in 2007/08 encompass both developing new innovative asset management processes and practices and developing innovative diagnostic techniques. The aim is to develop already well established themes such as life extension of aged assets within legal and heath and safety constraints, examination of new technologies, developing an understanding of, and innovative solutions for, the impact on substation assets of increasing levels of distributed generation on networks and condition monitoring techniques.

Eighteen new projects were approved during the year and they aimed to:
• S4164_4 – On load tap changer monitor – develop and install trial systems
• S4176_3 – Assessment and inspection of substation earthing systems
o S4181_2 - Transformer Post Mortems.
o S4185_2 - AM Forum membership.
• S4212_1 - Dissemination Seminar to ensure wider appreciation of STP module outputs
• S4219_1 – Management of substation batteries
• S4220_1 – Management of 145kV Disconnectors
• S4221_1 – Investigate Out of Phase Switching
• S4222_1 – Explore Alternatives to ENATS 35-1 Transformers
• S4223_1 – Review of Underground Substation design
• S4225_1 – Assessment of BS148 and IEC60296 Insulating Oils
• S4228_1 - Investigate Alternative Measuring Techniques for Insulation Materials
• S4234_1 - Exploration of Ferroresonance Issues</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="3">Incremental / Significant / Technological Substitution / Radical</td></tr>
</table>

<table>
<tr><td>Expected Benefits of Project</td><td colspan="3">Due to the age profile of the current system assets it is inevitable that unless significant new technology is used to extend asset life, CAPEX and possibly OPEX will need to increase significantly to maintain the present level of network reliability and safety.

If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain the benefits including:
• Offset future increases in CAPEX and OPEX
• Increased safety of staff and public by reducing the number of accidents/incidents;
Both preventing disruptive failures of oil-filled equipment to reduce land contamination and avoiding unnecessary scrapping of serviceable components will alleviate environmental impact</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-2 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 1-10 years - dependent on project</td></tr>
<tr><td>Probability of success</td><td>Range 5-50% dependent on project</td><td>Project NPV</td><td>£19216</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">The wide ranging projects are intended to provide numerous benefits, both in terms of safety, knowledge sharing, network performance, mitigation of risks to plant and minimising effects to the environment as well as cost saving and other business benefits.</td></tr>
<tr><td>Commentary on progress as at 31 March 2008</td><td colspan="3">The majority of projects have not only resulted in essential knowledge transfer, they have enabled skills to be developed between STP 4 Members and also European partners. Key examples of this were the participation in the AM Forum, (S4185_3), the sponsoring of the Ferro-Resonance Seminar, (S4234_1), the Out Of Phase Workshop, (S4221_1) and the Substation Maintenance Seminar, (S4212_1). Each of which has contributed significantly to developing better understanding of electrical plant, its application, utilisation, performance and life cycle. These projects have resulted in the creation of further supplementary projects for 2008/2009.

Additional key development and technical projects have also been undertaken. The On –Load Tap Changer Monitor, (S4164_4) and the Programme of Transformer Post Mortems, (S4181_2), for instance, could each lead to a reduction in potential multiple fatalities, together providing mitigation of multiple potential incidents. Condition based monitoring and the prediction of end of life of plant, will lead to an improvement in network performance, providing a clearer understanding of degradation and the failure processes, which will provide the ability to identify and predict end of life, providing many years benefit. This will enable assets to be replaced in a controlled manner, within agreed timescales, minimize disruptive failures and the implications associated with them, in terms of safety, cost, CI's and CML's.
Its use could result in time and cost savings for DNOs.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="3">All GB DNOs</td></tr>
<tr><td>R&D Provider</td><td colspan="3">EA Technology</td></tr>
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<table>
<tr><td>Project Title</td><td colspan="3">Strategic Technology Programme Networks for Distributed Energy Resources Module</td></tr>
<tr><td>Description of project</td><td colspan="3">Applied R&D into the network integration of distributed energy</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £7000
External £51240
Total £58240</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £8188
External £73258
Total £81446</td></tr>
<tr><td>Project Value</td><td>rolling programme over seven distributors</td><td>Projected 08/09 costs</td><td>Internal £4000
External £45000
Total £49000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The projects undertaken through budget year 2007/8 were aimed at enabling cost effective connections and ensuring techniques are in place to plan, operate and manage networks with significant amounts of 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.

Fifteen new project stages were approved during the year.

These projects aimed to:
• S5147_4 – Monitoring of Microgenerator Clusters
• S5147_5 – Analysis of Microgenerator Cluster monitoring results
• S5147_7 – Reporting of Microgenerator Monitoring
• S5149_5 – Explore Active Voltage Control
• S5142_4 – Generator Data and Structure for DG Connection Applications
• S5151_4 – Network Risk Modelling
• S5152_3/4 – Latest developments in the connection of distributed generation
• S5157_3 – Evaluate the Performance of Small Scale Reactive Power Compensators
• S5161_2 – Standard risk assessment approach to DNO protection
• S5167_1 – Assessment of enhanced ratings for overhead lines connecting windfarms
• S5170_1 – Explore low cost design options for connecting DG to overhead line networks
• S5171_1 - Investigate the use of inverter connected DG to alleviate fault level contribution
• S5172_1 - Optimum power factor to support a low carbon economy
• S5173_1 - Alternative techniques for temperature connected demands
• S5174_1 – Assessment of the potential for DSM from small customers
• S5176_1 – Assessing the impact of high penetrations of micro-generation on cable networks
• S5182_1 – Treatment of distribution network losses
• S5185_1 - Assessment of the potential for DSM from larger customers
• S5186_1/2 – Investigate effects on network of proposed ban on</td></tr>
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<table>
<tr><td></td><td colspan="3">incandescent light bulbs</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="3">Incremental / Significant / Technological Substitution</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">With government policy driving significant increases in generation connection to distribution networks the members need a range of innovative solutions to connection and network operation issues that are cost effective and which maintain the present level of network reliability and safety.

If the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain benefits including:
• Reducing the probability of voltage supply limit excursions resulting from increased distributed generation
• Improving quality of supply and reducing risk of component failure (by understanding the effect and optimising use of impedance in the system);
• A better understanding of the risk presented by the distribution assets when considered as a network rather than discrete components;
• Greater use of distributed generators to meet current DNO obligations (by assessing, from a DNO perspective, the implications of pending Distribution Code provisions relating to distributed generation);
• Reducing the amount of reinforcement needed (by use of dynamic ratings to allow network components to be used to their full capability) - the use of dynamic circuit ratings is a vital step in the move towards active management of networks.</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>Range 1-10 years - dependent on project</td></tr>
<tr><td>Probability of success</td><td>Range 10-30% dependent on project</td><td>Project NPV</td><td>£22504</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">The current project portfolio is designed to produce information and engineering solutions to support the increased need for distributed generation readiness. As such the projects selected for support have a high chance of supporting this top level objective and delivering the required benefits, especially when the portfolio is considered as a whole.</td></tr>
<tr><td>Commentary on progress as at 31 March 2008</td><td colspan="3">During 2007/08, Northern Ireland Electricity joined the Module, bringing the number of full members to eight A total of thirteen reports and briefing papers were delivered during the year, including a review of CIRED 2007 for all Modules; this was an efficient and cost-effective means of disseminating information and trends from the event, enabling STP members to identify areas of future research and development relevant to the UK context. The year also saw the completion of twelve months monitoring of the microgenerator cluster in Manchester, a network with a high penetration of microgeneration where the houses are new build (i.e. well insulated with a relatively low heating requirement). Laboratory tests on compact fluorescent light bulbs were undertaken to examine the network effects of the proposed ban on incandescent bulbs and a follow-on stage was approved to monitor</td></tr>
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	whole house performance under typical mixed loads with measurements concentrating on the harmonic effects.
Collaborative Partners	All GB DNOs
R&D Provider	EA Technology

<table>
<tr><td>Project Title</td><td colspan="3">Protective Coatings Forum</td></tr>
<tr><td>Description of project</td><td colspan="3">Quality control and consultancy services related to protective coatings for overhead line towers and substation plant.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £500
External £6240
Total £6740</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £500
External £6500
Total £7000</td></tr>
<tr><td>Project Value</td><td>£37440</td><td>Projected 08/09 costs</td><td>Internal £1000
External £6490
Total £7490</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">EA Technology has been actively involved in work on surface coatings for overhead line towers and substation plant for a number of years, primarily sponsored by the DNOs and the National Grid. Specifications for tower and plant paint systems have been produced for use by the sponsoring companies. For overhead line towers, most companies currently use two-coat paint systems based on urethane alkyd or modified vinyl resins, manufactured to specifications produced by EA Technology and the National Grid.

To ensure satisfactory quality control throughout the industry, a batch certification scheme has been set up and paint samples from manufacturers and painting contracts are checked on a regular basis. As a result, problems relating to paint application have been largely eliminated and the performance of the paint systems has been much improved. Other services provided include troubleshooting, evaluation of various new products and special purpose paint systems, surveys of coatings on new plant and general guidance on surface coatings.

In recent years, European legislation has been introduced with the aim of reducing emissions of Volatile Organic Compounds (VOCs), such as the solvents in paint systems, to the atmosphere. The Process Guidance Note PG6/23 (97): Coating of Metal and Plastics, introduced the concept of EPA Compliant Coatings and proposed alternative approaches for surface coatings to reduce VOC emissions.

In July 2003, a draft revised version of PG6/23 was issued for consultation, PG6/23A. The main change is the inclusion of requirements specified in EC Directive 1999/13/EC, known generally as the Solvent Emission Directive (SED). The aim of the SED is to reduce emissions of VOCs from specified industrial processes. Full implementation of SED is required by October 2007. This will not immediately affect the use of the solvent based paints currently used for painting towers and plant, because the directive is applicable only to factory applied coatings and does not include coatings applied to outside installations, such as bridges, refineries, towers etc.

However, The European Commission and EU Member States have recognised that they need to do even more to improve air quality, and hence two new directives are being prepared. One refers to ozone. The other, the future National Emissions Ceiling Directive will require Member States to reduce their emissions of several air pollutants including VOCs to lower levels from 2010. These directives may well lead Member States to require the Protective Coatings sector to further reduce emissions arising from the use of its products.

This suggests that current tower paints may be acceptable until 2010. However, the availability of suitable low solvent paint systems as</td></tr>
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	substitutes for the currently used solvent based systems must be seen as a priority for all users of large quantities of paints. In anticipation of the proposed legislation, EA Technology developed an environmentally friendly water based tower paint system as part of the NORUST project, part funded by the Commission of European Communities, in conjunction with a paint manufacturer, a resin manufacturer and an overseas (Spanish) utility company. Field trials were carried out on overhead line towers in six UK DNOs. These were completed in 1998, and one of the tasks of the project is to continue to monitor the field performance of the paint system, with a view to ensuring a smooth transmission to environmentally friendly paint systems as demanded by legislation. Other VOC compliant paint systems, which have been evaluated, through laboratory test programmes and field trials, have included water based and high solids two-pack epoxy coatings. A stated task within the project is to continue to assess VOC compliant paint systems which may be suitable for painting towers and substation plant.		
Type(s) of innovation involved	Significant		
Expected Benefits of Project	It is anticipated that the majority of overhead lines will be needed along existing routes for the foreseeable future. Present lines will remain in service as long as the structures can be maintained economically. Currently, the National Grid owns and operates some 7000 route-km of 400kV and 275kV transmission lines with approximately 28,000 towers. The DNOs operate and maintain the 132kV system which comprises approximately 48,000 towers in total. Current paint systems are expected to last for 10 to 12 years, provided the towers have been previously well maintained and the steelwork is in good condition. Life expectancy of the paint systems on rusty substrates will be lower, possibly 5 years. It is essential that any new VOC compliant paint systems proposed for use on overhead line towers should perform at least as well as the currently used solvent based systems, since they are likely to be more expensive, although material costs account for a relatively small proportion of total contract costs. For a typical DNO, a small improvement in performance would generate financial benefits in the region of £10,000 per annum, together with associated environmental benefits.		
Expected Timescale to adoption	Range 2-4 years - dependent on legislation	Duration of benefit once achieved	Ongoing
Probability of success	Range 50-100% dependent on project	Project NPV	£9354

Potential for achieving expected benefits	The potential for achieving the expected benefits is considered to be fairly high.
Commentary on progress as at 31 March 2008	Major tasks within the project are the development of VOC compliant coatings (in conjunction with paint manufacturers) and testing and evaluation of new products. Some high solids two-pack materials, which are VOC compliant, have been identified which have the potential to replace the solvent based systems, and may be applied as a single coat. However, application of these products in the field can present difficulties with mixing, pot-life and H&S. Water-based systems have performed well on galvanised and steel surfaces in good condition, but not as well as solvent based systems on rusty substrates. Composite systems, comprising solvent based primers, with water based top coats, which may comply with SED requirements, offer an alternative solution.
Collaborative Partners	ENA members
R&D Provider	EA Technology, paint manufacturers

Project Title	**Partial Discharge User Group**		
Description of project	The PD User group is a technical forum where information on partial discharge related failures can be discussed.		
Expenditure for financial year	Internal £4000 External £5954 Total **£9954**	Expenditure in previous (IFI) financial years	Internal £2000 External £12607 Total **£14607**
Project Value	£66540	Projected 08/09 costs	Internal £1000 External £6490 Total **£7490**
Technological area and / or issue addressed by project	Partial discharge is the primary cause of disruptive failure of HV switchgear. The PD User group is a technical forum where information on partial discharge related failures can be disseminated and the understanding of partial discharge on switchgear can be enhanced through targeted investigative, research and development work. This in turn will enhance the way in which HV assets are managed and maintained and make a positive impact on the safety of operators working within substations.		
Type(s) of innovation involved	Significant/Incremental		
Expected Benefits of Project	Due to the ageing profile of switchgear and the introduction of air insulated switchgear designs using cast resin insulation, which is less tolerant to the effects of partial discharge activity, unless the condition of switchgear is actively assessed and managed there is a likelihood of increasing failure rates. The expected benefits of the projects undertaken during FY08 are: • Understanding of the potential partial discharge related failure points for all types of switchgear. • Determine the mechanism of failure relating to surface discharge. • Attempt to ascertain the end of life period of switchgear found to be experiencing surface related partial discharge. • Understand the typical sound signatures of surface related partial discharge by the use of analysis in the time and frequency domain. • Enhanced interpretation of the results of routine partial discharge surveys. • Better targeting of maintenance teams to switchgear in need of attention. • Preservation or reduction of the low failure rate for HV distribution switchgear. • Understanding the effect of the environment on the levels of PD activity and condition of switchgear.		
Expected Timescale to adoption	Range 1-3 years - dependent on project	Duration of benefit once achieved	Ongoing
Probability of success	Range 50-100% dependent on project	Project NPV	£11225

Potential for achieving expected benefits	**Enhanced data manager** During FY08 the PD User Group invested further in the formation of a database of results that enables significant and key information to be quickly drawn from the large population of historical results. The database now incorporate pictures, drawings, failure records, sound files (for the analysis of heterodyned ultrasonic activity). This greatly enhances the incident reporting facilities which helps engineers to better interpret the results of partial discharge surveys and make an assessment on whether switchgear is in need of immediate attention. The next stage will be to make the database web enabled rather than having it supplied in Microsoft Access. **Profile of the long term degradation of switchgear** Following on from the investigation last year, different types of switchgear and components commonly used by the DNO's will be sited at EA Technology and investigated for discharge activity, in some cases creating a discharge source to be monitored. The aim of this work is to try and determine the mechanism of failure associated with surface discharge to try and determine the end of life period once a discharge source has been found. Work will also include the investigation into typical sound signatures for surface discharge activity.
Commentary on progress as at 31 March 2008	• Production of the report into the failure of the 11kV switchgear. Findings showed correlation between discharge levels and humidity but also highlighted the need for more investigation into the failure mechanisms relating to surface discharge. • The specification for the location of equipment within an outdoor environment was published on time. • Several new instruments / accessories developed to be tested by members. • New PD database demonstrated
Collaborative Partners	DNOs
R&D Provider	EA Technology

Project Title	**ACTIV project**		
Description of project	To trial a new supertapp n+ voltage control relay at various sites throughout the DNO community.		
Expenditure for financial year	Internal £5063 External £25215 Total £30278	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£254206	Projected 2008/09 costs	Internal £5000 External £37526 Total **£42526**
Technological area and / or issue addressed by project	Fundamentals Ltd have developed a new voltage control relay – the supertapp n+. This new relay is designed to account for the voltage support provided by local generation connected to the network whose voltage the relay is controlling. By compensating for the voltage support provided by embedded generation, the relay actively alters the voltage on the bus-bar at the substation, actively aiming to keep the whole network within statutory limits. Older voltage control relays have a set voltage level to maintain on the bus-bar at the substation and take no account of voltage support provided by embedded generation, as such it is makes it more difficult to connect any further generation. As the supertapp n+ aims to take account of voltage support provided by generation, it adjusts the target voltage accordingly and creates more headroom for the connection of additional embedded generation.		
Type(s) of innovation involved	Incremental		
Expected benefits of project	• Will provide technology that could be accepted by the industry that makes the connection of increased amounts of generation more feasible. The financial benefit per DNO per year is estimated to be: • £270,000 CAPEX based on a 30% probability of avoiding laying 5km of cable and 10km of overhead line each year for 10 years. £125,000 GDUoS based on 5MW additional capacity over 10 years.		
Expected timescale to adoption	2 Years	Duration of benefit once achieved	10 years
Probability of success	75%	Project NPV	£199077
Potential for achieving expected benefits	Early results from initial field trials are positive and estimated success of the project remains high..		
Commentary on project progress as at 31 March 2008	Project is progressing well and in line with expectations. .		

Collaborative Partners	Central Networks, EDF Energy, ScottishPower
R&D provider	EA Technology

Other Collaborative Projects

Project Title	**SuperGen V**		
Description of project	This is a 4 year major (£3M) multi party collaborative project Industrial Participants: National Grid, Scottish and Southern, SP Power Systems, United Utilities, Western Power Distribution, Central Networks, CE Electric UK, NIE, Advantica & EDF Energy Networks Universities: Manchester, Southampton, Edinburgh, Liverpool, Strathclyde, Queens (Belfast). The research programme is split into 6 work packages & 21 activities. Most of the research will be carried out by the universities		
Expenditure for financial year	Internal £1813 External £25000 Total **£26813**	Expenditure in previous (IFI) financial years	Internal £2,000 External £50,000 Total **£52,000**
Project Value		Projected 2008/09 costs	Internal £2,000 External £25,000 Total £27,000
Technological area and / or issue addressed by project	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 WP 6: Condition monitoring techniques.		
Type(s) of innovation involved	Radical		
Expected Benefits of Project	The expected aims of the project are: • To deliver a suite of intelligent diagnostic tools for plant • To provide platform technologies for integrated network planning and asset management • To progress plans to develop and implement improved and reduced environmental impact networks • To develop models and recommendations for network operation and management		
Expected Timescale to adoption	5 years -	Duration of benefit once achieved	20 years
Probability of success	25%	Project NPV	£42522
Potential for achieving expected benefits	Asset management is core to DNO businesses. The appropriate use of the emerging opportunities for condition monitoring is key to optimising performance, both financially and in quality of supply. Some of the technologies being developed in this programme are likely to be utilised, however much more important is the broader window this work gives to the global research community. Through demonstration sites the true value of condition monitoring will be identified, enabling appropriate business decisions on adoption of technologies.		

Commentary on progress as at 31 March 2008	The project is now fully resourced in all the universities. The high quality PhD students and RAs are naturally receiving training which will make them highly employable in our industry. A number of demonstrators have been identified and are being implemented. This is somewhat ahead of schedule which is very pleasing. The high-level work to develop optimal asset replacement and network expansion methodologies is progressing well, and it has been agreed that this project should become one such demonstrator, the form of which is being agreed by the Steering Group. More physical demonstrators are being built at both distribution and transmission substations. The initial evaluation of techniques is complete and machine learning techniques have been selected for implementation. The more fundamental work on ageing of plant which is necessary to underpin the more applied activities is also progressing according to plan, with development of methods to characterise ageing plant being developed. To date 14 reports and 38 publications have arisen from this work. The management processes are also running well. Several new instruments / accessories developed to be tested by members. New PD database demonstrated
Collaborative Partners	National Grid, Scottish Power, Scottish and Southern, United Utilities, Western Power Distribution, Central Networks, NIE, Advantica & EDF Energy Networks
R&D Provider	Universities of Manchester, Southampton, Edinburgh, Liverpool, Strathclyde, Queens (Belfast).

Project Title	**Superconducting Fault Current Limiter**		
Description of project	Development of a novel resistive super-conducting fault current limiter for applications up to 2000A 12kV		
Expenditure for financial year 2007/08	Internal £3000 External £83750 **Total £86750**	Expenditure in previous financial years	Internal £43875 External £36500 **Total £80375**
Project Value	£2000000	Projected 2008/09 costs	Internal £ 10000 External £106250 Total **£116250**
Technological area and / or issue addressed by project	This project is a joint venture between CE Electric, United Utilities and Scottish Power. The project is planned to run until 2010 and will see three superconducting fault current limiters installed, one at each participating DNO. The total estimated cost of the project to CE Electric is £500,000: with four equal partners, total project value is around £2m. Development in the area of fault current limiting devices has been carried out by a number of leading manufacturers and research establishments for several years as an alternative to network reconfiguration / asset replacement in tackling rising fault levels. Whilst a number of devices are now becoming available, the UK has been slow to react and trial such devices over concerns of fail-safety. The superconducting fault current limiter (SFCL) is perceived to be a lower-risk device, utilising a non-linear 'high-temperature' superconducting ceramic rather than any electronic, electromechanical or mechanical components. When the material is operated at around 65K it loses all electrical resistance, thereby acting as a short circuit to load current. Both the increased current density caused by fault current and the loss of cooling medium (liquid nitrogen) cause the device to heat and the ceramic to revert to its 'normal' resistive state. This added resistance has the effect of clamping the fault current to lower / acceptable limits where it will remain until the fault is cleared by conventional means (circuit breakers, fuses, etc.). The SFCL has been proven to operate in around 10ms.		
Type(s) of innovation involved	Radical		
Expected Benefits of Project	It is envisaged that in the future CE Electric would be required to replace plant at a 33kV/11kV primary substation every two years to accommodate the increased fault level due to the connection of new distributed generation sites. The estimated cost of each plant replacement is £500,000.		
Expected Timescale to adoption	2010	Duration of benefit once achieved	20 years
Probability of success	50%	Project NPV	£96747
Potential for achieving expected benefits	The potential benefit that this technology may provide at 11kV is limited because the difference in cost between the installation of a SFCL and the replacement of overstressed switchgear with a new (higher rated) switchboard is relatively small. However, this research may pave the way to the application of SFCL at higher voltages, which because of the		

	significant cost differential between SFCL and replacement switchgear would provide significant financial benefit.
Commentary on progress as at 31 March 2008	The consortium is at an advanced stage of development of the first limiter which will be installed on the UU system at Bamber Bridge. A site has also been proposed on the Scottish Power system for the installation of the second unit. CE Electric UK will provide the final trial site. Superconducting elements for the first trial site have been designed and type tested and full production of all the elements is underway. Cryogenic equipment to store and cool the elements is either on order or has been delivered ready for assembly. HV circuit-breakers and other items required to support the installation, are on order. Future milestones include the assembly and type testing at an independent test house prior to installation and commissioning towards the end of 2008.
Collaborative Partners	UU, SP
R&D Provider	Applied Superconductors Ltd

Project Title	**Reference Networks**		
Description of project	Development of a modelling technique for HV networks that will accurately reflect the impact on QoS of improvement strategies.		
Expenditure for financial year	Internal £3000 External -£2496 Total £504	Expenditure in previous (IFI) financial years	Internal £3,000 External £62496 Total **£65496**
Project Value	£255000	Projected 2008/09 costs	Internal £0 External £0 Total **£0**
Technological area and / or issue addressed by project	This is the development of a software tool designed to capture the reliability aspects of a real distribution system in a simple model that can be used to accurately evaluate a range of development scenarios.		
Type(s) of innovation involved	Incremental		
Expected benefits of project	If successful, it will allow the benefits of network developments to be accurately evaluated. This will help to ensure that only the most cost-effective developments proceed, improving the overall quality of service delivered to customers.		
Expected timescale to adoption	3 years	Duration of benefit once achieved	10 years
Probability of success	25%	Project NPV	£100000
Potential for achieving expected benefits	Tool still needs further development to make it practical for use in real network design. The network reduction techniques and scenario evaluation now work. However, difficulties in translating changes in the reference network to the changes required on the real network are causing some doubt over the viability of the tool.		
Commentary on project progress as at 31 March 2008	Network reduction tools and some scenario evaluation tools are now complete. Further development of the tool is still continuing but under alternative funding to IFI.		
Collaborative Partners	United Utilities, Scottish Power, Central Networks, PB Power		
R&D provider	Imperial College, London		

Project Title	**UltraTev alarm trial**		
Description of project	The Ultra TEV alarm is a permanent fixed version of the Ultra TEV hand held devices that our substation inspectors are currently using. This proposal is to identify a suitable set of HV switchboards and install the Ultra TEV alarm system to provide continuous monitoring for partial discharges which could lead to a disruptive failure It is also proposed to trial the use of GSM/GPRS connection from these units to the Nortech iHost solution. This will provide the facility to record individual events, enhancing the existing latching facility of the EA Technology hub		
Expenditure for financial year	Internal £2500 External £35000 Total £37500	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£407146	Projected 2008/09 costs	Internal £1000 External £15000 Total **£16000**
Technological area and / or issue addressed by project	Partial discharge is the primary cause of disruptive failure of HV switchgear. The UltraTEV Alarm system continuously monitors for partial discharge activity and alarms, using GPRS, when levels exceed threshold limits, allowing timely intervention by the DNO. This in turn enhances the way in which HV assets are managed and maintained and is making a positive impact on the safety of operators working within substations.		
Type(s) of innovation involved	Incremental		
Expected benefits of project	Due to the ageing profile of switchgear and the introduction of air insulated switchgear designs using cast resin insulation, which is less tolerant to the effects of partial discharge activity, there is a strong need for continuous monitoring of switchgear to reduce the likelihood of increasing failure rates. The expected benefits of the project during FY08 are: • Determine the appropriateness of both the TEV and Ultrasonic threshold levels • Gather sufficient data to determine the effectiveness of this approach for the detection of partial discharge activity and hence the prevention of discharge related incidents and disruptive failures on the network through timely intervention. The expected benefits going forward through to adoption are based on the deployment of UltraTEV Alarms in a selected 10% of Primary substations. It is envisaged that this will result in • An avoidance of 20% of switchgear failures due to PD related causes and an avoided cost of £826k over 20 years, providing an NPV of £322k. • Savings of 123,000 CML per year and 2000 CI per year (across collaborating DNOs) • Enhancement of safety based on: increasing operator awareness of deteriorating condition of insulation, automatic restriction of access to substations with discharge problems and early warning to maintenance staff working in substations.		

Expected timescale to adoption	2 years	Duration of benefit once achieved	ongoing
Probability of success	75%	Project NPV	£322000
Potential for achieving expected benefits	The work to date suggests that the benefits are achievable upon more widespread adoption of the monitoring systems.		
Commentary on project progress as at 31 March 2008	In CE, three units have been purchased and installed. Two of these have subsequently been relocated sue to lack of activity. One unit in particular has recorded intermittent activity that would have been missed by the hand-held alarm, although that activity has since ceased (suggesting an external cause). It is proposed to acquire a further unit to extend the trial into NEDL, providing a further cross-reference. A number of installations in the total project have positively identified partial discharge activity using both electromagnetic and ultrasonic sensors. In two of these installations, additional more sophisticated tools that are currently employed for the purpose of condition assessment and detection of PD activity were used in conjunction with the UltraTEV Alarm and in both instances the results were confirmed. Additional investigation and remedial work has not yet been completed.		
Collaborative Partners	DNOs (WPD, Central Networks, SSE) plus additional information from UltraTEV alarm installations on international electricity networks (e.g. Ireland, Malta, Singapore, and Hong Kong) is being fed into the project.		
R&D provider	EA Technology		

Project Title	**Met Office energy phase 2 climate change modelling**		
Description of project	In 2006 the Met Office carried out a scoping study on the impacts of climate change on the UK energy industry. The report was the result of a collaboration between E.ON UK, EDF Energy, National Grid and the Met Office Hadley Centre to scope the impacts of climate change on the UK energy industry. This Phase 2 project was industry-funded; it involved 11 UK energy companies and was undertaken by the Met Office. It focussed on the priorities identified by the earlier scoping study. During the project new tools and methods required to understand the impact of climate change on the energy industry were developed and new data resources designed to address gaps in underpinning information were produced.		
Expenditure for financial year	Internal £1000 External £35742 Total £36742	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£554930	Projected 2008/09 costs	Internal £0 External £0 Total **£0**
Technological area and / or issue addressed by project	The project has been run as a series of work packages (WP). Those WPs relevant to distribution and transmission are described below. WP1 – Modelling Energy Impacts. Models created to assess impacts of climate change on Electricity Demand, Conductor Performance, Transformer Performance, Cables, Overhead Network, and Wind Power. WP2 – Guidance for the Energy Industry on the use of the United Kingdom Impacts Programme new scenarios of climate change (UKCIP08). UKCIP08 is planned for released in November 2008. WP3 – Climate Models and Wind Projections. Investigating methods of including estimated of future wind resource in wind farm viability. WP4 – Climate Change and Underground Cable Performance. Modelling future soil conditions to increase understanding of the impacts of climate change on cables. WP6 – Climate change and the Urban Heat Island Effect. Producing information on the urban heat island for use when panning infrastructure in cities. WP7 – Final reporting and presentation of the results to each company. WP8 – Predicted climatologies for the UK: 2008 – 2018		
Type(s) of innovation involved	Significant		

Expected benefits of project	The expected benefits of project are: • For the elements assessed an understanding of the sensitivity to climate change and key meteorological drives of the impacts. This will highlight priorities for adaptation. • New models for projecting impacts suitable for inclusion in climate models or for application to climate model output. • Guidance on the application of climate models to energy industry applications which should results in appropriate use of climate information by Networks. • New information on urban heat islands and climatologies for the next 10 years to assist infrastructure design and planning.		
Expected Timescale to adoption	Year 2011	Duration of benefit once achieved	20 Years
Probability of Success	50%	Project NPV	£ 100000
Potential for achieving expected benefits	There is a good chance of achieving the expected benefits. This was a year long project that finished at the end of May 2008 on time and to budget and specification. Project outputs and reports are now available via the project website. The project has highlighted some areas of Networks where no change to existing practice is required because of climate change and other areas where adaptation may be beneficial. The new models that have been developed and used in this project will be a useful legacy. The new information produced specifically for the energy industry has been demonstrated to have significant benefits over what was available previously.		
Commentary on project progress as at 31 March 2008	In March 2008 the status of the project work packages was as follows. WP1 - Complete WP2 – 50% Complete WP3 - Complete WP4 – 90% Complete WP6 – 90% Complete WP7 – 50% Complete WP8 – 80% Complete Overall the project was 75% complete.		
Collaborative Partners	All the network operators and most energy supply businesses		
R&D provider	Met Office		

CE's internal innovation programme

Project Title	**Woodhouse Steel Girder Mast Replacement Specification.**		
Description of project	Development of a novel long-span 132/66kV OHL design		
Expenditure for financial year	Internal £3500 External £32571 Total £36071	Expenditure in previous financial years	Internal £247056 External £249081 Total £496137
Project Value	£340000	Projected 2008/9 costs	Internal £2500 External £0 Total £2500
Technological area and / or issue addressed by project	In the 1930s, YEDL's predecessor, the Yorkshire Electric Power Company, built a range of long-spanned 11, 33 & 66 kV steel girder mast lines, commonly known as the "Woodhouse mast designs". The "Woodhouse steel mast" supports were originally designed to accommodate 0.15" (7/.166") HDBC & 0.1" (7/.136") HDBC conductors using three basic design spans of 500 ft, 650 ft and 700 ft. A number of the circuits were later reconductored with 0.175" (37/.110") conductors designed on a 700 ft basic span. This was achieved without the need to carry out any alterations to the existing supports. Over time the majority of 11 kV supports have been replaced with traditional wood pole alternatives, the majority of them resulting in interpoling as a means to reduce the long span lengths. A similar approach has been applied to the 33 and 66 kV circuits, but difficult wayleaves situations mean that around 300 km still remain. The original specification cannot be re-used as it does not conform to current overhead line design requirements. Existing current designs such as AP1 or our proprietary OHL 9 and CE/C/37 specifications are limited to a span length of around 150m. The challenge facing us is that we have around 300 km of an asset that is critical to system security and, dependent on land use, a hazard to the public as it deteriorates. The absence of a like-for-like replacement renders it difficult to obtain wayleaves for routes using current designs. This has already led to our undergrounding one circuit in its entirety (Thurcroft-Mexborough-Edlington) and a high-risk section of another (the tee to Crowle). The high costs involved were justified by the pressing need to replace these lines before they posed an unacceptable risk to public safety.		
Type(s) of innovation involved	Technological Substitution		
Expected benefits of project	The estimated benefit of a direct replacement for the Woodhouse masts is estimated at £5k per km of circuit and there are 300km of circuits using the Woodhouse masts. The PV benefit calculation has been spread over a 20-year period, which is in line with the current replacement plan for the Woodhouse masts.		
Expected timescale to adoption	1 year	Duration of benefit once achieved	20+ years

Probability of success	90%	Project NPV	£325094
Potential for achieving expected benefits	The project is well advanced and entering the implementation phase. Probability of successfully completing the project and delivering the anticipated benefits is now extremely high		
Commentary on project progress as at 31 March 2008	The new specification was originally expected to be delivered to CE Electric by PB Power mid 06. However, the first specification failed type tests, requiring a revised design. The scope was also extended to provide for: • a self-supporting steel mast version; and • platforms etc. to aid assembly, in line with the requirements of the work at height regulations The revised wood pole design has passed type test, and a trial line has been built. The specification was approved in February 2008 and is to be used for the rebuild of existing Woodhouse mast lines. There will inevitably remain some integration issues that will require monitoring going forward to ensure the long term adoption of this new long span specification.		
Collaborative Partners	None		
R&D provider	PB Power		

Project Title	**Technology Roadmap**		
Description of project	To create a roadmap for developing technology to meet the likely future demands upon our network		
Expenditure for financial year	Internal £11500 External £52000 Total £63500	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£63500	Projected 2008/09 costs	Internal £0 External £0 Total **£0**
Technological area and / or issue addressed by project	While we have achieved significant success in establishing a framework that brings forward new R&D projects, and disseminates the findings thereof, a step change in performance requires further measures. It is therefore proposed to engage consultants to assist us in developing a technology roadmap. This map will take the output of a study of 'aspirations for a future network' to be developed internally, and lay out a route to achieve those aims through conventional, near-market and radical solutions. In turn, this map is intended to create a framework for us to generate ITTs for pro-active R&D work The projects that would be brought forward will complement the existing portfolio of internally-generated short-term projects, medium-term activities such as Supergen, SFCL, DCR and FLM by providing a layer of long-term developments		
Type(s) of innovation involved	From incremental to radical		
Expected benefits of project	A better understanding of the long-term radical solutions we might need to provide a network fit for future purpose, specifically to provide a framework to ensure focus of long-range R&D projects Benefits will be felt in more effective use of IFI budgets: 1% savings equate to £20k pa [at the time of commissioning: four times that at the time of this report]		
Expected timescale to adoption	7 years	Duration of benefit once achieved	Ongoing
Probability of success	75%	Project NPV	£413393
Potential for achieving expected benefits	The project has provided a framework for assessing R&D need, and proposed a viable suite of further projects. Subject to resource availability, this project will better allow us to deliver a coherent R&D programme as intended		
Commentary on project progress as at 31 March 2008	Project complete		
Collaborative Partners	None		
R&D provider	EA Technology		

Project Title	**Loss Of Mains Protection (ROCOF) Phase 2**		
Description of project	The project is to build on the loss of mains work carried out at Strathclyde University in 2006 to understand the behaviour of the loss of mains relays currently on the market under various simulated fault conditions for different generic types of generator. .		
Expenditure for financial year	Internal £1000 External £28750 Total **£29750**	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£29750	Projected 2008/09 costs	Internal £10000 External £40000 Total **£50000**
Technological area and / or issue addressed by project	There are three key project goals: 1) To better understand the performance of the loss of mains relays currently available so that a set of typical settings can be established for the main generic types of generators and control systems for each type of relay. 2) To enable a risk based assessment to be carried out when determining what generator interface protection to fit for a particular generator size and type. 3) To produce a Technical Standard on testing procedures for loss of mains relays so they can be assessed in a consistent manner. This standard will specify a set of faults that the relays must be stable for these will be in the form of comtrade files. The standard will also provide guidance on the parameters to be used in the relays to provide a benchmark minimum standard for relay manufactures to work to in the development of future loss of mains relays.		
Type(s) of innovation involved	Incremental		
Expected benefits of project	The Technical Standard will be used to assist the ENA Protection Assessment Panel to assess loss of mains relays and assist manufacturers in developing loss of mains relays to a common minimum standard relevant to the Distribution Industry. The system study work will provide a recommended range of settings for relays currently available on the market, it will also document the sensitivity and stability of these relays to the most common fault scenarios for the main generic generator configurations. This will enable DNOs to make more informed decisions on the type of generator interface protection to fit and provide sufficient technical date for basic risk assessment criteria to be used in the relative merits of inter-tripping verses loss of mains relays. Overall, the benefits will come through a combination of: 1. reduced up-front capex (if requirements can be relaxed); 2. reduced on-going opex (if nuisance tripping can be reduced); and 3. reduced system risk, by having protective relays better suited to their intended purpose		
Expected timescale to adoption	1 year	Duration of benefit once achieved	5-10years

Probability of success	90%	Project NPV	£20547
Potential for achieving expected benefits	All elements of the project are well advanced and success is highly likely.		
Commentary on project progress as at 31 March 2008	There are three key project goals: 1. Performance assessment has been made of several technology alternatives and work is continuing to complete this for all alternatives identified.. 2. Report has been issue outlining the protection options for single generator systems. This work is complete but a proposal for a third phase to investigate protection options for multiple generator/dynamic substations. 3. The study is complete and criteria for standards have been agreed. This now needs to be translated in to a standard ENA document.		
Collaborative Partners	ENA Members (for technical input only: project fully funded by CE)		
R&D provider	University Of Strathclyde		

Project Title	**Reverse Reactive Power Relays For LOM**		
Description of project	Assessment of the viability of using VAR relays as an alternative to inter-tripping to detect a loss of mains situation where the application of ROCOF or Vector shift relays is not permitted.		
Expenditure for financial year	Internal £1000 External £19875 Total **£20875**	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£20875	Projected 2008/09 costs	Internal £0 External £0 Total **£0**
Technological area and / or issue addressed by project	In order be considered acceptable as an alternative to inter-tripping, there is an need to understand the basis of operation of the techniques, the relays that are available, how they are applied on other networks etc. in addition to being comfortable with the performance under normal and abnormal operational conditions. The purpose of this project is to identify the issues that need to be addressed, address them and if the technique is considered to have merit undertake a field trial.		
Type(s) of innovation involved	Technology Substitution		
Expected benefits of project	The cost of VAR relays is thought to considerably cheaper than an inter-tripping scheme and if acceptable would reduce the protection requirements for smaller (HV connected) DG schemes.		
Expected timescale to adoption	NA	duration of benefit once achieved	NA
Probability of success	Project Completed	project NPV	NA
Potential for achieving expected benefits	Project Completed. The final report concluded that reverse reactive power flow relays offered similar sensitivity to Rate of Change of Frequency (RoCoF) relays, but with the potential to be less stable. As the novel technique offers no great advantage over conventional solutions, we have decided not to commission further work		
Commentary on project progress as at 31 March 2008	The project has been complete and a final report issued. As noted above, no further work is currently planned		
Collaborative Partners	None		
R&D provider	MGA Ltd.		

<table>
<tr><td>Project Title</td><td colspan="3">NaREC LV AVC feasibility Study</td></tr>
<tr><td>Description of project</td><td colspan="3">a feasibility study into novel on-load tap-changers for distribution transformers</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,250
External £19,550
Total £21,800</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Value</td><td>£21800</td><td>Projected 2008/09 costs</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">To assess likely technologies to provide on-load tap-changers for distribution (20kV, 11 kV or 6.6 kV to 400V) transformers, to inform future research work. Issues to be considered include:
Safety case;
Ease of accommodation within standard buildings;
Ease of retro-fit to existing units;
Reliability;
Energy loss in the unit and on the wider system;
Reduced automatic tapping range (i.e. are there benefits in switching over something other than the ±5% range in 2.5% steps of conventional off-load tap-changers, either using larger steps or fewer of them);
Installation/maintenance cost;
The potential impact of HD 472 (voltage harmonisation);
Control philosophies and implementation
Given there is an existing project using vacuum interrupters, technologies to be considered should include, but not be limited to:
Solid state switching between existing tap windings on the HV side;
Solid state switching on the LV side;
Use of parallel or series switched elements on the LV side to buck or boost voltage</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="3">significant</td></tr>
<tr><td>Expected benefits of project</td><td colspan="3">It is widely recognised that voltage rise is a key barrier to accepting high levels of DG onto the LV network. This can be ameliorated through providing voltage control facilities on the HV/LV transformer
That is, by actively managing the tap settings on distribution transformers, we can adjust the voltage at the LV bars to control voltage on the LV network. This will allow us to accept more DG onto a given network while remaining within statutory voltage limits
If successful, this would allow us to reduce the costs of reinforcement (or even, in the right circumstances, new construction) associated with connecting DG to the LV network.</td></tr>
</table>

Expected timescale to adoption	10 years	Duration of benefit once achieved	ongoing
Probability of success	25%	Project NPV	£205900
Potential for achieving expected benefits	As a feasibility study, there is no direct benefit to be reaped. The project has met its success criteria, as some promising avenues for further research have been identified		
Commentary on project progress as at 31 March 2008	Project complete: proposals for a follow-on project have been received from a university and are being considered		
Collaborative Partners	None		
R&D provider	NaREC; Newcastle University; Garfold Ltd		

Project Title	**Remote Indicating Fault Flow Indicators – Network Trial**		
Description of project	Trial installation of Remote Indicating fault flow indicators (RIFFI) including the development of an interface between the management software and the main NMS control system.		
Expenditure for financial year	Internal £24611 External £128518 Total £153129	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£276000	Projected 2008/09 costs	Internal £10,000 External £50,000 Total **£60,000**
Technological area and / or issue addressed by project	This project involves determining the potential value of pole-mounted remote-indicating fault flow indicators to the speed of restoring supplies and whether such devices will give pre-warning of developing faults. It will also develop the interfaces required to handle such devices within the Enmac based control system used by CE.		
Type(s) of innovation involved	Incremental		
Expected benefits of project	The trial will cover one region of the company (Northumberland) and will attempt to simulate the effects and performance of a full roll-out of the system across the whole company. This part of the project will be used to determine the best way of determining the location of the units and the installing and commissioning the equipment. It will also provide information on the reliability and effectiveness of the two options available for communications, GSM or GPRS. The benefit of this work will be in determining the most cost-effective way of rolling out such a system across the whole company. As part of the project an interface between the management software and the main NMS control system is being developed. This will include determining the best way to present the information from the FPIs to the control engineers and the best way to manage the potentially very large number of messages that will occur in a storm situation. The benefit of this work will be that it will enable control engineers to see the information from the FPIs in conjunction with information from the main remote control system on an easily assimilated schematic diagram. Better decisions as to restoration strategy should come out of such a system together with faster restoration of supplies. There are two main competing FPIs available in the UK. The trial will be used to determine the reliability of both, their effectiveness at detecting and reporting faults, and whether they pick-up the fleeting faults that can be a precursor to sustained faults. The benefits of this part of the work is that any significant differences in the effectiveness of the two competing FPIs should be identifiable. This will ensure that the most effective unit(s) will be used if deployment is extended to the whole company. In the longer term, the detection and reporting of fleeting faults should enable some faults to be located and rectified before they affect large numbers of customers. Note that at the end of the trial the effectiveness of the system will be evaluated to inform a decision as to whether to install the FPIs across the whole of the company's HV overhead network.		

Expected timescale to adoption	1 years	Duration of benefit once achieved	Ongoing
Probability of success	75%	Project NPV	£432000
Potential for achieving expected benefits	The work to date suggests that the benefits are achievable upon more widespread adoption of the FFIs.		
Commentary on project progress as at 31 March 2008	In CE, 257 RIFFIs have been installed at 294 attempted locations. All have been located in one region of NEDL to simulate, as far as possible, how this technology would be installed across the whole company. Failures to fit units were mainly due to the lack of a GPRS or GSM communications signal. The installed RIFFIs have been evenly split between the two potential RIFFI providers and between GSM and GPRS communication systems. To date GPRS has proved to be more reliable for remote end communications than GSM. The host controller has been successfully installed and is being used to control and monitor the RIFFIs. The iHost to Enmac interface has been developed and successfully tested on the NMS training server. Further work is being undertaken to determine the optimum on-screen configuration of the units and to determine the priority level of the various messages produced by the units before testing the units on the live NMS system. Minor problems with commissioning one type of RIFFI have been found and the manufacturer has already developed a fix for this. Half of the installed units made by this manufacturer have this fix installed. Some problems with the final GPRS link into the company have been encountered and corrected. This experience has allowed us to determine the most effective way of handling GPRS traffic. The effectiveness of the units in detecting and reporting permanent, transient and fleeting faults is currently being evaluated.		
Collaborative Partners	None		
R&D provider	Nortech Management Ltd, Bowden Brothers, GE Harris		

Project Title	**Innovative Fault Passage Indicator for Cable Systems (GM FPI)**		
Description of project	This is a staged project to develop a non-invasive fault passage indicator for retrofit locations on the HV cable network. Stage 1 of the project confirmed the theory that surface mounted magnetic sensors should be able to detect both overcurrent and earth faults on cable networks. Stage 2, undertaken this year, was to determine the availability of suitable magnetic sensors with the sensitivity and linearity to work effectively in a practical FFI.		
Expenditure for financial year	Internal £1500 External £9545 Total £11045	Expenditure in previous (IFI) financial years	Internal £1500 External £10725 Total **£12225**
Project Value	£75000	Projected 2008/09 costs	Internal £1500 External £13690 Total **£15190**
Technological area and / or issue addressed by project	This project is intended to develop a practical and reliable, while novel in design, fault passage indicator for HV cable networks. Though mainly intended for retrofit applications, it could be used effectively in new locations as well.		
Type(s) of innovation involved	Significant		
Expected benefits of project	The expected benefits of project are that it will reduce restoration times, particularly in conjunction with automated switching. This comes from providing: • An easily installed retro-fit unit for locations where no indicators are currently installed • Overcurrent detection as well as the earth-faults of conventional indicators • A generally more robust solution than conventional indicators. The benefit of fully deploying these units across a network could be as much as 4 CML.		
Expected Timescale to adoption	5 years	Duration of benefit once achieved	20 Years
Probability of Success	20%	Project NPV	£3m based on Ofgem's current IIS incentive rates.
Progress to date and potential for achieving expected benefits	A rigorous analysis has confirmed that the initial concept will work (in theory). Stage 2 (now completed) has confirmed that suitable low-cost magnetic sensors are available with the correct sensitivity and linearity for a unit to work. We consider these results are sufficiently positive to justify proceeding to the next stages of designing a test regime and to carry out laboratory based tests to confirm that the expected magnetic fields do occur around real cable samples and real sensors do work in this application.		
Collaborative Partners	None		

R&D provider	EA Technology

Project Title	**GROND contingency analysis**		
Description of project	Development of a software tool to auto-scan the whole HV network for overload/undervoltage conditions under single-circuit outage conditions.		
Expenditure for financial year	Internal £1000 External £9360 Total £10360	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£11360	Projected 2008/09 costs	Internal £1000 External £0 Total **£0**
Technological area and / or issue addressed by project	Currently design staff do not have the resources to pro-actively monitor loading on the whole HV network and in particular to look for potential overload/undervoltage situations under single circuit outage conditions. Without this monitoring we can (and do) hit problems with re-supplying customers following single fault situations. This leads to extended restoration times as quite often mobile generators are the only way to re-supply some of the customers involved. In the extreme some customers have to wait for repairs to be completed before supply can be restored. There is also an unproven concern that some circuits are running overloaded under normal conditions, unduly increasing fault rate. In the company we use the GROND software tool to determine the reliability of HV circuits and the effects on reliability of circuit changes. A "resupply" module is available for Grond which can do most of the calculations required for determining overload/undervoltage conditions under single-circuit outage situations but this only works on one manually selected circuit at a time. We are proposing a development of this module which will carry out this analysis automatically on every circuit on the HV system and present designers with a report which ranks circuits by the level of potential overload/undervoltage. This will highlight those circuits that need a more detailed investigation into the level of risk involved, whether they comply with the ER P2/6 security standard, and if reinforcement is required. Thus scarce (and expensive) design resources will be pointed in the direction of where they are most needed.		
Type(s) of innovation involved	Incremental		

Expected benefits of project	A key part of the project is that this whole network analysis can be carried out at any time. Thus we will be able to periodically monitor the network for its overall loading/voltage health (e.g. a KPI of how many circuits are in the potential overload/undervoltage condition) and obtain a trend over time of how this is moving. For the first time it will give us an objective measure of whether we are putting sufficient resources into reinforcement of the HV network or if we need more or less to maintain a healthy network For customers the periodic scan would allow us to identify and monitor developing overload/undervoltage conditions on the network on a proactive basis. At present there is little spare resource available to do this and most instances are only picked up on a reactive basis after there are problems restoring customers during a fault or when major new/enhanced connections force an investigation into that specific part of the network. This will also highlight potential ER P2 violations, and thereby enhance compliance with SEDLC 5A		
Expected timescale to adoption	1 year	Duration of benefit once achieved	Ongoing
Probability of success	75%	Project NPV	£25000
Potential for achieving expected benefits	Targeting scarce network design resources at areas that demonstrably need reinforcing locks in the personnel gains that have already been made whilst more effectively developing the distribution network. Initial indications from the project indicate that this will be possible.		
Commentary on project progress as at 31 March 2008	Initial software development complete. Results are currently being evaluated.		
Collaborative Partners	None		
R&D provider	Mathematical and computer Modelling (Grond software owner/developer)		

Project Title	**Long underground EHV cables**		
Description of project	To identify the potential issues with long distance distribution using underground cables.		
Expenditure for financial year	Internal £500 External £17132 Total £17632	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£17632	Projected 2008/09 costs	Internal £0 External £0 Total **£0**
Technological area and / or issue addressed by project	To assess the potential issues with long distance distribution using underground cables (and identify solutions), including but not limited to: • earthing & bonding; • electrical protection and control; • switching; • pre-commissioning tests; and • fault location It is anticipated that the study will address issues including but not limited to: • charging currents as they affect testing, protection and voltage control; • the merits of distance, unit, and other protection schemes; • communications over 40-50 km of cable; • intermediate switching points; • shunt and series compensation; and • DC links		
Type(s) of innovation involved	Incremental		
Expected benefits of project	We are getting a number of inquiries for wind farms in Northumberland that are a distance away from our EHV circuits. The reality of the situation is that we are very unlikely to get wayleaves for overhead lines so the method of supply is likely to be underground cable: this project seeks to demonstrate engineering and, ultimately, economic feasibility. In the extreme, this will make or break the connection of generation in remote areas. If we take the 100 MW of wind we expect in the Knowesgate/Harwood Forest area, the revenue driver alone would generate £150,000 pa		
Expected timescale to adoption	2-5 years	Duration of benefit once achieved	One scheme
Probability of success	10%	Project NPV	£121006
Potential for achieving expected benefits	the project has successfully identified the issues and generic solutions: further work is required to develop a practical toolkit for designers		

Commentary on project progress as at 31 March 2008	Project complete: follow-on work suspended pending further interest by DG developers in exploiting wind resource in Northumberland
Collaborative Partners	None
R&D provider	SKM

Project Title	**Oil Degradation**		
Description of project	Formally to review and document the knowledge gained by EA Technology through STP and other R&D on oil degradation		
Expenditure for financial year	Internal £1500 External £4200 Total £5700	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£5700	Projected 2008/09 costs	Internal £0 External £0 Total **£0**
Technological area and / or issue addressed by project	There is a body of knowledge gained by EA Technology that has been used to inform live-tank oil sampling and other maintenance practices. However, little of it has been formally documented in a way that allows us to create a clear audit trail for our maintenance intervals		
Type(s) of innovation involved	incremental		
Expected benefits of project	This will back up our maintenance policy, where many maintenance intervals are driven by oil degradation rates. We need these to discharge our moral and legal obligations to ensure that apparatus remains fit for service at all times		
Expected timescale to adoption	1 year	Duration of benefit once achieved	Ongoing
Probability of success	75%	Project NPV	£91,668
Potential for achieving expected benefits	As at 31 March 2008, our ground-mounted plant maintenance policy was being reviewed. This project will directly inform the maintenance intervals permitted for oil-filled switchgear		
Commentary on project progress as at 31 March 2008	Draft final report received		
Collaborative Partners	None		
R&D provider	EA Technology		

<table>
<tr><td>Project Title</td><td colspan="3">Network Risk</td></tr>
<tr><td>Description of project</td><td colspan="3">Development of a methodology to quantify network risk and develop a network risk modelling assessment tool</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3875
External £15330
Total £19250</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Value</td><td>£108500</td><td>Projected 2008/09 costs</td><td>Internal £4000
External £16000
Total £20000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">This project is a joint venture between CE Electric and Durham University. The project is a three year project with the majority of the work being undertaken by a mature student working towards a PhD.

The philosophy underpinning the design of distribution networks in the UK has evolved over a period of many years during the formative stages of the development of the networks. Very little work has been undertaken in recent years to review whether these fundamental principles are appropriate to meet current customer requirements.

A number of factors, which have increased in prominence in recent years, suggest that a review of these principles is appropriate. These include:
• Utilisation of distribution networks is increasing, and the latent network capability available to respond to unplanned events is reducing;
• Increasing awareness of global warming;
• Severe weather conditions are occurring more frequently;
• Customer expectations of network performance both at a headline level and at times of network duress are increasing;
• Customers may be more concerned about extremes of performance rather than the headline figures rewarded under IIP, and a concern that neither is properly reflected in current planning standards;
• The misalignment of network planning and operational standards;
• A view that network risk / resilience may be a key element in the next DPCR

This project is to explore these factors and develop an up to date view of network risk

The main objectives of the research project are:
• To gain a deeper understanding of the risk inherent in existing distribution networks;
• To determine how this translates into risk to customer supplies;
• To develop a means of quantifying this risk;
• To understand how this risk is likely to change in the future;
• To develop risk modelling and analysis methodologies;
• To make use of existing, or develop new, modelling and analysis tools to allow the above to be achieved; and
To focus on the technical issues and then make regulatory and commercial observations at the end of the project.</td></tr>
</table>

Type(s) of innovation involved	Incremental		
Expected benefits of project	The project will increase the understanding of network risk within the business and the anticipated benefits are in two key areas: The financial benefit per annum is estimated to be £100,000 based on deferred capital expenditure due to improved design and utilisation of network capacity for 5 years. There is also a supply quality benefit associated with a reduction in CML's or CI's through better management of network risk during normal operation, construction works and emergency situations.		
Expected timescale to adoption	3 Years	Duration of benefit once achieved	10 years
Probability of success	30%	Project NPV	£24000
Potential for achieving expected benefits	Early results are in line with the expected progress and the project is on target to deliver the required risk analysis.		
Commentary on project progress as at 31 March 2008	The first 6 months of the project has been focussed on ensuring that the PhD student is familiar with the risk management in CE Electric UK and the risk management techniques. Demonstration risk assessments have been carried out.		
Collaborative Partners	None		
R&D provider	Durham University		

Project Title	**OBYR14 UV Camera Survey**		
Description of project	Perform a trial inspection on a spare OBYR14 circuit breaker using a Daycor II UV camera. If this proves successful then carry out inspections for the rest of the fleet.		
Expenditure for financial year	Internal £250 External £4675 Total £4925	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total **£0**
Project Value	£4925	Projected 2008/09 costs	Internal £0 External £0 Total **£0**
Technological area and / or issue addressed by project	A circuit breakers installed on the EHV network at Tynemouth suffered a mechanical failure in its main insulator due to cracked bushings. As a result, the remainder of the installed capacity requires urgent inspection. It is extremely difficult to obtain isolations necessary to perform the inspections by traditional methods on the EHV network. This proposal is evaluates a new technology that would allow the performance of live inspections.		
Type(s) of innovation involved	Radical		
Expected benefits of project	Successful detection of cracks using the Daycor II camera would be make it possible to discover if the circuit breakers are showing early signs of mechanical failure, allowing corrective actions before a disruptive failure occurs. Similarly, where cracks are shown not to be present maintenance/replacement periods can be extended for the remaining switchgear. Further benefits of a successful project may include the use of the camera in preventative maintenance at voltage levels of 11kV and above.		
Expected timescale to adoption	N/A	Duration of benefit once achieved	N/A
Probability of success	0%	Project NPV	£0
Potential for achieving expected benefits	Project discontinued.		
Commentary on project progress as at 31 March 2008	Trial inspections on simulated cracks in porcelain insulators have been conducted. Results indicated that the proposed approach could not be utilised as anticipated and the project has been halted. Alternative approaches will be explored through separate projects.		
Collaborative Partners	None		
R&D provider	EA Technology		

Benefits Realised

22. An essential part of any R&D programme is that the outcome of completed projects is rolled out into 'business as usual' products and processes. Much of the work carried out this year is part of a staged progress, with few 'final' deliverables.

23. Reviewing projects listed as complete in this report yields:

- Avoided cost. The technology roadmap, deployed as part of our R&D strategy, will assist in focussing our innovation efforts;
- Direct savings. The completed Woodhouse mast replacement specification has the potential to reduce the costs of rebuilding selected overhead lines by around £10/m. The design now forms part of our baseline, and is being implemented on a pilot scheme (the 66kV tee to Crowle);
- Managing risk. The loss of mains relay work has identified means to make the system safer, and the findings have been put forward as the basis for an ENA Engineering Technical Report (ETR), due out later this year;
- Strategic. The Met Office project and most of the STP work falls into this category, as it adds to the body of knowledge without necessarily having an immediate impact. As part of our ongoing policy update programme, we have referred to this body of work, including in 2007/08:
  - Ground-Mounted Plant Inspection and Maintenance:
    - STP report 5879 - ongoing transformer post mortems
    - STP report 5949 - assessment of replacement insulator grease
    - STP report 6190 - procedures for the procurement, maintenance, testing and disposal of substation batteries
    - a bespoke report commissioned in 2007/08, T6109 - review of switchgear oil degradation, which brought together and built upon previous work, specifically:
      - S0409 stages 1 and 2: investigation of the degradation of materials in older 11kVoil filled switchgear
      - S0409 stage 3: investigation of materials in older 11kV oil filled switchgear
      - S0423 oil condition in 11kV switchgear
      - S0419 non-invasive detection of sludging oil in switchgear
      - S0431 investigation of general issues related to oil sludging in 11kV switchgear
      - S0411 cause and effect of phosphorus and manganese deposits on insulating bushing surfaces in bulk oil switchgear
      - S0420 a study of the oxidation of mineral insulating oils in the presence of metals
      - T3021: the use of reconditioned oil in 11kV switchgear
      - T3674: Live tank oil sampling

24. The 'unsuccessful' projects, such as the fault level monitor and UV camera (to detect partial discharge) still bring benefits. We have at least ruled out some options, allowing us to focus on other areas that might be more productive.

Programme Planning and Co-ordination

25. To co-ordinate and, as importantly, disseminate R&D activity across the business, we have previously established an internal working group. We will further enhance the innovation management process during 2008-2009. The resource spent on running the R&D process within CE Electric is not a project within its own right: however, without this commitment no R&D would be possible within the company. This cost includes project administration, project management, reporting, internal working group meetings and preparatory work on future projects.

NPV methodology

26. We have adopted a simple, robust and transparent approach to assessing costs and benefits. For each project, we have assessed both costs and potential benefits over a 20-year window, discounted back at 6.9% pre-tax real. Figures for collaborative projects have been provided by the contractor. These have been scrutinised to validate estimated benefits.

27. The benefit valuations are necessarily a matter of engineering judgement, but generally take the form of assessing the size of the issue and a credible reduction in unit costs. To reduce subjectivity, we seek to benchmark these assessments externally (e.g. through comparison to STP figures).

Summary of current portfolio

28. We can summarise the discussion above to yield a set of costs and benefits for ongoing projects across the portfolio:

Programme	Number of projects	External costs	Internal costs	PV cost	PV Benefit	Cost/ Benefit Ratio
BERR support: ENSG etc.		£0	£7,375	£33,320	£62,738	0.53
ENA P2: fault level monitor	1	£2,566	£500	£10,799	£184,090	0.06
ENA P9: earthing (grids & transfer potentials)	1	£2,625	£1,000	£3,116	£110,533	0.03
STP2 Overhead Network Module	12	£44,963	£1,875	-	£63,564*	-
STP3 Cable Networks Module	9	£53,637	£1,875	-	£53,490*	-
STP4 Substation Module	13	£41,558	£2,875	-	£59,559*	-
STP5 Networks for Distributed Energy Resources Module	19	£51,240	£7,000	-	£69,827*	-
EATL painting forum	2	£6,240	£500	-	£9,355*	-
EATL partial discharge user group	1	£5,954	£4,000	-	£11,225*	-
Supergen V	21	£25,000	£1,813	£82,439	£124,961	0.66
ASL SCFL	1	£83,750	£3,000	£372,821	£513,759	0.73
UltraTev alarm trial	1	£35,000	£2,500	£49,518	£241,500	0.21
Met Office energy phase 2 climate change modelling	1	£35,742	£1,000	£34,370	£64,000	0.54
loss of mains protection (RoCoF relays) phase 2	1	£28,750	£1,000	£27,830	£50,660	0.55
Woodhouse mast	1	£32,571	£3,500	£275,479	£600,573	0.46
Technology Roadmap	1	£52,000	£11,500	£59,401	£630,392	0.09
GM FPI	1	£9,545	£1,500	£774,025	£1,331,339	0.58
OBYR14 UV camera inspection	1	£4,675	£250	£4,310	£488,215	0.01
NaREC LV AVC feasibility Study	1	£19,550	£2,250	£20,393	£905,173	0.02
Long underground EHV cables	1	£17,132	£500	£16,494	£137,500	0.12
OHL Remote FPI trial	2	£128,518	£24,611	£143,246	£431,712	0.33
reference networks	1	-£2,496	£3,000	£51,957	£100,616	0.52
GROND contingency analysis	1	£9,360	£1,000	£9,691	£22,166	0.44
reverse reactive power relays (for LoM)	1	£19,875	£1,000	£19,528	£50,660	0.39
oil degradation	1	£4,200	£1,500	£5,332	£97,000	0.05
Network risk Modelling (Durham University)	1	£15,330	£3,875	£17,965	£26,344	0.68
EATL ACTIV	1	£25,215	£5,063	£28,323	£227,400	0.12
Innovation administration / project management.	-	£0	£19,438	£18,182	-	-
Total	**97**	**£752,500**	**£115,299**	**£2,058,539**	**£6,668,351**	**0.31**

* Figure is overall Project NPV values for the activity. Separate PV of cost and benefit are not available.

29. We can also derive the overall portfolio summary required by G85:

Number of active IFI projects	97
NPV of costs and anticipated benefits from committed IFI projects	£4,609,812
Summary of other benefits anticipated from active IFI projects	Marginal improvement in reliability
Total expenditure in reporting period.	£867,799
Total expenditure to date	£2,100,749
Benefits actually achieved from IFI projects to date	see text

Summary of 2007/08 IFI investment

30. We can also summarise the discussion above to provide the data specifically requested in the RIGs, split 40:60 in proportion to size of licensee:

IFI Costs 2007/08	**NEDL**	**YEDL**
eligible IFI expenditure	£362,930	£504,869
eligible IFI internal expenditure	£48,220	£67,078
combined distribution network revenue	£192,250,000	£267,900,000
carry-forward to 2007/8	£438,183	£609,553

Outlook for 2008/09

31. We envisage that the portfolio of IFI projects to be worked on in 2008/09 will be largely made up from:

- continuing to support the 'in progress' projects listed in this report, notably:
  - ENSG and subsidiary workstreams;
  - EA Technology STP;
  - Supergen V and VI;
  - ENA collaborative work;
  - ASL fault current limiter;
  - Network risk; and
  - GM Fault passage indicator.
- developing new projects, collaborative where possible but alone if not, including:
  - ZEFAL, a novel means for constraining fault current contributions;
  - health indices for underground cables;
  - AC power-flow system model for charging and other purposes;
  - vacuum bottle integrity testing ; and
  - the Energy Innovation Centre at Capenhurst.