ScottishPower
EnergyNetworks

Innovation Funding Incentive

Annual Report

Issue 1 – 31st July 2006

IFI Projects
April 05 – March 06

Prepared by
SP Power Systems Ltd
On behalf of SP Distribution Ltd and SP Manweb plc

Foreword

Welcome to the ScottishPower EnergyNetworks' Innovation Funding Incentive Annual Report for 2005/06.

2005/06 has been an eventful year for the UK in terms of research and development in the sector. Energy is very firmly on the national agenda and in the daily media following the initiation of the Government's Energy Review. The outcome has given rise to a range of options on both the generation and supply side, which will have an impact on transmission and distribution networks going forward.

It is clear that networks will become more complex in their design and operation while the pressure for increased efficiency throughout the regulatory process will continue. The application of new technologies to the networks is an important part of the response to meet these challenges. To this end, I welcome Ofgem's introduction of the Innovation Funding Incentive framework. The IFI has given renewed vigour to our development activity, facilitating projects that, although beneficial in the long term, would previously not have been undertaken by a cash constrained Regulated business.

As outlined in this report, we have a number of exciting projects now underway across a range of subject areas. Our commitment to these is strong and I look forward to seeing our networks change and improve as a result over the coming years. Furthermore, I welcome the opportunity to extend the implementation of a similar mechanism to our transmission network through the current transmission price review where similar challenges exist.

David Rutherford
Director ScottishPower EnergyNetworks

Executive Summary

The first full year of the IFI mechanism for the Distribution licences has been embraced whole-heartedly within ScottishPower EnergyNetworks. Our focus has been to develop a portfolio of projects spanning not just our current needs, but also concentrating on broader issues such as the impact a diverse and variable generation mix will have on our networks into the future. Through this process, technological development has been given renewed focus, moving up the agenda in the business and assisting in accelerating the route to adoption.

Examples of successful technologies include LV fault location, a project that was taken out of development early, and leading to the purchase of over 30 units for field use following the strength of benefits derived in the initial phases. Another leading development, applying intelligence to circuit breaker opening 'signatures', has led to a product that is now in the process of being integrated into the business as a standard practice both before and after 11kV switchgear maintenance.

At a more strategic level, our collaborative project with Rolls Royce, University of Strathclyde and ITI Energy has been used to signpost the potential effects of distributed generation and microgeneration on real 11kV and LV networks. The scenarios developed within this project, focussing on the network of 2020, have fed into National Electricity Network Strategy Group (ENSG) Horizon Scanning work programme as industry leading.

We have levered our IFI portfolio further by engaging in a number of externally funded and collaborative projects, giving not only uplift to our budget, but also giving direction and steer to academia and manufacturers with net benefits to UK plc. The current tally is for 4 successful projects via the DTI Technology Programme; leading industry roles in a number of the EPSRC Supergen programmes; a strategic partnership project with EPSRC, ABB and EDF-Energy and numerous other collaborative ventures with UK DNOs.

Our focus for 2006/07 will continue to build on the foundations laid in 2005/06, to drive projects towards delivery, increase the programme further and to ensure that research outputs can be exploited in the most expedient manner. We hope to translate this success across our Regulated business following the proposed extension of the IFI to include the SP-Transmission Licence.

Introduction & Background

Context

As part of the most recent Distribution Price Control Review, Ofgem introduced two new incentive mechanisms: the Innovation Funding Incentive (IFI) and Registered Power Zone (RPZ). They were consulted on as an integral part of the DPCR proposals and were widely supported by a large majority of consultees.

The primary aim of these two new incentives is to encourage the DNOs to apply innovation in the way they pursue the technical development of their networks. Ofgem recognised that innovation has a different risk/reward balance compared with a DNO's core business. The incentives provided by the IFI and RPZ mechanisms are designed to create a risk/reward balance that is consistent with research, development and innovation.

The two main business drivers for providing these incentives at this time are the growing need to efficiently manage the renewal of network assets and to provide connections for an increasing capacity of distributed generation at all distribution voltage levels. These are significant challenges that will both benefit from innovation.

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 132kV, to deliver value (i.e. financial, supply quality, environmental, safety) to end consumers. IFI projects can embrace any aspect of the distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning. The detail of the IFI mechanism is set out in the Special Licence Condition C3 and the DG Regulatory Instructions and Guidance (RIGs).

Registered Power Zone (RPZ)

In contrast to the IFI, RPZs are focused specifically on the connection of generation to distribution systems. The estimates made by DNOs as part of the DPCR process indicated that some 10GW of generation could be connected in the next five years. This generation could connect at every distribution voltage level bringing new system design and operating challenges. RPZs are therefore intended to encourage DNOs to develop and demonstrate new, more cost effective ways of connecting and operating generation that will deliver specific benefits to new distributed generators and broader benefits to consumers generally. The detail of the RPZ mechanism is set out in the Special Licence Condition D2 and the DG Regulatory Instructions and Guidance (RIGs).

Overview

A total of 36 IFI projects were undertaken by SP EnergyNetworks on behalf of both the SP Distribution Ltd and SP Manweb plc Licence areas for the period 1st April 05 – 31st March 06.

No RPZ applications were submitted to Ofgem during this period.

Summary Tables

The following tables have been taken from the Regulatory Instructions and Guidance documents (RIGs). For completeness of IFI Reporting Year 1, the 2004/05 Early Start summary tables have also been included.

2004/05 'Early Start' Period

Table 1: IFI Summary - SP Distribution Ltd Licence Area 04/05

IFI Allowance (0.5% of 2004/05 turnover)	£1.69m
Unused IFI Carry Forward to 2005/06	£0
Number of Active IFI Projects	10 (end March 05)
NPV of costs and anticipated benefits from committed IFI projects	£200,337
Summary of other benefits anticipated from IFI projects	As outlined in 0405 Report
External expenditure 2004/05 on IFI projects	£69,034
Internal expenditure 2004/05 on IFI projects	£11,280
Total expenditure 2004/05 on IFI projects	**£80,314**
Benefits actually achieved from IFI projects to date	N/A

Table 2: IFI Summary - SP Manweb plc Licence Area 04/05

IFI Allowance (0.5% of 2004/05 turnover)	£1.1m
Unused IFI Carry Forward to 2005/06	£0
Number of Active IFI Projects	12 (end March 05)
NPV of costs and anticipated benefits from committed IFI projects	£410,814
Summary of other benefits anticipated from IFI projects	As outlined in 0405 Report
External expenditure 2004/05 on IFI projects	£123,107
Internal expenditure 2004/05 on IFI projects	£25,488
Total expenditure 2004/05 on IFI projects	**£148,595**
Benefits actually achieved from IFI projects to date	N/A

2005/06 Period

Table 3: IFI Summary - SP Distribution Ltd Licence Area 05/06

IFI Allowance (0.5% of 2005/06 turnover)	£1,625,600
Unused IFI Carry Forward to 2006/07	£812,800
Number of Active IFI Projects	34
NPV of costs and anticipated benefits from committed IFI projects	£4,533,152
Summary of other benefits anticipated from IFI projects	See individual reports – Appendix C
External expenditure 2005/06 on IFI projects	£241,431
Internal expenditure 2005/06 on IFI projects	£71,884
Total expenditure 2005/06 on IFI projects	**£313,315**
Benefits actually achieved from IFI projects to date	Too early to demonstrate

Table 4: IFI Summary - SP Manweb plc Licence Area 05/06

IFI Allowance (0.5% of 2005/06 turnover)	£1,073,400
Unused IFI Carry Forward to 2006/07	£536,700
Number of Active IFI Projects	36
NPV of costs and anticipated benefits from committed IFI projects	£3,277,820
Summary of other benefits anticipated from IFI projects	See individual reports – Appendix C
External expenditure 2005/06 on IFI projects	£163,341
Internal expenditure 2005/06on IFI projects	£70,207
Total expenditure 2005/06 on IFI projects	**£233,548**
Benefits actually achieved from IFI projects to date	Too early to demonstrate

Summary Table Notes

Internal expenditure for the 2004/05 period has been recalculated using the same hourly and overhead rate as for 2005/06, giving rise to a reduced overall figure than that previously submitted.

During 2005/06 and in the collation of this report we have revised our methodology for NPV assessments[1] for IFI projects, which has been reflected in the 05/06 figures. It is noted that the figures described in the tables should be interpreted with caution, as the figures quoted in the NPVs will only be realised upon completion of the project, and once

[1] Detailed in Appendix B

fully adopted into the business. Costs in these tables are for the Reporting Year 1 period only and are expected to increase as our developments progress.

Whilst some projects have now completed, or have been taken out of the development phase early, they are still in the young stages of adoption. To this end, we feel that it is too early to robustly show tangible benefits.

The following table shows the total breakdown of internal and external IFI spend in Reporting Year 1, the expected IFI recovery and carry forward into 2006/07 for both SP Distribution Ltd and SP Manweb plc.

Table 5: Reporting Year expenditure (Reporting Year = 04/05 Early Start + 05/06)

	SP-Distribution	SP-Manweb	Total
Total Reporting Year External IFI Expenditure	£310,465	£286,448	£596,913
Total Reporting Year Internal IFI Expenditure	£83,165	£95,695	£178,860
Total Reporting Year Expenditure (1)	£393,630	£382,143	£775,773
Total Reporting Year Eligible IFI Expenditure with 15% internal exp cap (2)	£365,253	£336,997	£702,250
Internal expenditure at risk (1) – (2)	£28,377	£45,146	£73,523
Total Expected Recovery @ 90%	£328,728	£303,297	£632,025
Total Carry Forward to 2006/07 (50% at 0.5% turnover)	£812,800	£536,700	£1,349,500

Cost Breakdown

As SP Power Systems operates across both the SP-Distribution and SP-Manweb areas, successful developments undertaken in one part of the business will equally apply to both licences. In line with this, costs have been split against each licence based on the turnover and hence size of each network area.

Table 6: Cost Breakdown between Licence Areas

Licence Area	Annual Turnover (05/06)	Percentage Split
SP-Distribution	£325.1million	~ 60%
SP-Manweb	£214.7 million	~ 40%

Therefore, for projects with an equal application between both SP-D and SP-M, costs have been apportioned on a 60% / 40% split (respectively). Projects identified as only applying to one licence, or that apply in favour of one over the other have been scaled accordingly (see Table A1).

Internal Costs

Internal costs in Table 5 are shown capped at 15% of the total technology expenditure, in line with the guidance in the IFI RIGs. The detail given in Appendix B and C shown the true internal expenditure for each project. This exceeds this cap for a number of reasons:

1. The number of new projects started in 05/06
2. Involvement in geared programmes / projects
3. The stage most projects are in their development cycle

Further details on the internal / external cost balance are provided in Appendix B.

Programme management of IFI for personnel in roles as a direct result of the initiative have been taken as:

- 50% FTE – Programme Manager
- 25% FTE – Graduate trainee assistant

and applied evenly across all current projects.

Internal Innovation Mechanisms

Ensuring IFI projects are properly managed is an eligibility requirement set out in Engineering Recommendation G85. Since the introduction of the IFI we have put in place new systems, people and processes to manage and co-ordinate activities in these areas. This includes:

- Technology & Innovation Manager – a single dedicated resource with the Engineering, Asset Management department to co-ordinate the programme and disseminate information (in post >12mths)
- Technology Implementation Programme Co-ordinator – a single dedicated resource focussed on the delivery of trials, accelerating the IFI programme and assisting in the creation of business cases for technology adoption (in post 06/07)
- R&D Strategy – an overarching strategy for IFI has been developed and implemented.
- Project Inception Documents (PID) – the development of a standard PID to capture information and the application assumptions made in the net present value calculation at the start of a project.
- Procurement strategy – tendered IFI projects are now split into two phases: feasibility and pilot. The feasibility stage invites companies to test their current equipment in a real network environment in order to get a better understanding of the work (and hence cost) needed to take to product into an operational environment (the pilot).
- Legal conditions – SP has near standard terms and conditions and a formal sign off process for IFI projects. This includes an agreed position for Intellectual Property Rights (IPR) stemming from these projects.
- Financial measures - new systems have been introduced to authorise and monitor budgets for IFI projects.
- R&D Approvals Panel – a formal panel of business experts has been put in place, which not only authorises IFI projects, but also ensures business awareness and engagement. This panel is to become a management board for the IFI

programme, with a remit to keep track of projects and facilitate the exploitation of benefits as they arise.

- Project delivery – An increasing number of our 1st and 2nd year graduate trainees are linked to manage IFI projects. This provides both keen and capable resources for the day-to-day management of projects, and development opportunities for our up and coming staff (the development of technology is a key IET CEng requirement).

The use of the IFI has been to tackle a balanced portfolio of projects catering for both tactical (current) and strategic (future) requirements of the company across a range of issues. This ensures that funding is evenly spread across a range of issues, and not targeting one or two more obvious areas. Detail of all our projects is included in the summary tables of Appendix C, Table 7 gives a flavour of how some of our projects map into the appropriate development area.

Table 7: Examples of projects by R&D category

Area	Example Project	SP Project Reference	Tactical / Strategic
Asset ageing	Circuit Breaker Intelligence	IFI 0407	Tactical
Facilitating Distributed Generation connections	Remote Line Temperature Monitor	IFI 0514	Tactical
	Thermal Modelling for Active Network Management	IFI 0513	Tactical / Strategic
	Autonomous Regional Active Network Management System (AURA-NMS)	IFI 0532	Strategic
Performance improvements	IED Radio	IFI 0501	Tactical
	OHL Fault Passage Indicators with wireless comms	IFI 0406	Tactical
Reduced environmental impact	Alternative Oil	IFI 0404	Strategic

Project Reports

Summary sheets for each of the individual projects have been provided in Appendix C. In the interests of efficiency, only one summary sheet has been produced with associated internal / external costs and Net Present Value (NPV) calculations for a whole project (i.e. unless otherwise specified, they are not split by licence area).

Appendix A – Expenditure Breakdown of Projects between Licences

Table A1: Overview of 05/06 projects showing application between distribution licences

Project Number	Project Title	Project Split		SP-M		SP-D	
		SP-M	SP-D	Internal £	External £	Internal £	External £
IFI 0401-2	STP - Module 2 - Overhead Networks	40%	60%	£1,844	£14,400	£2,766	£21,600
IFI 0401-3	STP - Module 3 - Cable Networks	40%	60%	£1,959	£25,400	£2,938	£38,100
IFI 0401-4	STP - Module 4 - Substations	40%	60%	£1,731	£14,400	£2,596	£21,600
IFI 0401-5	STP - Module 5 - Distributed Generation	40%	60%	£1,994	£14,400	£2,991	£21,600
IFI 0402	LV Single Phase Voltage Regulator	40%	60%	£3,242	£6,111	£4,863	£9,167
IFI 0403	Reference Network Development	40%	60%	£1,566	£24,000	£2,348	£36,000
IFI 0404	Alternative Oils	40%	60%	£644	£0	£966	£0
IFI 0405-2	Test Construction of Alternative Trident 132kV Overhead Line	100%	0%	£15,873	£2,387	£0	£0
IFI 0406	Overhead Line Fault Passage Indicators	40%	60%	£417	£0	£626	£0
IFI 0407	Kelman Circuit Breaker Intelligence Analysis	40%	60%	£2,832	£45,018	£4,247	£67,526
IFI 0408	Minimum Switchgear Project	100%	0%	£6,411	£0	£0	£0
IFI 0409	LV Fault Location Kehui T-P21	40%	60%	£3,134	£0	£4,701	£0
IFI 0501	IED Radio	40%	60%	£1,506	£1,515	£2,259	£2,272
IFI 0502	Fault Level Monitor Project	40%	60%	£417	£0	£626	£0
IFI 0503	L36 33kv Overhead Line Spec. inc. OPPC	40%	60%	£417	£0	£626	£0
IFI 0504	Fault Infeed Calculation verifications	40%	60%	£417	£0	£626	£0
IFI 0505	Supergen V - AMPerES	40%	60%	£644	£0	£966	£0
IFI 0506	Portable Smart Link (ASL) tester	40%	60%	£691	£2,800	£1,036	£4,200
IFI 0507	SmartDust	40%	60%	£1,673	£892	£2,509	£1,339
IFI 0508	Development of REDOX flow battery for energy storage	40%	60%	£1,198	£0	£1,797	£0
IFI 0509	Superconducting Fault Current Limiter	40%	60%	£2,987	£2,000	£4,481	£3,000
IFI 0512	Broadband Powerline Carrier	40%	60%	£1,135	£1,360	£1,703	£2,040
IFI 0513	Thermal Modelling and Active Network Management	40%	60%	£1,290	£0	£1,936	£0
IFI 0514	Remote Line Temperature Monitor	40%	60%	£1,170	£4,000	£1,755	£6,000
IFI 0515	ScottishPower / RollsRoyce Prototype Network	40%	60%	£6,226	£0	£9,340	£0
IFI 0517	GridSense LineTracker FPI (Conductor Temperature)	40%	60%	£417	£0	£626	£0
IFI 0520	Energy Storage Devices for Distribution Networks	40%	60%	£1,750	£400	£2,625	£600
IFI 0522	Supergen III	40%	60%	£417	£0	£626	£0
IFI 0527	Testing Procedure for ROCOF relays	40%	60%	£865	£1,075	£1,298	£1,613
IFI 0528	Hydrogen Electrolyser / Storage DTI Proj	40%	60%	£417	£0	£626	£0
IFI 0529	ESR Network (ESR 21)	40%	60%	£884	£2,400	£1,327	£3,600
IFI 0530	Optimising voltage control / VAr performance of a large scale WF	40%	60%	£1,493	£783	£2,239	£1,174
IFI 0532	AURA-NMS (Automated Regional Active Network Management System)	40%	60%	£1,293	£0	£1,939	£0
IFI 0535	Radiometric Arc Fault Location	40%	60%	£417	£0	£626	£0
IFI 0536	ENA Earthing project (OSG SG14)	40%	60%	£417	£0	£626	£0
IFI 0537	ENA Lightning Protection (develop ETR 134)	40%	60%	£417	£0	£626	£0

	SP-M		SP-D	
Totals	Internal £	External £	Internal £	External £
	£70,207	£163,341	£71,884	£241,431
Ratios	30%	70%	23%	77%

Table A2: Overview of 04/05 'Early Start' projects showing application between distribution licences

Project Number	Project Title	Project Split		SP-M		SP-D	
		SP-M	SP-D	Internal £	External £	Internal £	External £
IFI 0401-2	STP - Module 2 - Overhead Networks	40%	60%	£226	£6,995	£338	£10,492
IFI 0401-3	STP - Module 3 - Cable Networks	40%	60%	£485	£6,995	£727	£10,492
IFI 0401-4	STP - Module 4 - Substations	40%	60%	£485	£6,995	£727	£10,492
IFI 0401-5	STP - Module 5 - Distributed Generation	40%	60%	£539	£6,995	£808	£10,492
IFI 0402	LV Single Phase Voltage Regulator	40%	60%	£540	£0	£811	£0
IFI 0403	Reference Network Development	40%	60%	£504	£0	£756	£0
IFI 0404	Alternative Oils	40%	60%	£192	£0	£288	£0
IFI 0405-2	Test Construction of Alternative Trident 132kV Overhead Line	100%	0%	£15,668	£77,084	£0	£0
IFI 0406	Overhead Line Fault Passage Indicators	40%	60%	£2,227	£0	£3,341	£0
IFI 0407	Kelman Circuit Breaker Intelligence Analysis	40%	60%	£1,382	£14,988	£2,073	£22,483
IFI 0408	Minimum Switchgear Project	100%	0%	£2,300	£0	£0	£0
IFI 0409	LV Fault Location Kehui T-P21	40%	60%	£941	£3,055	£1,411	£4,583

	SP-M		SP-D	
Totals	Internal £	External £	Internal £	External £
	£25,488	£123,107	£11,280	£69,034
Ratios	17%	83%	14%	86%

Table A3: IFI Reporting Year 1 projects showing application between distribution licences

Project Number	Project Title	Project Split		SP-M		SP-D	
		SP-M	SP-D	Internal £	External £	Internal £	External £
IFI 0401-2	STP - Module 2 - Overhead Networks	40%	60%	£2,070	£21,395	£3,104	£32,092
IFI 0401-3	STP - Module 3 - Cable Networks	40%	60%	£2,443	£32,395	£3,665	£48,592
IFI 0401-4	STP - Module 4 - Substations	40%	60%	£2,216	£21,395	£3,323	£32,092
IFI 0401-5	STP - Module 5 - Distributed Generation	40%	60%	£2,533	£21,395	£3,799	£32,092
IFI 0402	LV Single Phase Voltage Regulator	40%	60%	£3,782	£6,111	£5,674	£9,167
IFI 0403	Reference Network Development	40%	60%	£2,070	£24,000	£3,104	£36,000
IFI 0404	Alternative Oils	40%	60%	£836	£0	£1,254	£0
IFI 0405-2	Test Construction of Alternative Trident 132kV Overhead Line	100%	0%	£31,541	£79,471	£0	£0
IFI 0406	Overhead Line Fault Passage Indicators	40%	60%	£2,644	£0	£3,967	£0
IFI 0407	Kelman Circuit Breaker Intelligence Analysis	40%	60%	£4,213	£60,006	£6,320	£90,009
IFI 0408	Minimum Switchgear Project	100%	0%	£8,711	£0	£0	£0
IFI 0409	LV Fault Location Kehui T-P21	40%	60%	£4,075	£3,055	£6,112	£4,583
IFI 0501	IED Radio	40%	60%	£1,506	£1,515	£2,259	£2,272
IFI 0502	Fault Level Monitor Project	40%	60%	£417	£0	£626	£0
IFI 0503	L36 33kv Overhead Line Spec. inc. OPPC	40%	60%	£417	£0	£626	£0
IFI 0504	Fault Infeed Calculation verifications	40%	60%	£417	£0	£626	£0
IFI 0505	Supergen V - AMPerES	40%	60%	£644	£0	£966	£0
IFI 0506	Portable Smart Link (ASL) tester	40%	60%	£691	£2,800	£1,036	£4,200
IFI 0507	SmartDust	40%	60%	£1,673	£892	£2,509	£1,339
IFI 0508	Development of REDOX flow battery for energy storage	40%	60%	£1,198	£0	£1,797	£0
IFI 0509	Superconducting Fault Current Limiter	40%	60%	£2,987	£2,000	£4,481	£3,000
IFI 0512	Broadband Powerline Carrier	40%	60%	£1,135	£1,360	£1,703	£2,040
IFI 0513	Thermal Modelling and Active Network Management	40%	60%	£1,290	£0	£1,936	£0
IFI 0514	Remote Line Temperature Monitor	40%	60%	£1,170	£4,000	£1,755	£6,000
IFI 0515	ScottishPower / RollsRoyce Prototype Network	40%	60%	£6,226	£0	£9,340	£0
IFI 0517	GridSense LineTracker FPI (Conductor Temperature)	40%	60%	£417	£0	£626	£0
IFI 0520	Energy Storage Devices for Distribution Networks	40%	60%	£1,750	£400	£2,625	£600
IFI 0522	Supergen III	40%	60%	£417	£0	£626	£0
IFI 0527	Testing Procedure for ROCOF relays	40%	60%	£865	£1,075	£1,298	£1,613
IFI 0528	Hydrogen Electrolyser / Storage DTI Proj	40%	60%	£417	£0	£626	£0
IFI 0529	ESR Network (ESR 21)	40%	60%	£884	£2,400	£1,327	£3,600
IFI 0530	Optimising voltage control / VAr performance of a large scale WF	40%	60%	£1,493	£783	£2,239	£1,174
IFI 0532	AURA-NMS (Automated Regional Active Network Management System)	40%	60%	£1,293	£0	£1,939	£0
IFI 0535	Radiometric Arc Fault Location	40%	60%	£417	£0	£626	£0
IFI 0536	ENA Earthing project (OSG SG14)	40%	60%	£417	£0	£626	£0
IFI 0537	ENA Lightning Protection (develop ETR 134)	40%	60%	£417	£0	£626	£0

	SP-M		SP-D	
Totals	Internal £	External £	Internal £	External £
	£95,695	£286,448	£83,165	£310,465
Ratios	25%	75%	21%	79%

Table A4: Project NPVs, split between distribution licences

Project Number	Project Title	Project Split		NPV		
		SP-M	SP-D	Project NPV	NPV SP-M	NPV SP-D
IFI 0401-2	STP - Module 2 - Overhead Networks	40%	60%	£17,171	£6,868	£10,303
IFI 0401-3	STP - Module 3 - Cable Networks	40%	60%	£17,171	£6,868	£10,303
IFI 0401-4	STP - Module 4 - Substations	40%	60%	£17,171	£6,868	£10,303
IFI 0401-5	STP - Module 5 - Distributed Generation	40%	60%	£17,171	£6,868	£10,303
IFI 0402	LV Single Phase Voltage Regulator	40%	60%	£64,723	£25,889	£38,834
IFI 0403	Reference Network Development	40%	60%	£61,650	£24,660	£36,990
IFI 0404	Alternative Oils	40%	60%	£967,716	£387,086	£580,630
IFI 0405-2	Test Construction of Alternative Trident 132kV Overhead Line	100%	0%	£92,425	£92,425	£0
IFI 0406	Overhead Line Fault Passage Indicators	40%	60%	£589,499	£235,800	£353,699
IFI 0407	Kalman Circuit Breaker Intelligence Analysis	40%	60%	-£11,104	-£4,442	-£6,662
IFI 0408	Minimum Switchgear Project	100%	0%	£78,966	£78,966	£0
IFI 0409	LV Fault Location Kelvi T-P21	40%	60%	£2,119,996	£847,998	£1,271,998
IFI 0501	IED Radio	40%	60%	£971,511	£388,604	£582,907
IFI 0502	Fault Level Monitor Project	40%	60%	£184,090	£92,045	£92,045
IFI 0503	L36 33kv Overhead Line Spec. inc. OPPC	40%	60%	£1,616,875	£646,750	£970,125
IFI 0504	Fault Infeed Calculation verifications	40%	60%	-£12,603	-£5,041	-£7,562
IFI 0505	Supergen V - AMPerES	40%	60%	£0	£0	£0
IFI 0506	Portable Smart Link (ASL) tester	40%	60%	£63,970	£25,588	£38,382
IFI 0507	SmartDust	40%	60%	£26,683	£10,673	£16,010
IFI 0508	Development of REDOX flow battery for energy storage	40%	60%	£84,716	£33,886	£50,830
IFI 0509	Superconducting Fault Current Limiter	40%	60%	-£267,191	-£106,876	-£160,315
IFI 0512	Broadband Powerline Carrier	40%	60%	-£6,238	-£2,495	-£3,743
IFI 0513	Thermal Modelling and Active Network Management	40%	60%	£301,867	£120,747	£181,120
IFI 0514	Remote Line Temperature Monitor	40%	60%	£110,911	£44,364	£66,547
IFI 0515	ScottishPower / RollsRoyce Prototype Network	40%	60%	£47,114	£18,846	£28,268
IFI 0517	GridSense LineTracker FPI (Conductor Temperature)	40%	60%	£243,458	£97,383	£146,075
IFI 0520	Energy Storage Devices for Distribution Networks	40%	60%	-£4,677	-£1,871	-£2,806
IFI 0522	Supergen III	40%	60%	£0	£0	£0
IFI 0527	Testing Procedure for ROCOF relays	40%	60%	£157,009	£62,804	£94,205
IFI 0528	Hydrogen Electrolyser / Storage DTI Proj	40%	60%	£0	£0	£0
IFI 0529	ESR Network (ESR 21)	40%	60%	-£16,445	-£6,578	-£9,867
IFI 0530	Optimising voltage control / VAr performance of a large scale WF	40%	60%	£11,622	£4,649	£6,973
IFI 0532	AURA-NMS (Automated Regional Active Network Management System)	40%	60%	-£101,918	-£40,767	-£61,151
IFI 0535	Radiometric Arc Fault Location	40%	60%	£45,787	£18,315	£27,472
IFI 0536	ENA Earthing project (OSG SG14)	40%	60%	£ 162,330	£ 81,165	£ 81,165
IFI 0537	ENA Lightning Protection (develop ETR 134)	40%	60%	£ 159,546	£ 79,773	£ 79,773
				Overall	SP-M	SP-D
			Overall NPV	£7,810,972	£3,277,820	£4,533,152

Project Progress Curves

Expenditure profiles are described below to give an appreciation of costs that will be required prior to a project realising a stated benefit through the development cycle. Figure A1 shows a hypothetical expenditure profile for a development project. Expenditure is defined as:

- **External** – Money paid to 3rd parties for work (consultancy, purchase of equipment, monitoring, etc)
- **Internal** – SP EnergyNetworks' staff time on eligible IFI development work multiplied by the appropriate hourly rate. The success of a project is highly dependent on the levels of internal support a project is given.
- **Overall investment** - The total cost of a project (predominantly external cost) of which the company is accessing through collaborative or external funding leverage. This is the combined investment from SP Power Systems and other collaborative partners.

In line with sound project management, all IFI projects have been staged into milestones, i.e. the R&D provider will only receive payment upon successful completion of a defined stage. Whilst these costs will feature in following years, it does affect the balance of internal to external expenditure in the short term.

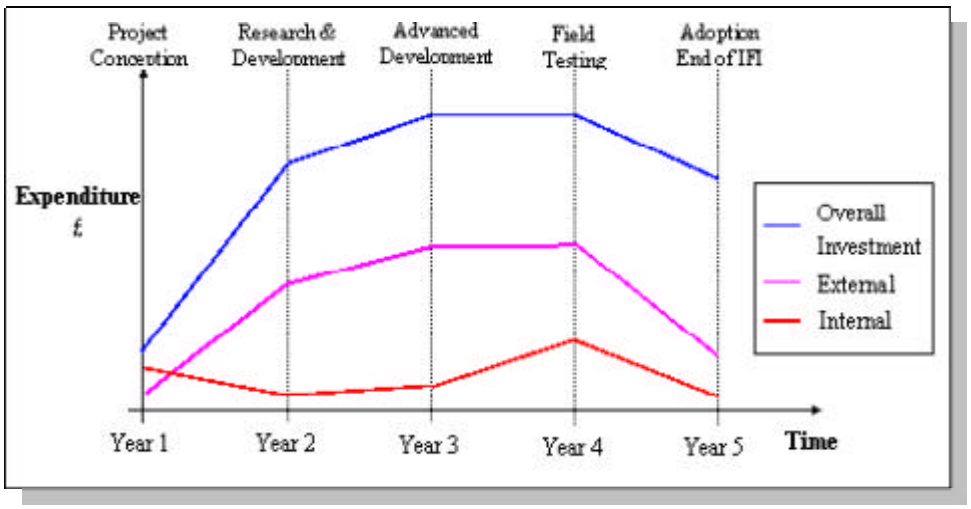


Figure A1: Example Expenditure Profile for an IFI Project

As the diagram shows, the internal expenditure is likely to be high in the first year due to the costs of initially scoping the projects, finding collaborate partners and identifying appropriate R&D providers. During this phase external expenditure will be at a minimum.

As Research and Development gets underway, the external expenditure will increase as milestones of development are signed off and payments are made to the R&D provider, during this phase internal expenditure will decrease and internal resources will be used mainly to steer progress.

In stages of advanced development, the projects probability of success will increase and external expenditure will hit its peak due to development work being accelerated. Internal expenditure is also likely to increase at this point as the outputs from development work will increase giving the project manager more tasks to co-ordinate as well as the responsibility of devising methods of utilising developments.

In the field trial stages, external expenditure shift from bench-top development to investment in contractors to install, conduct and monitor projects field trials. Even is contractors are employed for this role, internal expenditure is likely to be high, a result of the necessary training prior to installation.

When the project enters into the adoption phase, all expenditure will be ramped down. Business cases will be made for the integrating successful projects into the company.

Appendix B – Methodology for NPV calculations in IFI projects

Introduction

Engineering Recommendation G85 the innovation "Good Practice Guide" clearly states that the expected benefits for IFI projects must be defined at the outset of the project. For financial benefits the standard business approach is the Net Present Value (NPV) calculation, giving a quantitative representation of the financial benefits that the new technologies will bring verses the cost of the development.

As R&D is naturally higher risk than more traditional projects there are many factors, which need to be carefully considered at a projects outset. As a result, the standard NPV assessment approach must be altered to reflect this.

General Methodology

Risk can be factored into an NPV calculation in two ways, with both achieving similar results:

- Applying a variable discount rate
- Using a separate multiplying factor to reduce the benefits.

In line with guidance from Ofgem, our NPV calculations utilise a fixed 6.9% discount rate in line with the agreed cost of capital for the SP-Distribution and SP-Manweb licences in DPCR4. We therefore introduce risk as a separate factor, the Probability of Success to scale the benefits of each project, as described in the equation below.

$$NPV = \sum_{t=0}^{N} \frac{Ct}{(1+i)^t}$$

$$C_t = (Benefit - \text{Adoption Expenditure}) \times PoS - \text{Development Expenditure}$$

t	time (in years) that cash has been invested in the project
N	the total length of the project (in years)
i	the cost of capital and
C_t	the cash flow at that point in time
PoS	the probability of successful development

Aside:

Benefit	–	Cash benefits for at a point in time
Adoption expenditure	–	Adoption expenditure at a point in time
Development expenditure	–	Development expenditure at a point in time

The logic behind the way the NPV, and in particular, the C_t factor is calculated is as follows:

The cost of development will always be a direct cost, as the money will be spent if the project goes ahead – there is a PV associated with this figure.

Benefits in the development phase are scaled by the probability of success, the logic being that if benefits are possible in the development phase, these will only be realised if the development work is successful.

Both benefits and expenditure in the adoption phase are scaled by the probability of success of development; the logic behind this is that expenditure will only occur in the adoption phase if the development work is successful. Similarity the benefits in the adoption phase show the same dependence on successful development.

Phasing

It is noted that if the NPV is taken on solely the development phase of a project, many projects would not get off the ground. This is indicated in Figure B1, where, even by showing the development phase split into two: feasibility and pilot, the magnitude of roll-out in the pilot is generally too low to re-coup the original development costs (which can be high). Assumptions on this uptake therefore need to be identified into the adoption phase to ensure a credible result.

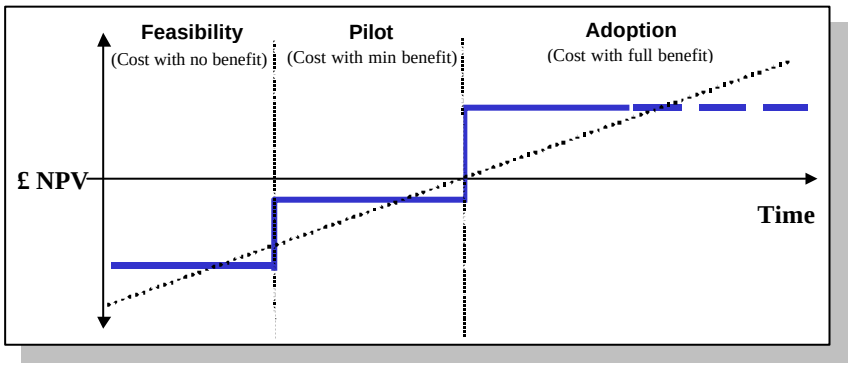


Figure B1: How a projects NPV changes over the course of its development.

Cost Assumptions

The costs of an IFI project for the purposes of the NPV calculation can be complicated to quantify, often relying on a number of assumptions. As a minimum, the following are considered:

Development Costs

- Cost to develop a product / service / etc
- Purchase of equipment (e.g. necessary equipment to commence the trial, e.g. units for trial)
- Internal cost to project manage and steer

- Cost of installation (equipment, manpower, etc)

Adoption Costs

- Anticipated product unit cost
- Anticipated installation cost
- Anticipated roll-out across network

Benefit Assumptions

Benefits too can come in a variety of manners. In some cases a direct financial saving between an existing solution and technology solution may be possible, but in others we must consider more complex mechanisms such as:

- the balance between capex reductions and increasing opex (for communications)
- the companies exposure to risk, be that Regulatory or Statutory (CI/CML, environmental or the impact on safety, etc)
- improved understanding and targeting of investment.

Duration of Benefit

The NPV for IFI projects considers projects beyond the traditional development phase and into adoption. In order to measure similar projects this has been simplified as:

- Current carrying Plant (e.g. cables, overhead lines, switchgear) – 20 year asset life
- Auxiliary Plant (e.g. protection equipment, comms, etc) – 10 year asset life
- Tools & Equipment (e.g. portable fault location equipment, etc) – 5 year asset life

Probability of Success (PoS)

The Probability of Success is applied as a scaling factor to all expected benefits during the development phase of a project, and can consequently, have a significant impact on the financial assessment.

In order to give a level of consistency to the application of PoS figures, we have linked our project Probabilities of Success to the concept of Technology Readiness Levels (TRLs). TRLs were first conceived by NASA and are much used in military R&D as a way of gauging a projects status and therefore risk by indicating how far a technology development may be from adoption.

Table B 1: Technology Readiness Level / Probability of Success Definition

TRL	Definition	SP-EN Assessment of Probability of Success
1	Basic principles observed and reported.	Not IFI Eligible
2	Technology concept and/or application formulated.	25%
3	Analytical and experimental critical function and/or characteristic proof of concept.	
4	Technology component and/or basic technology sub-system validation in laboratory environment.	50%
5	Technology component and/or basic sub-system validation in relevant environment.	
6	Technology system/subsystem model or prototype demonstration in a relevant environment.	75%
7	Technology system prototype demonstration in an operational environment.	
8	Actual technology system completed and qualified through test and demonstration.	Case Specific
9	Technology System "qualified" through successful mission operations.	Not IFI Eligible (business case stage)

Figure B2 show diagrammatically, the likelihood of obtaining benefits from a project to its stage of development and probability of success. It is noted that this assessment is a simplification, as it does not fully consider some of the non-linear steps, e.g. from TRL 6 – TRL 7, a commonly expensive transition, which can make/break a project.

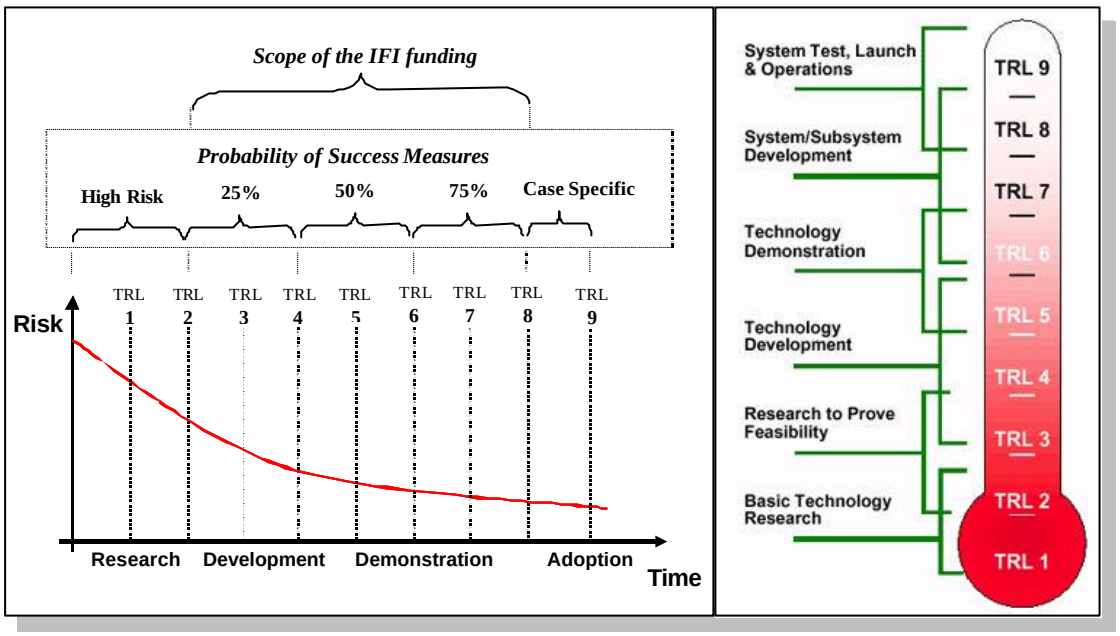


Figure B2: Relationship between Technology Readiness Level and Probability of Success

[Source (in part): NASA]

It is important to note that the TRL and PoS used in the NPV will be based solely upon assumptions at the outset of a project. As IFI is a mechanism to encourage technological developments, projects will naturally be driven up the TRL scale (with a rising PoS) as they progress to trial and demonstration (specific information in project TRLs is given in Appendix C). However, in the interests of efficiency, the NPV calculation will not be revisited during the development phase.

The PoS has a significant bearing on the NPV assessment, as projects with a low TRL will give rise much lower, and in some cases negative, NPVs if the development costs are high, and the roll out is conservative. We believe this to be in line with the true spirit of IFI, demonstrating that risk is being taken in areas where without such a recovery mechanism, these developments would have been seen as too risky for a Regulated business to undertake. By way of example, the AURA-NMS project starts from a low TRL, and hence low probability of success; for the case study we have identified this translates as a negative NPV.

TRL = 2 PoS = 25% NPV = (-£101,920)

However as the project progresses, the TRL would rise, as would the PoS.

TRL = 4 PoS = 50% NPV = £687,765
TRL = 6 PoS = 75% NPV = £1,477,450
TRL = 9 PoS = 100% NPV = £2,267,130

Successful development of this project would also open up the options to deploy such a system to more applications, further improving the scope for benefits.

Probability of Adoption (PoA)

In all cases for the NPV calculations, there is an assumption that once developed, the technology will be adopted. However, R&D is inherently speculative in nature and only a small fraction of projects developed will actually be adopted within an organisation, this being dependent on a range of factors such as:

- Scale / cost of Rollout
- Complexity
- Regulatory opportunities / barriers (Revenue / Penalties)
- Legislative barriers

All NPV assessments will be revisited and improved prior to adoption. Any lessons learnt will feedback into our NPV methodology outlined above.

Although a figure has not been applied to the NPV calculations, it is recognised that only 10%-20% of successfully developed projects are likely to be implemented.

Appendix C – Project Reports
IFI Projects: April 05 – March 06

Table C1: IFI 0401-1: STP Module 2 – Overhead Lines

<table>
<tr><td>Project Title</td><td colspan="3">Strategic Technology Programme (STP): Module 2 - Overhead Networks</td></tr>
<tr><td>Project Description</td><td colspan="3">This describes a collection of Overhead Line projects under development at EA Technology SP-EN has invested in these projects as part as a collective of DNOs</td></tr>
<tr><td>Expenditure for (IFI) financial year</td><td>Internal £4,610
External £36,000
Total £40,610</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £1,240
External £17,487
Total £18,727</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>c. £240k p.a.</td><td>Projected 06/07 costs for SP-EN</td><td>Internal c. £8k p.a.
External c. £37k p.a.
Total c. £45k p.a.</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The STP overhead network programme for budget year 2005/6 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:
S2120_2 - Improve detection of defective surge arresters in-situ with selection and evaluation of the most promising solutions.
S2126_2 - Undertake long-term monitoring of conductor temperature by obtaining and analysing 12 months trial data.
S2132 - Validate current and proposed new ice accretion models
S2133 - Investigate the use of sacrificial anodes for protecting tower foundations to defer or remove the need for full foundation refurbishment.
S2134_1 - Determine the susceptibility of currently used surge arresters to the principal modes of failure
S2135 - Evaluate the life expectancy of copper conductors.
S2136 - Participate in European Project COST 727: Measuring and forecasting atmospheric icing on structures.
S2138_1 - Investigate live-line jumper-cutting limitations Stage 2 is to define a realistic experimental programme.
S2139 - Begin to evaluate a new corona discharge camera system.
S2140 - Explore possible means of checking the foundations of newly installed poles</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>Yes</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Due to the age profile of system equipment 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 these projects are technically successful and the findings and recommendations from</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">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;
reduce lifetime costs by the appropriate use of alternative materials.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Range 1-7 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 2-10 years -dependent on project</td></tr>
<tr><td colspan="2">Probability of Success</td><td colspan="2">Range 5-20% - dependent on project</td></tr>
<tr><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£17,171
NPV developed by EATL on behalf of DNOs – not using SP methodology</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">All projects are currently on target.</td></tr>
</table>

Project Status **March 06**	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. • *S2120_2 - Improve detection of defective surge arresters with selection and evaluation of the most promising solutions.* Laboratory tests have determined the most effective techniques and these have been presented to members with recommendations for further action. • *S2126_2 - Undertake long-term monitoring of conductor temperature by obtaining and analysing 12 months trial data.* The trial is continuing with the expectation that the results will indicate it should be possible to re-rate (up-rate) some overhead line circuits in certain circumstances. • *S2132- Validate current ice accretion models.* The data currently being collected will be used to revise national overhead line design standards • *S2133- Investigate the use of sacrificial anodes for protecting tower foundations to defer or remove the need for full foundation refurbishment.* A practical reference document has been produced to assist in the application and specification of such devices • *S2134_1 - Determine the susceptibility of currently used surge arresters to the principal modes of failure.* The findings provide a review of the capabilities of a range of surge arresters, allowing informed and more cost effective specification of these devices. • *S2135- Life expectancy of copper conductors.* The results of initial laboratory testing of samples of varying age provided from UK distribution networks will be available shortly. They should allow an initial assessment of the overall condition of copper based conductors to be made. • *S2136- Measuring and forecasting atmospheric icing on structures.* This is part of a much larger European collaborative project aiming to provide more accurate mapping of ice prone areas. This in turn will allow the most appropriate structure to be constructed. • *S2138_1 - Investigate live-line jumper-cutting limitations.* Controlled testing regime has been specified and this should lead to improved working practices being adopted. • *S2139Begin to evaluate a new corona discharge camera system.* This project is at a very early stage. • *S2140 Explore possible means of checking the foundations of newly installed poles.* An initial review of worldwide practice and commercially available techniques has begun.
Collaborative Partners	Central Networks, United Utilities, Western Power Distribution, Scottish & Southern Energy, EDF Energy
R&D Providers	EA Technology Ltd

Table C2: IFI 0401-2: STP Module 3 – Cable Networks

<table>
<tr><td>Project Title</td><td colspan="3">Strategic Technology Programme (STP): Module 3 - Cable Networks</td></tr>
<tr><td>Project Description</td><td colspan="3">This describes a collection of Underground Cable projects under development at EA Technology. SP-EN has invested in these research projects as part as a collective of DNOs</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £4,897
External £63,500[2]
Total £70,092</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £2,680
External £17,487
Total £20,167</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>c. £280k p.a.</td><td>Projected 06/07 costs for SP-EN</td><td>Internal c. £8k p.a.
External c. £37k p.a.
Total c. £45k p.a.</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The STP cable network programme for budget year 2005/6 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 2005-06 (include some approved in previous years) aimed to:
S3100_2 – Define better functional requirements for link boxes.
S3108_2 – Produce software for assessing earthing practice on PME systems.
S3115 – Determine the corrosion resistance of aluminium foil cables.
S3120 – Assess novel flame retardant coatings for cables in basements.
S3121 – Produce a cable fluid sniffer Stage 1(b) Feasibility study.
S3123 – Produce a guide and specify functional requirements for the selection of cable ducts.
S3125 – Assess new degreasing products for MV and LV cables.
S3126 – Explore issues associated with the use of polyurethane and development of alternative jointing resins.
S3131 – Produce a summary of CIGRE issues relating to HV cables.
S3113_2 - Addition of duct bank modelling functionality within CRATER cable rating software.
S3113_3 - Addition of paper cable modelling within CRATER cable rating product.
S3132_1 - Addition of HV polymeric cable modelling functionality within CRATER cable rating software.
S3132_2 - Addition of LV cable modelling functionality within CRATER cable rating software.
S3132_3 - Addition of cyclic and emergency rating modelling functionality within CRATER cable rating software.
S3132_4 - Addition of limited time rating of mixed circuit modelling functionality within CRATER cable rating software.
S3132_5 - CRATER cable rating software, overview report.
S3132_6 - Addition of single core MV paper cable modeling functionality within CRATER cable rating software.
S3132_7 - Addition of cable crossing modelling functionality within CRATER cable</td></tr>
</table>

[2] Includes £27.5k as part of SP buy in for CRATER development package

<table>
<tr><td></td><td colspan="4">rating software.
• S3140_1 – produce a spreadsheet tool for pulling-in of cables into ducts.
• S3144_1 – Evaluate the Hydragel process for the treatment of redundant fluid filled cables.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>Yes</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO member of the programme to gain the following benefits, including:
• offset future increases in CAPEX and OPEX;
• savings of the order of 0.25 CML per connected customer;
• increased safety of staff and public by reducing the number of accidents / incidents.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Range 1-5 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 2-10 years -dependent on project</td></tr>
<tr><td colspan="2">Probability of Success</td><td colspan="3">Range 2-30% - dependent on project</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£17,171
NPV developed by EATL on behalf of DNOs – not using SP methodology</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The Scheme is on target to deliver expected benefits.</td></tr>
</table>

Project Progress **March 06**	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. • S3100_2 – Define better functional requirements for link boxes. A document that defines functional requirements for LV link boxes has been produced for member companies. Previously such a document did not exist. • S3108_2 – Software for earthing practice on PME systems. An assessment tool has been produced for earthing practice on PME systems which evaluates the compliance with regulations and practices, carries out a check of LV cable circuit design. • S3115 – Corrosion resistance of aluminium foil cables. Tests have shown that corrosion of the la minated aluminium foil sheath is likely if the outer sheath of the cable is damaged leading to moisture penetration to the cable core. • S3120 – Flame retardant coatings for cables in basements. Findings recommended the use of a system consisting of a water-based intumescent coating and an associated water resistant topcoat. This should give valuable long-term fire protection to PE cables in basements and substations. • S3121 - Cable fluid sniffer Stage 1(b) Feasibility study. Laboratory familiarisation has been carried out and field trials are being undertaken. • S3123 – Guide and functional requirements for the selection of cable ducts. A report giving some advice on the use of plastic ducts in heavily loaded circuits has been produced. • S3125 - Degreasing products for MV and LV cables. The project defined a suitable wet-wipe that will ensure satisfactory cleaning of LV, MV and HV cables without adversely affecting their performance. • S3131 – Summary of CIGRE issues relating to HV cables. An extensive report (140 pages) provides a comprehensive picture of work carried out by Cigré over the past 5 years, as well that currently underway and some that is planned. This places the work of the Module in an international context. • During 05/06 SP bought into the CRATER mo dule (having previously not been a part of the early stages of development). Further developments to this software undertaken during 05/06 include: o S3113_2 - Addition of duct bank modelling functionality o S3113_3 - Paper cable modelling functionality o S3132_1 - HV polymeric cable modelling functionality o S3132_2 - LV cable modelling functionality o S3132_3 - Cyclic and emergency rating modelling functionality o S3132_4 – Addition of limited time rating of mixed circuit modelling functionality o S3132_5 - CRATER cable rating software, overview report. The report, which is in preparation, will cover a range of practical applications for CRATER. The intention is that the report will form a handy reference to be used in conjunction with the basic operating manuals. o S3132_6 - Addition of single core MV paper cable modelling functionality o S3132_7 - Addition of cable crossing modelling functionality • S3140_1 – produce a spreadsheet tool for pulling-in of cables into ducts. Proprietary software is being evaluated for this project, which is at an early stage. • S3144_1 – Evaluate the Hydragel process for the treatment of redundant fluid filled cables. Information has been collected on the two available processes and further information is being gathered from members.
Collaborative Partners	Central Networks, CE Electric, United Utilities, Western Power Distribution, Scottish & Southern Energy, EDF Energy
R&D Provider	EA Technology Ltd

Table C3: IFI 0401-3: STP Module 4 – Substations

Project Title	STP Module 4 -Substations		
Description of project	This describes a collection of Substation projects under development at EA Technology. SP-EN is an invested in these research projects as part as a collective of DNOs		
Expenditure for financial year	Internal £4,327 External £36,000 Total **£401,327**	Expenditure in previous (IFI) financial years	Internal £2,680 External £17,487 Total **£20,167**
Project Value (Collaborative + external + SP-EN)	c. £280k p.a.	Projected 06/07 costs for SP-EN	Internal c. £8k p.a. External c. £37k p.a. Total c. **£45k p.a.**
Technological area and / or issue addressed by project	The programme of projects which were approved for funding from the STP substations module budget and were undertaken in 2005/06 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 (shown in bold below). The projects undertaken within the programme during 2005-06 (include some approved in previous years) aimed to: <u>In progress Projects</u> • S0499 - Extend the TASA tap-changer diagnostic Trial. • S4107_2 – Field test on a sample of switchgear. the headspace gas testing technique to indicate the condition of oil filled switchgear • S4180 – Develop an indicator to detect discharge activity in substations. • S4172 – Follow-up of S0455 paint preparation for tanks to determine the longer term performance of the technique. • S4173 – Enhance the Transformer thermal rating assessment system. • S4178 – Testing and management of substation standby batteries. • S4181 – Ongoing programme of transformer post mortems to provide better correlation between condition assessment tests, true condition and remaining life. • S4182 – Develop a better understanding of frequency response analysis of transformers. • S4186 – Study of PM cast resin VTs. • S4188_1 – Assess replacement insulator grease. • S4189_1 – Examine substation noise. • S4190_1 - Review of pad mounted substations. • S4193_1 - Develop a common approach to risk and reliability. <u>Completed Projects</u> • S0497 – Transformer post mortems to assist estimation of remaining life from non-invasive tests. • S4130_4 – Assess wipes for HV oil filled equipment. • S4149 - Assess the quality, performance and longevity of recent substation equipment. • S4155 - Investigate ester based insulating oils. • S4162 – Extend the range of non-intrusive PD for > 90kV switchgear. • S4164 – Feasibility study into on-line tapchanger monitoring.		

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

S4167 – Improve CBRM by use of better understanding of degradation processes.
S4172 – Scoping studies on transformer refurbishment, fault passage indicators, out of phase switching and fire legislation for substations.
S4174 - Compare a range of power system protection software.
S4175 – Assess circuit breaker cleaning techniques and materials.
S4176 – Compare available earth testing instruments.
S4179 - Explore in-situ testing of vacuum interrupters.
S4187_1 – Hold a risk modelling workshop.

</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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.

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>Expected Timescale to adoption</td><td colspan="2">2 years (average)</td><td>Duration of benefit once achieved</td><td>10 years (average)</td></tr>
<tr><td colspan="2">Probability of Success</td><td colspan="3">Success probability is expected to be 25% overall on the whole programme of projects.</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£17,171
NPV developed by EATL on behalf of DNOs – not using SP methodology</td></tr>
</table>

Potential for achieving expected benefits	All projects are currently on target.
Project Progress **March 06**	In progress Projects • S0499 - Extend the TASA tap-changer diagnostic Trial. The original trial had a low sample population and this work aims to increase the sample size. If earlier results are confirmed then the technique offers the potential for non-invasive condition assessment of tapchangers, with consequent improvements in network performance due to avoided failures and reduced OPEX from better targeted maintenance. • S4107_2 - Headspace gas testing of oil filled switchgear. Working closely with members, the project aims to collect headspace gas samples from units within the field and resolve any GCMS issues. If correlation is successful then the project offers the prospect of targeted maintenance and reduction of invasive inspections. • S4180 – Develop an indicator to detect discharge activity in substations. Results suggest the device in its present form cannot reliable detect/indicator discharge activity in many substation environments. This development will not be pursued within STP, but related trials of an electronic NO_x detector are being undertaken by the Discharge User Group. • *S4172 – Follow-up of S0455 Surface preparation of tanks.* The performance of the paint systems are being reviewed as a follow-up to earlier work. • *S4173 – Transformer thermal rating system.* This project is to re-develop the current Transformer Thermal Rating software to enable members to assess BSP Transformer safe loading limits. • *S4178 – Testing and management of substation standby batteries.* The project aims to assess the effectiveness of Battery Impedance testing methods to replace traditional discharge testing. • *S4181 – On-going programme of transformer post mortems.* Further work in this area to build on the good results obtained in an earlier project, where a good correlation between non-invasive tests and internal examinations had been shown • *S4182 – Understanding frequency response analysis.* Frequency Response Analysis is a potentially useful condition assessment technique that can be significant in identifying and defining end of life for grid and primary transformers. Initial tests have produced some good results. • *S4186 – Study of PM cast resin VTs.* Members are completing an issues questionnaire and testing regimes are being developed. • *S4188_1 – Assess replacement insulator grease.* The project is to compare the performance of Insojell Grease with its proposed replacement, Dow Corning 3099 HVIC by performing a number of pre-specified accelerated aging tests. • *S4189_1 – Examine substation noise.* The project is investigating and clarifying the issues surrounding substation noise and develop a common, agreed framework to enable members to assess noise issues and take appropriate actions. • *S4187_1 – Hold a risk modelling workshop.* A workshop for members and experts to discuss risk quantification was held.

Project Progress **March 06**	• *S4190_1 - Review of pad mounted substations.* The project will provide an overview of members experience and identify any issues that may be arising through changing legislation. • *S4193_1 - Develop a common approach to risk and reliability.* The objective of this initial stage of work is to quantify the information requirements and determine its availability. An outline of the approach to be adopted has been produced and is currently being refined. Completed Projects • *S0497 – Transformer post mortems to assist estimation of remaining life from non-invasive tests.* A good correlation between non-invasive tests and internal examinations has been shown. This will assist in interpreting on-going non-invasive testing of other transformers. • *S4130_4 – Assess wipes for HV oil filled equipment.* Final development and testing of a new 3rd party high performance wipe, which was specially developed to the specification, which was developed in early stages of the project, was undertaken. This is now a product available for members • *S4149 - Assess the quality, performance and longevity of recent substation equipment.* An analysis of failure rates and reliability of modern substation equipment was undertaken and has highlighted a number of issues which warrant further investigation. • *S4155 - Investigate ester based insulating oils.* The project concluded that both natural and synthetic ester oils offer advantages over mineral oil in terms of biodegradability and electrical performance although oxidation stability and viscosity are poor. • *S4162 – Extend the range of non-intrusive PD for use on > 90kV switchgear.* The work identified the population of equipment suitable for PD testing, concluding that some types would benefit from such testing. • *S4164 – Feasibility study into on-line tap-changer monitoring.* The project concluded that it is possible to consistently characterise the operation of such devices using acoustic emissions techniques. • *S4167 – Improve CBRM by use of better understanding of degradation processes.* Mathematical models of asset ageing have been refined and calibrated in order to improve the accuracy of CBRM results. • *S4172 – Scoping studies on transformer refurbishment, fault passage indicators, out of phase switching and fire legislation for substations.* A series of short projects that allowed specific issues to be examined before deciding if a larger project in that area is appropriate. • *S4174 - Compare a range of power system protection software.* The available power system protection software was ranked in terms of its functionality, cost and ease of use. This will be used to assist members in making informed decisions. • *S4175 – Assess circuit breaker cleaning techniques and materials.* This project assessed different techniques and materials for cleaning circuit breaker contacts. A number of materials have been recommended together with a working practice. • *S4176 – Compare available earth testing instruments.* The project examined the operation of a number of simple clamp-on instruments and compared their effectiveness. The results showed that several instruments were quite inaccurate and could give misleading results. • *S4179 - Explore testing of vacuum interrupters.* The project investigated current and alternative methods of testing vacuum interrupters. It concluded that routine loss of vacuum testing would provide little benefit. It would be more appropriate to determine "at risk" interrupters and inspect these more frequently.
Collaborative Partners	Central Networks, CE Electric, United Utilities, Western Power Distribution, Scottish & Southern Energy, EDF Energy
R&D Provider	EA Technology Ltd

Table C4: IFI 0401-4: STP Module 5 – Distributed Generation

Project Title	Strategic Technology Programme (STP): Module 5 - Distributed Generation		
Description of project	This describes a collection of Distributed Generation projects under development at EA Technology. SP-EN is an invested in these research projects as part as a collective of DNOs		
Expenditure for financial year	Internal £4,985 External £36,000 Total **£43,361**	Expenditure in previous (IFI) financial years	Internal £2,980 External £17,487 Total **£20,827**
Project Value (Collaborative + external + SP-EN)	c. £240k p.a.	Projected 06/07 costs for SP-EN	Internal c. £8k p.a. External c. £37k p.a. Total c. **£45k p.a.**
Technological area and / or issue addressed by project	The projects undertaken through budget year 2005/6 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. Fourteen new project stages were approved during the year (shown in bold below). The projects undertaken within the programme during 2005-06 (include some approved in previous years) aimed to: <u>Projects in Progress</u> • S5138 – Review of Industry Codes • S5147_3 – Monitor Microgenerator Clusters • S5149_4 – Explore Active Voltage Control • S5150_2 – Review G59/1 and G75 Protection and identify improvements • S5151_3 – Model Network Risk • S5142 – Define Generator Data and Structure for DG Connection Applications • S5154_1 – Develop a Voltage Control Policy Assessment Tool on the IPSA Platform • S5155_1 – Explore Lower Cost Connection Solutions for Distributed Generation • S5157_1 – Evaluate the Performance of Small Scale Reactive Power Compensators <u>Completed Project Stages</u> • S5144 – Workshop on Regulatory and Economic Issues • S5145 – Dynamic Circuit Ratings • S5147_1 - Microgeneration Clusters • S5149_1 - Active Voltage Control • S5150 Stage 1 – G59 and G75 Protection • S5151_1– Network Risk Modelling • S5133 – Tapchangers Reverse Power Capabilities • S5143 – Produce a Draft Code of Practice on Stability • S5149 Stages 2 & 3 - Active Voltage Control • S5151 Stage 2 – Network Risk Modelling • S5152_1 – Examine the Latest Developments in the Connection of Distributed Generation		

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">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 (eaVCAT interface to IPSA software tool);
• 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 colspan="2">2 years (average)</td><td>Duration of benefit once achieved</td><td>10 years (average)</td></tr>
<tr><td colspan="2">Probability of Success</td><td colspan="3">Success probability is expected to be 25% overall on the whole programme of projects.</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="2">£17,171
NPV developed by EATL on behalf of DNOs – not using SP methodology</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">All projects are currently on target.</td></tr>
</table>

Project Status **March 06**	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. • *S5147_3 – Microgenerator Clusters.* Installation of monitoring points is currently underway and a new substation is being commissioned. Monitoring will commence upon completion of installation and commissioning. • *S5149_4 – Explore Active Voltage Control.* Modelling of typical radial and interconnected networks in preparation for flexing key parameters to examine limits of active voltage control. • *S5150_2 – G59/1 and G75 Protection.* An initial review is complete and further work is pending results from allied university project. • *S5151_3 – Model Network Risk.* Following establishment of user requirements and review of available risk models and approaches is being undertaken. • *S5142 – Define generator Data and Structure for DG Connection Applications.* The generator data has been identified and a data structure agreed. Rationalisation of this data should now be considered. • *S5150 Stage 1 – G59 and G75 Protection.* The Project Initiation Document has been prepared and approved. • *S5151_1– Model Network Risk.* The Project Initiation Document has been prepared and approved. • *S5133 – Tapchangers Reverse Power Capabilities.* It was concluded that under certain conditions there is an increased probability of internal flashover for single compartment tap-changers with single transition resistors. Steps should be taken to increase the maintenance frequency or de-rate the tap-changer to negate these affects. • *S5143 – Draft Code of Practice on Stability.* The draft code of practice can be used to develop policy within each member company. It will facilitate the connection of distributed generation by providing a guideline on stability issues. • *S5149 Stages 2 & 3 - Active Voltage Control.* An overview of current control practices and how distributed generation impacts on them has been produced and a workshop held to explore the specific issues. This provides a firm basis for in depth studies of how active voltage control can be implemented and its advantages and disadvantages in different situations. • *S5151 Stage 2 – Model Network Risk.* The user requirements of a network risk model have been defined, documented and agreed and will be used to direct subsequent stages of the project. • *S5152 – Latest Developments in the Connection of Distributed Generation.* Regular updates on new developments have been provided to members to help inform and influence the research programme.
Collaborative Partners	Central Networks, CE Electric, United Utilities, Scottish & Southern Energy, EDF Energy
R&D provider	EA Technology Ltd

Table C5: IFI 0402: Single Phase LV Voltage Regulators

<table>
<tr><td>Project Title</td><td colspan="5">Single Phase LV Regulator</td></tr>
<tr><td>Description of project</td><td colspan="5">Development of a single-phase power electronic LV voltage regulator, for connection into a LV line to provide fast response voltage compensation for both over and under-voltages effectively managing / mitigating LV voltage complaints</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £8,105
External £15,278
Total £23,383</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £2,990
External £0
Total £2,990</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£214,440</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £17,500
External £123,500
Total £141,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">It is envisaged that this device will primarily used as a means of rapidly resolving voltage complaints in rural areas.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>No</td><td>Yes</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">The device may be capable of resolving both temporary and permanent voltage complaints dependent on the type of complaint and the economics of the situation.

Where there is a clear case for network reinforcement, which would require time to engineer the most cost effective solution, the voltage regulator could be used to resolve the complaint whilst a reinforcement scheme is designed, way-leaves negotiated and construction undertaken.

Where the voltage complaint is due to disturbing loads or unidentified causes it could provide a permanent solution due to the fast response of the device to voltage dips and sags.

There may be an eventual case where LV voltage regulators are used to maintain statutory voltages, to compensate for a less static voltage on the 11kV networks due to an increased penetration of distributed generation.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td colspan="3">TRL Development (Start– Current)
1 2 3 4 5 6 7 8 9
  </td></tr>
<tr><td colspan="3">Project NPV (Present Benefits – Present Costs) x Probability of Success</td><td colspan="3">£64,723</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">The project is currently on target</td></tr>
</table>

Project Progress **March 06**	• Specification produced and tendered • Design modifications agreed • Type testing requirements identified and currently in progress • Further modification approved to enable product to meet specification • Delivery expected mid June with field testing commence Sept 06 (to last 12mths)
Collaborative Partners	United Utilities (for trial phase)
R&D Provider	MicroPlanet USA

Table C6: IFI 0403: Reference Networks Phase 2

Project Title	Reference Networks - Phase 2		
Description of project	The project will produce a practical software tool to create optimum disaggregation groups and analyse existing networks and proposed performance improvement strategies.		
Expenditure for financial year	Internal £3,914 External £60,000 Total **£63,914**	Expenditure in previous (IFI) financial years	Internal £2,700 External £0 Total **£2,700**
Project Value (Collaborative + external + SP-EN)	£341,200	Projected 06/07 costs for SP-EN	Internal £2,400 External £5,000 Total **£7,400**
Technological area and / or issue addressed by project	A framework is being developed that will enable network performances to be objectively compared, the differences to be understood and explained, and cost and benefits of alternative distribution network investment strategies to be evaluated.		

Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	No	No	No

Expected Benefits of Project	Ensuring that capital expenditure on improving the performance of the network will be optimised in respect of applying the expenditure to circuits where the greatest benefit can be obtained. The financial benefits of greater understanding of network performance drivers, and improved regulation are difficult to quantify but have the potential to be extremely large.		
Expected Timescale to adoption	2 years	Duration of benefit once achieved	5 years
Probability of Success	50%	TRL Development (Start – Current)	

1	2	3	4	5	6	7	8	9
			✦	✦				

Project NPV (Present Benefits – Present Costs) x Probability of Success	£61,650

Potential for achieving expected benefits	The project remains on-track to achieve the expected deliverables.
Project Status **March 06**	Good progress is being made in ensuring that the reference networks derived by the developing software are truly representative of the real networks from which they are derived. The next stage of work will to run real network data from each collaborative company through the developed models to assess impact.
Collaborative Partners	United Utilities, Central Networks, PB Power
R&D Providers	Imperial College London

Table C7: IFI 0404: Alternative Insulating Oils

<table>
<tr><td>Project Title</td><td colspan="9">Alternative Insulating Oils Project</td></tr>
<tr><td>Description of project</td><td colspan="9">Applied research programme consisting of a series of investigations designed to make a thorough evaluation of the electrical/ageing properties of alternative oils for use in both aged power transformers and new plant.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="3">Internal £1,610
External £0
Total £1,770</td><td>Expenditure in previous (IFI) financial years</td><td colspan="4">Internal £1,040
External £0
Total £1,040</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="3">£142,290</td><td>Projected 06/07 costs for SP-EN</td><td colspan="4">Internal £1,400
External £17,800
Total £19,200</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="9">Evaluation of the Characteristics of Alternative Oils is being undertaken to access the relative merits for Retro-Filling Power Transformers and filling New Transformers with alternative oils have over using standard mineral oils.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td colspan="2">Significant</td><td colspan="2">Technological substitution</td><td colspan="4">Radical</td></tr>
<tr><td>No</td><td colspan="2">No</td><td colspan="2">Yes</td><td colspan="4">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="9">• Reduced environmental risk associated with oil spills.
• Potential to up-rate transformers at strategic sites.
• Opportunity to improve Energy Networks credibility with SEPA and other governing bodies.
• Opportunity to improve Energy Networks reputation with regards to environmental awareness.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="3">5 years</td><td>Duration of benefit once achieved</td><td colspan="4">20 years</td></tr>
<tr><td rowspan="2">Probability of Success</td><td rowspan="2">50%</td><td colspan="8">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td colspan="4">Project NPV: (Present Benefits x Probability of Success) – Present Costs</td><td colspan="6">£967,716</td></tr>
</table>

Potential for achieving expected benefits	The project has been delayed by 3 months due to commercial reasons.
Project Progress **March 06**	• Comparison of dielectric properties under accelerated ageing and varying temperatures, between ester based oils and mineral oil completed. • Comparison of dielectric properties, under different relative humidities, between ester based oils and mineral oil completed. • DGA analysis and comparison between ester based and mineral oils completed. • Oil impregnated paper breakdown tests carried out and comparisons made between ester based and mineral oils. • Preliminary computer modelling studies underway.
Collaborative Partners	United Utilities, Central Networks
R&D Provider	University of Manchester

Table C8: IFI 0405: Alternative Design for 132kV Overhead Lines

<table>
<tr><td>Project Title</td><td colspan="3">Alternative Design for 132kV Overhead Lines</td></tr>
<tr><td>Description of project</td><td colspan="3">The design of a new heavy Trident 132kV wood pole overhead line specification, incorporating an underslung OPGW earth-wire for counteracting the rise of earth potential issues and for communications purposes.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £15,873
External £2,387
Total £18,260</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £33,236
External £77,084
Total £110,320</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>£966,321</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £192,344
External £16,525
Total £208,869</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">This is a project initiated to combat issues raised for the connection of renewable generation in Wales (SP-Manweb network).

Following the development of a specification, this project aims to construct a trial section of the line to identify associated construction or maintenance difficulties.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">There are multiple benefits to this project, including:
• Safety: Lower Rise of Earth Potential at substations through the addition of an earth-wire
• Environmental: A higher rated single circuit line may prevent the construction of multiple overhead lines for a given network connection – there is also a significant cost benefit to customers / customer connections associated with this.
• Provision of communications: May permit the use of active network management into rural areas with previously poor communications (again cost benefits).</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 years</td><td>Duration of benefit once achieved</td><td>20 years</td></tr>
</table>

Probability of Success	50%	TRL Development (Start – Current)								
		1	2	3	4	5	6	7	8	9
										
Project NPV (Present Benefits x Probability of Success) – Present Costs		£92,425								
Potential for achieving expected benefits		Project is currently on target to deliver expected benefits.								
Project Progress **March 06**		• Specification complete and approved • There is currently a tender out for trial build of 7 – 8 spans of overhead line • Forestry commission land identified as testing site • Trial build expected summer 2006 followed by a 6mth trial								
Collaborative Partners		N/A								
R&D Provider		LSTC and construction contractor TBA								

Table C9: IFI 0406: Overhead Line Fault Passage Indicators

Project Title	Overhead Line Fault Passage Indicators		
Description of project	This project seeks to pilot 2 variants of programmable fault passage indicators to measure and record transient and permanent system faults on both the 33kV and 11kV overhead networks.		
Expenditure for financial year	Internal £1,043 External £0 Total **£1,043**	Expenditure in previous (IFI) financial years	Internal £12,224 External £0 Total **£12,224**
Project Value (Collaborative + external + SP-EN)	£329,794	Projected 06/07 costs for SP-EN	Internal £6,550 External £44,323 Total **£50,873**
Technological area and / or issue addressed by project	Implementing a reliable fault passage indicator with wireless communications for use on 33kV and 11kV overhead network will aid the location and isolation of faults.		

Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	No	No	No

Expected Benefits of Project	More efficient use of operational staff searching for a fault due to the indicators giving a more targeted area of network to search resulting in reduced travel, an improved reaction time and faster restoration of supply to customers following a loss of supply. This innovation should improve CML figures ands significant potential to reduce penalty costs. Reduced damage to land through unnecessary access. This also has customer service benefits, with a potential improved perception from landowners.

Expected Timescale to adoption	9 Months	Duration of benefit once achieved	10 years
Probability of Success	50%	TRL Development (Start – Current)	

1	2	3	4	5	6	7	8	9
				✦	✦			

Project NPV (Present Benefits x Probability of Success) – Present Costs	£589,499

Potential for achieving expected benefits	• Phase 1 of the project has been completed. • Phase 2 of the project has been delayed by 3 months due to limited resources available to carry out work.
Project Progress **March 06**	• Trial with local communications on 33 kV line successful with conductor mounted unit. • Trial with local communications on 11 kV line successful with pole mounted unit. • Phase 2 communications to centralised location development approved.
Collaborative Partners	No formal collaboration, though informal knowledge sharing with United Utilities for SP project IFI 0516 (see later)
R&D Provider	CHK GridSense Pty

Table C10: IFI 0407: Kelman Circuit Breaker Intelligence

<table>
<tr><td>Project Title</td><td colspan="5">Kelman Circuit Breaker Intelligence Analysis</td></tr>
<tr><td>Description of project</td><td colspan="5">Development of hardware/software “expert system tool” that provides an assessment a circuit breakers’ tripping chara cteristics.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £6,036
External £112,544
Total £119,623</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £7,505
External £37,471
Total £44,976</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£413,582</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">This system tool is being developed with a view to reduce supply interruptions by highlighting problems with the electrical and mechanical mechanisms associated with 11kV and 33kV circuit breakers.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Expected improvement in network performance associated with stuck circuit breakers of around 12.5% in the first year following implementation.

Project will enable business to move towards condition-based maintenance by providing measure of circuit breaker mechanism condition.

Project should produce a quality stamp establishing circuit breaker condition after maintenance helping reduce CI /and CML.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Adopted</td><td>Duration of benefit once achieved</td><td colspan="2">5 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">75%</td><td colspan="3">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£-11,104
Figure is negative for conservative roll-out and application of risk in calculation</td></tr>
</table>

Potential for achieving expected benefits	Project Development has been completed successfully
Project Progress **March 06**	• Circuit breaker data collected from the network • Expert software tool created to recognise circuit breaker tripping / closing characteristics and identity problems ready for adoption onto tablet workstations and rollout in the business • Single Server database of equipment information ready to be integrated into SP-EN IT systems • Analysis server developed with two way communication to and from the tablet applications
Collaborative Partners	N/A
R&D Providers	Strathclyde University / ITBS / SAIC

Table C11: IFI 0408: Minimum Switchgear Project

<table>
<tr><td>Project Title</td><td colspan="5">‘Minimum’ Switchgear Project</td></tr>
<tr><td>Description of project</td><td colspan="5">This project seeks to investigate, design and specify an alternative switchgear / protection arrangement to the 11kV ‘unit’ protected substations in the urban areas of the SP-Manweb network</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £6,411
External £0
Total £6,411</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £5,010
External £0
Total £5,010</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£35,070</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £2,500
External £0
Total £2,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The proportionally higher costs associated with creating and maintaining a unit protected interconnected network at 11kV are under increased scrutiny when benchmarked against conventional radial systems. This project aims find an alternative with similar performance at lower cost with the view of reducing capital expenditure</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">This project has the potential to reduce the cost of each 11kV substation, thereby gaining efficiencies to target network spend more appropriately.

If a design were found that would significantly reduce the cost of this network design, it has the potential of being rolled out into previously radialised networks to give the CI / CML benefits and equipment utilisation associated with interconnected networks.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2.5 years</td><td>Duration of benefit once achieved</td><td colspan="2">10 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td colspan="3">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
  </td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£78,966</td></tr>
</table>

Potential for achieving expected benefits	Project has been delayed by 6 months due to both technical and resource reasons.
Project Progress **March 06**	• A number of early meetings were held with key internal stakeholders, to discuss potential design changes • Commercial and Technical options on how to reduce costs identified • Solkor panel value engineering exercise with current vendor resulted in unsatisfactory cost-benefit solution • Technical specification under development for Solkor panel tender
Collaborative Partners	N/A
R&D Providers	TBC Phase 2

Table C 12: IFI 0409: LV Fault Location Devices

<table>
<tr><td>Project Title</td><td colspan="5">LV Fault Location</td></tr>
<tr><td>Description of project</td><td colspan="5">A device is being developed for use on the Low Voltage networks to capture transient fault information and correlate to an associated fault location.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £7,835
External £0
Total £7,835</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £5,000
External £7,638
Total £12,638</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£184,800</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £7,100
External £75,000
Total £83,100</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The device is being developed preliminary for fault location on persistent LV faults.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td colspan="2">Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td colspan="2">No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Preliminary use of the device for fault location on persistent LV faults is expected to:
Reduce the number of repeated fuse replacements
Minimise the number of joint holes
Remove the fault from the system in a shorter timescale than traditional ‘cut-and-test’ methods</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</td><td>Duration of benefit once achieved</td><td colspan="2">Typically 8-10 years depending on technology development</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td colspan="3">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9
★——★</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£2,119,996</td></tr>
</table>

Potential for achieving expected benefits	Phase 1 successfully completed and has been taken outside development into adoption (30+ units purchased by business). Phase 2 underway to automate remote polling of devices. Project is currently on target to deliver expected benefits.
Project Progress **March 06**	• Proved that the technology works • System still requires some development on the software. • Some work required getting round the problem of getting communications when the locator is in a metal pillar. • Development of reliable auto-poling defined as urgent requirement for central system to be operated from a control room, • Individual units do not require further development.
Collaborative Partners	Phase 1: N/A; Phase 2 (expected): EDF -Energy; United Utilities
R&D Providers	Kehui (UK) Ltd

Table C13: IFI 0501: IED Radio

<table>
<tr><td>Project Title</td><td colspan="6">IED Radio</td></tr>
<tr><td>Description of project</td><td colspan="6">This project aims to develop a new type of radio that links directly into the pole-mounted switchgear and enables its own system to behave as though it were an RTU.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £3,765
External £3,787
Total £7,552</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£23,389</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £0
External £11,837
Total £11,837</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">The new generation of Pole Mounted Auto-reclosers (Noja), and Pole Mounted Gas switch (Novexia Auguste) equipment includes a facility that allows it to be communicated to via a computer link, in addition to hard-wired control and indications that are interfaced to an RTU, which then communicates by radio to the NMC via the Primary substation based equipment. To utilise the now available functionality, this project aims to develop a new type of radio that links directly into the pole mounted switchgear and enables its own system to behave as though it were an RTU.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">The development of the IED radio will ultimately reduce the cost per installation of network controllable points. Reducing the cost of network controllable points will make it more feasible to install them in more locations of the network effectively reducing CI and CML penalties</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">75%</td><td colspan="4">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9
  </td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£971,511</td></tr>
</table>

Potential for achieving expected benefits	The project is on target to achieve expected benefits
Project Progress **March 06**	• Product developed, factory accepted • Integration into system due to occur in 2006/07
Collaborative Partners	N/A
R&D Providers	Radius

Table C14: IFI 0502: Fault Level Monitor Project

<table>
<tr><td>Project Title</td><td colspan="5">Fault Level Monitor Project</td></tr>
<tr><td>Description of project</td><td colspan="5">An ENA co-ordinated project the objective of which is the development of an instrument that can successfully measure fault level on a distribution network with repeatability and reliability.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £1,043
External £0
Total £1,043</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£190,000</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £2,500
External £8,000
Total £10,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The device will connect to the network, and assess the network source impedance from small-scale disturbances resulting from transformer tap changer operation, etc. This impedance can accurately be correlated to a true network fault level for that location, providing near real-time information to network control and planning engineers alike.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">The developed unit will allow the DNOs to accurately assess fault infeed levels and design distribution networks appropriately
• it will facilitate the connection of distributed generation by providing a standardised and accurate method of assessing network fault levels.
• it will enable an ongoing assessment of the effects of distributed generation to be made;
• it should help to satisfy generator developers that decisions to upgrade networks are not subjective but based on objective measurement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 years</td><td>Duration of benefit once achieved</td><td colspan="2">10 years</td></tr>
<tr><td rowspan="2">Probability of Success</td><td rowspan="2">25%</td><td colspan="4">TRL Development (Start – Current)</td></tr>
<tr><td colspan="4">1 2 3 4 5 6 7 8 9
✦</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£92,045
NPV for ENA projects calculated on a per Licence basis (as shown in Table A4)</td></tr>
</table>

Potential for achieving expected benefits	Project is currently on target to deliver expected benefits.
Project Progress **March 06**	• University of Strathclyde commenced work on algorithm for calculation of fault levels
Collaborative Partners	ENA Member companies
R&D Providers	University of Strathclyde, EA Technology

Table C15: IFI 0503: L36 33kV Overhead Line Spec inc. OPPC

Project Title	L36 33kV Overhead Line Spec incorporating OPPC		
Description of project	Development of trial section of 33kV overhead line (L36) incorporating Optical Path Phase Conductor (OPPC) optical fibres for circuit communications.		
Expenditure for financial year	Internal £1,043 External £0 Total **£1,043**	Expenditure in previous (IFI) financial years	Internal N/A External N/A Total N/A
Project Value (Collaborative + external + SP-EN)	£50,000	Projected 06/07 costs for SP-EN	Internal £10,300 External £35,000 Total **£45,300**
Technological area and / or issue addressed by project	A number of recent generation connections have led to a necessity to use circuits with a connection capacity over and above the existing 33kV ratings of c. 20MVA. Within the design the opportunity has been taken to introduce Optical Fibres into the phase conductors of the new specification as a robust / economic means of communication. Folllowing the development of a specification, this project aims to construct a trial section of the line to identify associated construction or maintenance difficulties. This installation will also be used as a training facility to investigate potential O+M difficulties associated with fibre optics in phase conductors.		

Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	No	Yes	No

Expected Benefits of Project	• Safety: Potential avoidance of unnecessary construction work associated with traditional methods of providing communications and hence reduction in the number of accidents. • Financial: Without this specification an existing connection above 20MVA would require either the provision of two 33kV circuits or a 132kV connection. Communications are an additional requirement that are becoming increasingly important, this installation has the potential to reduce O+M costs associated with third party • Quality of Supply: The L36 design is compliant with BS EN 50341:2001. This factors in some degree of failure containment, giving the ability to perform in a severe weather environment and ensure a more reliable means of connection. • Environmental: Potential reduction in the need for cable track excavations consequently limiting the impact of the connection works on the environment.

<table>
<tr><td>Expected Timescale to adoption</td><td>1 year</td><td>Duration of benefit once achieved</td><td>40 years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">50%</td><td colspan="2">TRL Development (Start – Current)</td></tr>
<tr><td colspan="2">1 2 3 4 5 6 7 8 9</td></tr>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">£1,616,875</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">Project has been put on hold by 2 months pending commercial agreements. Due to trial during 06/07.</td></tr>
<tr><td>Project Progress March 06</td><td colspan="3">• Specification complete
• Project currently awaiting tender to build trial line at SP training centre, Cumbernauld</td></tr>
<tr><td>Collaborative Partners</td><td colspan="3">N/A</td></tr>
<tr><td>R&D Providers</td><td colspan="3">Design Phase: Lumpi Conductors (Austria)</td></tr>
</table>

Table C16: IFI 0504: Fault Infeed Calculations

<table>
<tr><td>Project Title</td><td colspan="6">Fault Infeed Calculations</td></tr>
<tr><td>Description of project</td><td colspan="6">A part funded project through the DTI Technology Programme this aims to improve the quality of fault current calculations in commercial loadflow software packages.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £1,043
External £0
Total £1,043</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£116,500</td><td colspan="2">Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £2,500
External £2,500
Total £5,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">The methods for calculating fault current contribution in commercial loadflow packages, vary from vendor to vendor. This project aims to assess the currently available solutions to assess best practice and define new algorithms to improve the quality of output.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>Yes</td><td>No</td><td colspan="2">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">Fault current can have a significant bearing on reinforcement spend. As switchgear does not have an overload capability for fault level, when exceeded (either through load growth, motor infeed or generation connections), investment is required to replace for higher rated units.

Improved understanding at design stage would ensure investment is targeted at optimum times, and on the most appropriate circuits. It is noted, that new methodologies could increase the levels of investment in a given network, however this would give rise to safety and equipment longevity improvements in the long term.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 years</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">10 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td colspan="5">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
  </td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">-£12,603
The NPV of this project is negative, as it is not expected to deliver any financial benefits. The project aims to help the business to target spend to ensure we have a safe and secure distribution system.</td></tr>
</table>

Potential for achieving expected benefits	Project is currently on target to deliver expected benefits.
Project Progress **March 06**	• Project successfully accepted at outline and full application stages on DTI technology program • Project recently commenced • Network data is currently being collected for analysis
Collaborative Partners	United Utilities, Central Networks, DTI (via Technology Programme)
R&D Providers	TNEI Ltd

Table C17: IFI 0505 Supergen V Amperes

<table>
<tr><td>Project Title</td><td colspan="3">Supergen V</td></tr>
<tr><td>Description of project</td><td colspan="3">Supergen is an EPSRC strategic partnership programme incorporating a collection of projects across a number of UK academic establishments. This fifth call, Supergen V is entitled Asset Management & Performance of Energy Systems (AMPerES).</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1,610
External £0
Total £1,610</td><td>Expenditure in previous (IFI) financial years</td><td>Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>£3,140,000</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £7,000
External £0
Total £7,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">SUPERGEN V proposal is aimed at:
Improving knowledge of plant ageing
Developing condition monitoring techniques
Developing plant with reduced environmental impact
Developing new protection and control techniques
Enhanced network performance and planning tools</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Creation of intelligent diagnostic tools for plant and integrated network planning / asset management

Reduction in the environmental impact of plant</td></tr>
<tr><td>Expected Timescale to adoption</td><td>10 Years</td><td>Duration of benefit once achieved</td><td>20 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">TRL Development (Start – Current)<table><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td></td><td>  </td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">A NPV calculation has not yet been carried out. NPV calculations will be undertaken when the scope of projects that are of interest are finalised. This will be done prior to the first payment milestone</td></tr>
</table>

Potential for achieving expected benefits	Projects are in the early stages of commencement at the universities.
Project Progress **March 06**	• Project received funding from EPSRC (Dec 05) • Project list circulated amongst ENA member companies to ensure industrial linkage to all projects • Steering group established • Commercial terms and conditions currently in negotiation • Project commenced March 06
Collaborative Partners	National Grid, United Utilities, Scottish & Southern Energy, EDF-Energy, Western Power Distribution, Central Networks, CE Electric UK, Northern Ireland Electric, EPSRC
R&D Providers	EPSRC selected universities – Manchester, Strathclyde, Liverpool, Southampton, Edinburgh, Queens University Belfast

Table C18: IFI 0506: Portable Smart Link (ASL)tester

<table>
<tr><td>Project Title</td><td colspan="3">Portable Automatic Sectionalising Link (ASL) tester</td></tr>
<tr><td>Description of project</td><td colspan="3">The development of a portable ASL (‘smart’ link) tester for use in the field to confirm performance prior to installation.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1,727
External £7,000
Total £8,727</td><td>Expenditure in previous (IFI) financial years</td><td>Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>£8,500</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £5,200
Extemal £7,000
Total £12,200</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">Auto-Sectionalising Links (ASLs) are extensively used on SP’s overhead line networks in conjunction with pole mounted auto-reclosing circuit breaker to minimise the numbers of Customer Interruptions following a network fault.

SP has experienced some problems with mal-operations of an earlier vintage of units. The ASL testers that can be distributed to maintenance and fault operations overhead line staff that will allow them to test ASLs in the field allowing healthy units to be reused immediately on the network.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Testing of ASLs in the field should enable healthy ASLs to be reused immediately on the network following operation, this should save money and operational time.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td>Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9</td></tr>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">£63,970</td></tr>
</table>

Potential for achieving expected benefits	The project has been delayed for 3 months due to technical difficulties. These have been overcome and the project is on target to deliver in 06/07.
Project Progress **March 06**	• Prototype built, general functionality accepted by SP, however sine wave was not accurate enough at the extreme ends of specified range. • Project redesigned following bench testing • Design currently being developed into commercial product • Final units expected July 06
Collaborative Partners	Nortech, Cooper Bussmann, Access Hire Services LTD
R&D Providers	Nortech

Table C19: IFI 0507: Smart Dust

<table>
<tr><td>Project Title</td><td colspan="5">Smart Dust</td></tr>
<tr><td>Description of project</td><td colspan="5">This project will involve testing the capabilities of SmartDust Motes and assessing the Project applications of sensor networks in Distribution business.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £4,182
Extemal £2,231
Total £6,413</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£312,400</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £1,700
External £46,000
Total £47,700</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The feasibility of the use of motes for as a medium for fault passage indication is being investigated in this project, the aim being increasing the efficiency of fault finding on the 11KV overhead network ultimately reducing CML penalties</td></tr>
<tr><td rowspan="3">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td colspan="2">Yes</td></tr>
<tr><td colspan="5">SmartDust implemented as a method of fault passage indication could have an enormous effect on how faults on the overhead network are located. They could have a huge impact on CI/CML figures as the technology would be effectively pin pointing faults on the network. This results in a significant financial saving

Other applications (brief summary of potential uses)</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">5 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td colspan="3">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9
  </td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£26,653</td></tr>
</table>

Potential for achieving expected benefits	Project has been delayed for 3 months for technical and commercial reasons
Project Progress **March 06**	• Project tendered to a range of product developers • Feasibility study let with Willow technologies / Crossbow • Feasibility study in progress awaiting completion and reporting, expected June 06 • Feasibility study identifying most suitable applications that generic resources that can be used for.
Collaborative Partners	N/A
R&D Providers	Crossbow / Willow Technologies

Table C20: IFI 0508: Development of Redox flow battery for energy storage

<table>
<tr><td>Project Title</td><td colspan="3">Development of Redox flow battery for energy storage</td></tr>
<tr><td>Description of project</td><td colspan="3">A part funded project through the DTI Technology Programme this aims to develop (design, build, test and install) an 11kV 250kW Redox flow battery unit for energy storage.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,995
External £0
Total £2,995</td><td>Expenditure in previous (IFI) financial years</td><td>Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>£477,984</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £2,400
External £3,360
Total £5,760</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">Uses include, voltage support of long lines, overcoming reverse power effects through transformers and potential improvements to network performance. Development of a device which can be connected the our 11kV network and provide power by charging from the AC supply</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">This could provide financial benefits through offering solutions through module stacks which may prevent the need to upgrade certain parts of the network where voltage problems exist, thereby providing potential savings.

By placing these devices in the network, voltage problems could be reduced. Furthermore, a device could be employed where providing a supply is difficult of costly. A unit could run in conjunction with a small wind turbine to provide an islanded network.

As a replacement for current lead-acid batteries, this technology has a low environmental impact.

One of the most significant outcomes expected of this project is the understanding for how storage systems could be connected to the network, and their likely applications.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td>Duration of benefit once achieved</td><td>10 Years</td></tr>
</table>

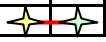
Probability of Success	25%	TRL Development (Start – Current)							
		1	2	3	4	5	6	7	8	9
										
Project NPV (Present Benefits x Probability of Success) – Present Costs		£84,716							
Potential for achieving expected benefits		Project is currently on target to deliver expected benefits.							
Project Progress **March 06**		• Project commenced December 05 • Collaboration agreement reached • Project successfully accepted at outline and full application stages on DTI technology program • Application design commenced • Unit design commenced							
Collaborative Partners		DTI (via Technology Programme), ESD Ltd, Univ. of Southampton, Econnect, Swanbarton Ltd							
R&D Providers		ESD Ltd (project managers)							

Table C21: IFI 0509: Superconducting Fault Current Limiter

<table>
<tr><td>Project Title</td><td colspan="3">Superconducting Fault Current Limiter</td></tr>
<tr><td>Description of project</td><td colspan="3">A part funded project through the DTI Technology Programme this aims to design, develop and trial three 12kV Superconducting Fault Current Limiting (SFCL) devices on three different UK networks.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £7,468
External £5,000
Total £12,468</td><td>Expenditure in previous (IFI) financial years</td><td>Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>£2,345,967</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £17,000
External £125,303
Total £142,303</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The development of a non-linear ‘high-temperature’ superconducting ceramic in series with a circuit breaker for the clamping and clearance of fault energy.

When the material is operated at below its critical temperature it loses all electrical resistance, thereby allowing load current to flow with negligible losses. Either the increased current density caused by fault current, or the loss of cooling medium (liquid nitrogen) causes the temperature of the superconducting material to rise and it reverts to a normal resistive state.

Being a solid state device, the SFCL has been proven to operate in a few milliseconds, after which the impedance remains high until the fault is cleared by conventional means (protection operated circuit breakers, fuses, etc.). The SFCL’s operation is sufficiently fast to ensure that the first peak of the fault current is limited. The subsequent limited current can be set to suit a specific application.

Three devices (one per DNO) will be constructed and installed covering a range of applications: transformer tails; bus section; interconnected network connection. The successful completion of this project is likely to pave the way for higher voltage devices.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">To develop, understand and address the issues associated with the connection of an 11kV fault current limiting device to the network.

Successful trials will result in the development of commercially available devices that are capable of clamping fault levels to within network design limits. Once proven, this will open up another option for tackling network fault level, potentially providing an alternative to network reinforcement.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 years</td><td>Duration of benefit once achieved</td><td>20 years</td></tr>
</table>

<table>
<tr><td>Probability of Success</td><td>25%</td><td colspan="9">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
  </td></tr>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£-267,191
Project NPV is negative due to the low TRL / high costs upon commencement</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">Project expected to commence Apr 06</td></tr>
<tr><td>Project Progress March 06</td><td colspan="10">• Project successfully accepted at outline and full application stages on DTI technology programme
• Detailed project milestones identified
• Collaboration agreement in progress
• Expected commencement April 06</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">DTI (via Technology Programme), United Utilities, CE Electric UK, Applied Superconductors Ltd</td></tr>
<tr><td>R&D Providers</td><td colspan="10">Applied Superconductors Ltd</td></tr>
</table>

Table C22: IFI 0512: Broadband Power Carrier

Project Title	Broadband Power Carrier		
Description of project	The aim of this project is to investigate / develop an alternative communication system that could be used on the SPPS network.		
Expenditure for financial year	Internal £2,838 External £3,400 Total **£6,238**	Expenditure in previous (IFI) financial years	Internal N/A External N/A Total N/A
Project Value (Collaborative + external + SP-EN)	£56,122 (potential)	Projected 06/07 costs for SP-EN	Internal £0 External £0 Total **£0**
Technological area and / or issue addressed by project	The alternative communication system is for the purpose of protection, tele-control, rural automation, smart metering and continuous asset monitoring. If successful. it could give the 11kV and LV network the ability to send communication signals along existing conductors and through transformers.		

Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	No	Yes	No	No

Expected Benefits of Project	By using existing conductors to transmit communication signals for automation, alarms, metering etc, there is no need for additional pilot cables and hence a saving is made on materials and maintenance. By using the technology for tele-control and automation, CI and CML figures can be reduced.		
Expected Timescale to adoption	3 Years	Duration of benefit once achieved	10 Years
Probability of Success	50%	TRL Development (Start – Current)	

1	2	3	4	5	6	7	8	9
				✦	✦			

Project NPV (Present Benefits x Probability of Success) – Present Costs	-£6,238 NPV is negative as based on feasibility stage alone

Potential for achieving expected benefits	Project has been closed as the technology the feasibility study has proved not to be at a mature enough technology to implement.
Project Progress **March 06**	• Feasibility trial carried out at Hoylake training centre. • Product had some interesting functionality but was determined to be too far from market / costly to be implemented on the network for purely network control, in comparison with other communication products. • It was concluded that too much development work would be required and the project would be taken no further. A project to investigate the cost/benefits for alternative forms of communication is likely to established in 06/07.
Collaborative Partners	N/A
R&D Providers	Plugnet, Open University

Table C23: IFI 0513: Thermal modelling and Active Network Management

<table>
<tr><td>Project Title</td><td colspan="3">Thermal modelling and Active Network Management</td></tr>
<tr><td>Description of project</td><td colspan="3">A part funded project through the DTI Technology Programme this aims to optimise network design, operation and control by exploitation of circuit thermal ratings.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,226
External £0
Total £3,226</td><td>Expenditure in previous (IFI) financial years</td><td>Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>£903,000</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £25,000
External £50,000
Total £75,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The ratings given to circuits are a function of the temperature by which they operate. The thermal status of a power system component is determined by a number of factors such as current flow, meteorological conditions and component heat transfer characteristics.

This project seeks to explore the potential benefits arising from: (a) the improved utilisation of power system assets through the use of real time knowledge of the thermal status of the power system and (b) the development of an active controller to facilitate this exploitation and to balance those issues requiring action by operational staff and those that can be dealt with by machine intelligence.

The result of this work will be a prototype active controller, using novel thermal state estimation and control techniques, installed on the SP network.</td></tr>
<tr><td>Type(s) of innovation involved</td><td colspan="3"><table><tr><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr><tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr></table></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Active network management and exploitation of equipment latent thermal ratings may be a way of accommodating increased levels of renewable generation in distribution networks cost effectively.

Improved utilisation of distribution assets resulting in deferral and/or avoidance of reinforcement investments in distribution systems.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 Years</td><td>Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">TRL Development (Start – Current)<table><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td></td><td></td><td>✦</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
</table>

Project NPV (Present Benefits x Probability of Success) – Present Costs	£301,867
Potential for achieving expected benefits	The project has been delayed for 3 months due to commercial reasons.
Project Progress **March 06**	• Project currently awaiting agreement from Siemens (following takeover of VA Tech) to proceed with project. Agreed deadline slip with DTI. • Project successfully accepted at outline and full application stages on DTI technology program • Development of detailed project milestones • Collaboration agreement in negotiation • Project expected to commence Sept 06 following appointment of Durham PhD student
Collaborative Partners	DTI (via Technology Programme), Durham University, Imass, Siemens, PB Power
R&D Providers	PB Power (project manager), as above

Table C24: IFI 0514: Remote Line Temperature Monitor

<table>
<tr><td>Project Title</td><td colspan="5">Remote Line Temperature Monitor</td></tr>
<tr><td>Description of project</td><td colspan="5">The project currently focuses on developing a system for monitoring temperature on 11kV overhead line networks.

The delivered prototype will be a portable temperature monitor that can be installed, assessed and evaluated in a number of locations throughout the network.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £2,925
External £10,000
Total £12,925</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£41,500</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £5,900
External £29,618
Total £39,518</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">Fault and load monitor devices enhanced with temperature sensing capabilities implemented in order to utilise the true capacities of overhead line for use with generation connection schemes at 11kV.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Knowledge of the thermal properties of a line may allow the release of additional capacity reducing the cost of a generation connection at 11kV. This could have a significant effect on targeting capital spent reduce environmental impact.

Using the FPI will give greater visibility of network faults potentially leading to a reduction in Customer Minutes Lost (CML).</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td colspan="3">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£110,911</td></tr>
</table>

Potential for achieving expected benefits	The project has been delayed 4 months due to technical and resource issues
Project Progress **March 06**	• Stage 1 prototype completed • Successful modification of fault passage indicator to monitor line temperature parameters • Scope of project extended to correlate line temperature with real-time weather conditions
Collaborative Partners	N/A
R&D Providers	FMC Tech

Table C25: IFI 0515: ScottishPower / Rolls-Royce Prototype Network

<table>
<tr><td>Project Title</td><td colspan="3">ScottishPower / Rolls-Royce Prototype Network</td></tr>
<tr><td>Description of project</td><td colspan="3">Development of a prototyping network at Dealain House as a test-bed / proving ground for active network management techniques and other ‘high risk’ technologies to allow the network to migrate from their current forms towards a future vision / architecture.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £15,566
External £0
Total £15,566</td><td>Expenditure in previous (IFI) financial years</td><td>Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>£7,200,000</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £10,000
External £1,000,000
Total £1,010,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The project was initiated to understand how the network is likely to change with different types / penetrations of generation, and other external factors across the PEST (Political, Economic, Sociological and Technological) spectrum. The focus of the project has been the 11kV and LV networks, focussing on a timeframe of 2020. By applying results from scenarios to real models of the SP networks, potential future conflicts can be identified.

Following from this analysis, an exercise was undertaken to identify the technologies that could best meet the needs of the network.

A critical path item to the speed of technology adoption is the ability to demonstrate projects on a real network. To address this, a high level view of a network demonstrator has been defined.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Phase 1
An understanding of the steady-state network design fundamentals as the network evolves:
Understanding of how the network is likely to change
Identification of network hotspots as generation is applied to different systems
Identification of outline strategies to mitigate potential risk
Identification of key technologies for development
Phase 2
Transfer and translation of the steady-state design to a more detailed assessment of network performance showing the interaction of components on a complex system
Integration of existing assets to different types / penetrations of generation
Integration of mitigation technologies to existing network
Test bed to prove the range of combinations / permutations
Primary output requirements
Focus for SP capital expenditure</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">

o Is the network we are currently rebuilding right for 2020+?
o How can we best meet least cost design and high performance goals – best network design to do this

Analyse, test and prove tools and techniques for:

o CML / CI mitigation
o Load / Fault level management
o Statutory Obligations (voltage, frequency, etc)

</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td>Duration of benefit once achieved</td><td>20 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
  </td></tr>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="2">£ 47,114</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">The project has been delayed for 1 month due to commercial reasons.</td></tr>
<tr><td>Project Progress March 06</td><td colspan="3">Phase 1 is due for completion May 06. Five work packages were carried out in the six months of this project.

WP1 – System architecture, Phase 1 complete
WP2 – Protection and control, Phase 1 due May 06
WP3 – Demonstrator Design, Phase 1 due May 06
WP4 – Markets and Benefits, Phase 1 due April 06
WP5 – Product Business cases, Phase 1 due May 06

The scenario planning for 2020 deliverable under WP1, undertaken in this project, has since been taken forward to the national Network Architecture Horizon Scanning group under the Electricity Networks Strategy Group (ENSG).</td></tr>
<tr><td>Collaborative Partners</td><td colspan="3">Rolls Royce, ITI Energy, University of Strathclyde</td></tr>
<tr><td>R&D Providers</td><td colspan="3">University of Strathclyde (lead)</td></tr>
</table>

Table C26: IFI 0517: GridSense LineTracker FPI (Conductor Temperature)

<table>
<tr><td>Project Title</td><td colspan="6">GridSense LineTracker FPI (Conductor Temperature)</td></tr>
<tr><td>Description of project</td><td colspan="6">The LineTracker is a fault and load monitor device from which data is downloaded wirelessly to a control centre at 33kV.

The key aims are to add conductor and ambient temperature to LineTracker and increase voltage withstand for operation at 132kV.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £1,043
External £0
Total £1,043</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£66,000</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £7,200
External £67,000
Total £74,200</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">Fault and Load Monitor devices enhanced with temperature sensing capabilities implemented in order to utilise the true capacities of OH Line for use with generation connection schemes at 33kV</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td colspan="2">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">Knowledge of the thermal properties of a line may allow the release of additional capacity reducing the cost of a generation connection at 33kV. This could have a significant effect on targeting capital spent reduce environmental impact.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 Year</td><td>Duration of benefit once achieved</td><td colspan="2">20 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td colspan="4">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9
</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£243,458</td></tr>
</table>

Potential for achieving expected benefits	The project is on target to deliver.
Project Progress **March 06**	• This project is being led by United Utilities with SP buying into the programme (linking with project IFI 0406) • Formal reporting has being provided to UU at each milestone and the project is progressing to the scheduled timescales and costs. • The project should be completed in July with a number of prototype units available for trial. It may be necessary to purchase additional devices to allow a reasonable assessment of the developed devices in various applications. This will give a greater understanding of the potential benefits, which will be needed to build a case for adoption • It is anticipated that SP and UU will collaborate in a trial of the developed devices and share the experience of the trial.
Collaborative Partners	United Utilities (this is a project being led by UU, SP are buying into the p rogramme during 2006/07)
R&D Providers	GridSense

Table C27: IFI 0520: Energy Storage Devices for Distribution Networks

<table>
<tr><td>Project Title</td><td colspan="6">Energy Storage Devices for Distribution Networks</td></tr>
<tr><td>Description of project</td><td colspan="6">This project aims to investigate the feasibility of using different type of energy storage devices on the distribution network as a means of balancing distributed generation outputs with load demands</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £4,375
External £1,000
Total £5,375</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£TBC</td><td colspan="2">Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £2,500
External £10,000
Total £12,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">The project aims to investigate technologies which will make distributed generation connections make feasible by helping to resolve some of the issues they cause on distribution network</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>No</td><td colspan="2">No</td><td colspan="2">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">Distributed generation connections could be made more feasible by lowering negating the need for reinforcements.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="5">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>  </td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="5">-£4,677
The first phase of this project is only a feasibility study, hence the NPV is –ve, the project scope is likely to increase significantly when development areas are identified</td></tr>
</table>

Potential for achieving expected benefits	The project has been delayed for 3 months due to technical and resource issues.
Project Progress **March 06**	• SP have been members of SHFCA for 1 year • SP have gained up to date industry knowledge of: • Status of Development of Hydrogen Fuel Cells (FCs) with respect to micro FC's, Automotive FCs and static power (UPS and Primary Power) • Possibility of using FCs for development projects (IFI) for UPS system (Grid S/S) • SP current stance is that FCs currently hold no application with EnergyNetworks • SP however realize the impact FCs could have on Networks will utilise this information on the prototype network project
Collaborative Partners	N/A
R&D Providers	Scottish Hydrogen and Fuel Cell Association (SHFCA)

Table C28: IFI 0522: Supergen III

<table>
<tr><td>Project Title</td><td colspan="3">Supergen 3 – Highly Distributed Power Systems</td></tr>
<tr><td>Description of project</td><td colspan="3">The SUPERGEN Highly Distributed Power Systems Consortium will address the research challenges associated with a systems approach to the design, operation and control of highly distributed power systems (HDPS).

It is the systems approach, the development of modular solutions and methods to support the realisation of highly distributed power systems (microgeneration, storage, etc), and importantly the focus on rigorous analysis methods for integrated technical, economic and environmental appraisal of such systems that both sets it apart from and complements other research initiatives.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1043
External £0
Total £1043</td><td>Expenditure in previous (IFI) financial years</td><td>Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>£TBC</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £2000
External £0
Total £2000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The key objectives of the consortium’s programme of work are:
Identify the most effective conceptual design for the realisation of a highly distributed power system (HDPS)
Creation of an integrated appraisal framework for the economic, environmental and technical assessment of HDPS
Assessment of market transformation and network access approaches in support of HDPS development.
Realise a simulation facility capable of characterising, modelling and appropriately analysing the behaviour of a HDPS
Engineering of management and control system for effective coordination of Distributed Energy Resources (DERs) in HDPS
Realisation of DER inverter interface and control modes compatible with HDPS control, protection and power quality requirements
Demonstration of modular DER integration and interfacing</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">New demand and generation profiles
Cumulative and interactive behaviour of many small DERs, in particular <5MVA units.
Network integration of many small DERs, and mechanisms for “plug and play” integration.
Impact on operational management.
Device performance, in particular the incorporation of network added-value features.</td></tr>
</table>

<table>
<tr><td></td><td colspan="9">• Operational planning with DERs, to support network investment against hard constraints.
• Market mechanisms, including charging mechanisms and the effectiveness of long term and short term market signals to influence DER behaviour.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td colspan="2">Duration of benefit once achieved</td><td colspan="6">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td rowspan="3">25%</td><td colspan="8">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td>  </td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="8">N/A
Assessment not made as this project has no SP-EN cost input</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="9">Programme has recently commenced and is currently on target.</td></tr>
<tr><td>Project Progress March 06</td><td colspan="9">• EPSRC funding obtained
• Project commenced</td></tr>
<tr><td>Collaborative Partners</td><td colspan="9">EPSRC, Rolls Royce, plus letters of support from other industrial partners</td></tr>
<tr><td>R&D Providers</td><td colspan="9">University of Strathclyde (lead), Loughborough University, University of Manchester, University of Oxford, University of Bath, Imperial College</td></tr>
</table>

Table C29: IFI 0527: Testing Procedure for ROCOF relays

Project Title	Testing Procedure for ROCOF relays		
Description of project	Testing will be carried out on a range of "loss of mains" relays in order to develop a clear understanding of the stability of these relays when confronted by a range of network disturbances applied at a range of relay settings. This information will be used to develop a matrix of optimum settings and test procedures for relay specification.		
Expenditure for financial year	Internal £2,163 External £2,688 Total **£4,851**	Expenditure in previous (IFI) financial years	Internal N/A External N/A Total N/A
Project Value (Collaborative + external + SP-EN)	£22,492	Projected 06/07 costs for SP-EN	Internal £1,800 External £2,000 Total **£3,800**
Technological area and / or issue addressed by project	Production of relays and identification of protection settings to be used in network protection schemes, which enable the protection to function nominally when subjected to a range of disturbances, which may be found on current and future distribution networks.		

Type(s) of innovation involved	Incremental	Significant	Technological substitution	Radical
	Yes	No	No	No

Expected Benefits of Project	On completion of the work there will be an improved understanding of loss of mains relays and how they respond to system disturbances and genuine loss of mains, which will enable more effective settings to be applied to relays. More effective settings will reduce the number of spurious trips of generator installations due to system disturbances. Reducing generator trips will result in savings in operational time and prevent the cost incurred by loss of generation whilst also reducing disturbances to other connected customers improving quality of supply. An improved understanding and confidence in the quality of loss of mains relays will reduce the time for producing a scheme design and negate to need to fit inter-tripping. This would result in a substantial saving in installation costs making more embedded generation schemes economically viable		
Expected Timescale to adoption	2 Years	Duration of benefit once achieved	10 Years

<table>
<tr><td>Probability of Success</td><td>25%</td><td colspan="9">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
  </td></tr>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£157,009</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The project has been delayed by 6 months due to technical reasons</td></tr>
<tr><td>Project Progress March 06</td><td colspan="10">• Selected settings for selected relays determined
• Knowledge of how these relays react to disturbances on the 33 kV and 11 kV networks gained
• The setting selection process is bring carried out with a number of different relays</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">CE Electric, Central Networks, EDF Energy, National Grid, Scottish and Southern Energy, United Utilities, Western Power Distribution</td></tr>
<tr><td>R&D Providers</td><td colspan="10">University of Strathclyde</td></tr>
</table>

Table C30: IFI 0528: Hydrogen Electrolyser / Storage DTI Submission

<table>
<tr><td>Project Title</td><td colspan="5">WINDSTOR - Hydrogen Electrolyser / Storage DTI Submission</td></tr>
<tr><td>Description of project</td><td colspan="5">This was an unsuccessful submission to September 05 DTI Technology Programme competition for funding. Its purpose was to develop and evaluate an integrated electrolyser/hydrogen/fuel cell energy storage system applied to a distribution network constrained wind farm output, with additional output into the transport system.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £1043
External £0
Total £1043</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£2,550,000</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">WINDSTOR is an innovative applied research project that aims to lead to the integration of a novel electrolyser/hydrogen/fuel cell energy storage system applied to a distribution network constrained wind farm output.

The project will further involve the development of a fuel cell utility vehicle, fuelled by electrolyser hydrogen off-gas. The aims of the project include the development of PEM fuel cell technology, hydrogen storage and electrolyser plant, their integration for utility applications, techno-economic evaluations, performance assessments and the development of a fuel cell utility vehicle and its fuelling infrastructure.

WINDSTOR aimed to offer multiple exploitation routes to multiple applications, with a range of significant benefits spanning the power utilities, renewables, fuel cells, hydrogen systems, transport and academic sectors.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>No</td><td>No</td><td colspan="2">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Understanding of hydrogen storage applications to distribution networks, potentially reducing the need for high capacity circuits to be built for variable source generation.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td colspan="3">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
✦</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">N/A
Project failed to receive funding, and was stopped. A detailed NPV was not completed.</td></tr>
</table>

Potential for achieving expected benefits	Project closed
Project Progress **March 06**	• Project failed to receive DTI grant, SP-EN have decided not to pursue this technology at this time.
Collaborative Partners	ScottishPower Generation, EA Technology Ltd, plus others

Table C31: IFI 0529: ESR network (ESR 21)

<table>
<tr><td>Project Title</td><td colspan="5">ESR network (ESR 21)</td></tr>
<tr><td>Description of project</td><td colspan="5">The ESR Network is an academia / industry exchange to identify and link university funded projects to key industry stakeholders.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £2,211
External £6,000
Total £8,211</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£213,000</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £1,800
External £3,000
Total £4,800</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">ESR Network, the successor to ERCOS (Electricity Research Co-funding Scheme), acts as a data exchange between industry and academia for research activities. Originally established to manage a programme of 34 funded projects, it was initially co-funded between industrial partners and the EPSRC. Since 2003 the network has been funded entirely be network members (both industrial and academic).

This network covers the majority of the UK universities and monitors all electricity related research activities funded by EPSRC, DTI (Technology Programme), etc.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td colspan="2">Yes</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">▪ Monitoring / data exchange of all EPSRC funded projects submitted in ‘responsive mode’
▪ Monitoring / data exchange of other UK/EU research initiatives (e.g. Supergen 3, UKERC both presented at the Oct 05 meeting)
▪ Network of academic contacts
▪ Network of industrial contacts</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">0 Years</td><td>Duration of benefit once achieved</td><td colspan="2">3 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td colspan="3">TRL Development (Start – Current)
1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
| ✦ | | | | | |</td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">-£16,445</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">This project encompasses a number of small projects each at differing stages of development</td></tr>
</table>

Project Progress **March 06**	▪ The Network currently monitors 56 projects across the electricity sector (see website for details) Research Strategies: ▪ ESR Network research strategy 'An Integrated Approach to Structural Integrity in Electrical Power Plant (INSTEPP)' ▪ ESR Network research strategy 'Particulates in Electricity Generation Plant (PARTICEL)' ▪ ESR Network research strategy 'Tools for power system operation in a competitive environment (TOPSYNC)' ▪ 'COndition Monitoring of Electrical Transmission and distribution plant (COMET)' ESR Network R&D Matrix has been published in IEE Power Engineer, IEE Power Engineer, June/July 2004, pp 20-23, entitled "Match Making"
Collaborative Partners	**Industrial:** Scottish Power Generation, QinetiQ, National Grid, BNFL, Magnox Generation, SERCO Assurance, VATECH Reyrolle, ABB Switzerland Ltd, RWE Innogy Plc, ALSTOM Power, SP Power Systems Ltd, AREVA T&D (Technology Centre), E-ON UK (Power Technology Centre) **Academic:** Brunel University, Cranfield University, Glasgow Caledonian University, Imperial College London, Loughborough University, Queen's University of Belfast, The University of Birmingham, The University of Nottingham, University of Bath, University of Birmingham, University of Bristol, University of Kent, University of Leeds, University of Manchester, University of Southampton, University of Strathclyde, University of Sussex, University of Wales Swansea, University of Cambridge **Government:** DTI, EPSRC
R&D Providers	See above academics

Table C32: IFI 0530: Optimising Voltage Control/Var performance of a large scale WF

<table>
<tr><td>Project Title</td><td colspan="5">Optimising Voltage Control/Var performance of a large scale WF</td></tr>
<tr><td>Description of project</td><td colspan="5">Applied research work to identify an alternative voltage control solution for a 60MW 132kV connected windfarm, in a complex network with a high degree of legacy generation.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £3,732
External £1,957
Total £5,690</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£2,750</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">A 132kV-connected windfarm is being investigated with aim to control real and reactive power flow to maintain the 132kV system voltage at the wind farm substation to within the range +7%, -4%. Currently if the windfarm is unable to maintain voltage to within these limits a trip signal is automatically sent by the DNO to the open the connecting circuit breakers.

The existing network is weak and subject to high network losses. The windfarm manages voltage control to stay connected within the technical limits.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>No</td><td>Yes</td><td>No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Keeping the wind farm voltage steady without rapid changes stops the tap changers from excessive operation, leading to a longer lifetime and lower maintenance costs.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">0 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td colspan="3">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9
  </td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="3">£11,622</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">The project has been completed successfully, but requires further work in order to realise benefits.</td></tr>
</table>

Project Progress **March 06**	• Report on project completed • New methodology for control of multiple generation sources • Commercial restraints (existing generation) have meant that new methodology is unfeasible • Further development will be fed into the AURA-NMS (IFI 0532) project
Collaborative Partners	N/A
R&D Providers	University College London (UCL)

Table C33: IFI 0532: AURA-NMS

<table>
<tr><td>Project Title</td><td colspan="3">AURA-NMS (Automated Regional Active Network Management System)</td></tr>
<tr><td>Description of project</td><td colspan="3">This project aims to produce a control structure and set of control algorithms that realise the notion of an active distribution network and enhance the service a network operator provides to load and generation customers, improving network performance (asset use, etc.).</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,232
External £0
Total £3,232</td><td>Expenditure in previous (IFI) financial years</td><td>Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td>£5,760,000</td><td>Projected 06/07 costs for SP-EN</td><td>Internal £22,000
External £300,000
Total £322,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The SP portion of this work is to focus on constraint management techniques for use on new / existing generation connections, focussing on the 33kV and 132kV networks. Although relevant to both SP-D and SP-M networks, the primary focus in case studies will be to overcome existing limitations in SP-M.
Overcome complexity of existing hard-wired intertripping schemes
Determine a solution for managing multiple generation connections in a given locality
Develop and implement a system that can work in harmony with existing SCADA infrastructure
Overcome communications / equipment limitations of existing SCADA systems</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td>Radical</td></tr>
<tr><td>Yes</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Development of a constraint management solution from the top academics in the UK
Implement solution and prove concept
Potential to create Registered Power Zone for additional revenue on the DG incentive</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td>Duration of benefit once achieved</td><td>20 Years</td></tr>
</table>

<table>
<tr><td rowspan="2">Probability of Success</td><td rowspan="2">25%</td><td colspan="9">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td colspan="2">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="9">£-101,918</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="10">The project has been delayed for 5 months due to commercial factors and is planned to commence 06/07.</td></tr>
<tr><td>Project Progress March 06</td><td colspan="10">▪ Preliminary approval from EPSRC for funding
▪ Outline Memorandum of Understanding circulated between partners
▪ Detailed specification, milestones and deliverables currently in development</td></tr>
<tr><td>Collaborative Partners</td><td colspan="10">ABB, EDF-Energy, EPSRC Strategic Partnership (Universities: Imperial College London (lead), Strathclyde, Durham, Edinburgh, Loughborough,)</td></tr>
<tr><td>R&D Providers</td><td colspan="10">ABB, Universities: Imperial College London (lead), Strathclyde, Durham, Edinburgh</td></tr>
</table>

Table C34: IFI 0535: Radiometric Arc Fault Location

<table>
<tr><td>Project Title</td><td colspan="6">Radiometric Arc Fault Location</td></tr>
<tr><td>Description of project</td><td colspan="6">Applied research, and follow up installation of a system to triangulate fault locations on overhead lines from the high frequency radio wave signatures produced from an arcing fault.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £1,043
External £0
Total £1,043</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£292,000</td><td colspan="2">Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £2,500
External £15,000
Total £17,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">The principle of the technology is:
• There is a correlation between RF discharges and network faults on overhead lines
• The RF signal can be picked up by a radio antenna up to around 70km away
• If antennae are spread across the network, a mesh is formed – in a similar manner to the GSM network
• If a fault can be accurately clocked, triangulation can be used from a number of base stations to give an approximate geographic location (accuracy ~300m)
• If this information is linked to GIS / SCADA data a more accurate fault location can be obtained</td></tr>
<tr><td>Type(s) of innovation involved</td><td>Incremental
No</td><td>Significant
Yes</td><td colspan="2">Technological substitution
No</td><td colspan="2">Radical
No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">If successful, the use of radiometric ‘cells’ could be used to accurately locate fault locations on all overhead line networks within that zone.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">25%</td><td colspan="5">TRL Development (Start – Current)
1 2 3 4 5 6 7 8 9
  </td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£45,787</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="6">Project is planned to commence September 06.</td></tr>
</table>

Project Progress **March 06**	• Preliminary Approval • Project tabled with ENA R&D working group • Technical Specification Developed • Project expected to commence Sept 06
Collaborative Partners	Potential ENA member companies
R&D Providers	University of Strathclyde

Table C35: IFI 0536: ENA Earthing Project

<table>
<tr><td>Project Title</td><td colspan="5">ENA Earthing Project (OSG SG14)</td></tr>
<tr><td>Description of project</td><td colspan="5">This Project aims to develop new techniques to assess the impact lower voltage earth electrodes of higher voltage ‘hot zones’, and to measure the resistance of distribution substation earth systems.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £1,043
External £0
Total £1,043</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£27,000</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £700
External £3,125
Total £3,825</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The project will provide greater understanding of the interaction between unconnected earthing systems. In particular an ability to better assess the extent to which a 'cold' earthing system modifies the extent of the ROEP contours around a 'hot substation earth system.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td>Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">• Greater understanding of the interaction between unconnected earthing systems.
• Avoidance of additional work at around 300 substations/yr to provide extended separation of electrodes.
• Avoidance of 5% chance of major diversions required of BT apparatus due to ROEP zones</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">2 Years</td><td>Duration of benefit once achieved</td><td colspan="2">8 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">50%</td><td colspan="4">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£81,165
Different to ENA ‘standard’ as figures have been passed through SP NPV methodology</td></tr>
</table>

Potential for achieving expected benefits	The project has been delayed for 5 months due to commercial factors.
Project Progress **March 06**	• Initial research work was completed to determine whether there was a need for further work in this area. The outcome of this justified further work being carried out. • The earthing consultant has been in discussions with the various DNOs to identify suitable sites for testing to be carried out. Sites have been made available within CN and WPD and the testing work commenced. It is not yet known whether savings will be achieved until the outcome of the testing work is known.
Collaborative Partners	CE Electric, Central Networks, EDF Energy, National Grid, Scottish and Southern Energy, United Utilities, Western Power Distribution
R&D Providers	Strategy & Solutions

Table C36: IFI 0537: ENA Lightning Protection

<table>
<tr><td>Project Title</td><td colspan="6">ENA Lightning Protection (develop ETR 134)</td></tr>
<tr><td>Description of project</td><td colspan="6">The project aims to produce a new ETR on lightning protection with a Scope that covers:· background information on the lightning density across the UK· advice on equipment protection levels and arrangements· catalogue practices and procedures – with an explanation· provide a view on international practices / proce dures· reference peripheral issues (such as earthing and protection) were these are applicable· provide a list of reference documents</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £1,043
External £0
Total £1,043</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal N/A
External N/A
Total N/A</td></tr>
<tr><td>Project Value (Collaborative + external + SP-EN)</td><td colspan="2">£6,901</td><td>Projected 06/07 costs for SP-EN</td><td colspan="2">Internal £700
External £0
Total £700</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="6">The project aims to investigate ways of assets from damage caused by lightning</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td>Incremental</td><td>Significant</td><td colspan="2">Technological substitution</td><td colspan="2">Radical</td></tr>
<tr><td>Yes</td><td>No</td><td colspan="2">No</td><td colspan="2">No</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="6">• Reduction in Failure/faults due to lightning
• Improved risk assessment
• Reduction in CML's</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">3 Years</td><td>Duration of benefit once achieved</td><td colspan="2">10 Years</td></tr>
<tr><td rowspan="3">Probability of Success</td><td colspan="2" rowspan="3">50%</td><td colspan="4">TRL Development (Start – Current)</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5 6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Project NPV (Present Benefits x Probability of Success) – Present Costs</td><td colspan="4">£79,773
Different to ENA ‘standard’ as figures have been passed through SP NPV methodology</td></tr>
</table>

Potential for achieving expected benefits	The project is on target.
Project Progress **March 06**	Document is close to completion.
Collaborative Partners	CE Electric, Central Networks, EDF Energy, National Grid, Scottish and Southern Energy, United Utilities, Western Power Distribution