Innovation Funding Incentive
And
Registered Power Zone
Report

for period 1st April 2014 to 31st March 2015

Scottish Hydro Electric Power Distribution

Southern Electric Power Distribution

1. Executive Summary

Innovation Funding Incentive

Over the last year, Scottish and Southern Energy Power Distribution (SSEPD) has continued in its commitment to research and development (R&D) activities using the Innovation Funding Incentive (IFI).

During the year ending 31st March 2015, our distribution teams have initiated new projects, and continued IFI projects started in previous years under our two wholly owned subsidiaries: Scottish Hydro Electric Power Distribution plc (SHEPD), and Southern Electric Power Distribution plc (SEPD).

As in previous years, there are a wide range of activities ranging from national collaborations with multiple work packages, to specific projects that address identified problem areas. In particular, we have projects aiming to improve the capability of the distribution network and address the challenges of a low carbon energy future such as growth in electrical demand from heat pumps and electric vehicles or the increase in renewable energy power flows arising from the connection of more renewable generation. Wherever possible, we have sought to minimise the cost of R&D activities borne by the customer through seeking complementary funding and forming collaborations.

The total qualifying expenditure for the reporting period of 1st April 2014 to 31st March 2015 for SSEPD was £3,670,000. This total comprises expenditure of:

- £ 2,520,000 by our SEPD business
- £ 1,150,000 by our SHEPD business

Registered Power Zone

One Registered Power Zone (RPZ) scheme was registered for the Orkney Isles in the SHEPD area in 2005/06 and the first two generators were connected in 2009. The RPZ incentive applies for five years to generation projects with a connection start date (as defined in the RIGS) between 1st April 2005 and 31st March 2012. The incentive does not apply to any generation connecting after this period. The RPZ incentive will therefore reduce year on year from now on as existing RPZ generation projects connected between 1st April 2005 and 31st March 2012 reach their respective five year marks.

Although the RPZ scheme has now ended for new generators, SHEPD has continued to use the Active Network Management (ANM) scheme established within the RPZ to connect further distributed generation (DG), bringing the total capacity connected at the 31st March 2015 up to 25.75MW.

2. Introduction

As part of the Distribution Price Control Review (DPCR) effective from 1 April 2005, Ofgem (the regulatory body for the energy industry) introduced two new incentives: the IFI and RPZ. The primary aim of these two incentives was to encourage the Distribution Network Operators (DNOs) to apply innovation in the way they pursue the technical development of their networks. A Good Practice Guide (Engineering Recommendation G85) has been produced by the DNOs and is available free of charge via the Energy Network Association's (ENA's) website: www.energynetworks.org.

The IFI mechanism is intended to provide funding for projects primarily focused on the technical development of the networks to deliver value (i.e. financial, quality of supply, environmental, safety) to end consumers. IFI projects can embrace aspects of distribution system asset management from design through to construction, commissioning, operation, maintenance and decommissioning. A network operator or owner is allowed to spend up to 0.5% of its Combined Distribution Network Revenue on eligible IFI projects.

The RPZ scheme was intended to encourage DNOs to develop and demonstrate new, more cost effective ways of connecting and operating generation that would deliver specific benefits to new DG and broader benefits to consumers generally. The RPZ incentive applied to generation connected from April 2005 to March 2012, and lasts for five years after the date of connection. Although this incentive has ended for new connections, SHEPD has continued to connect generation in the RPZ by taking advantage of the additional network capacity available due to the ANM scheme established there.

Open reporting (i.e. available in the public domain) of IFI & RPZ projects is required by Ofgem; this is intended to stimulate good management and promote sharing of innovation good practice. In line with this, we will publish our IFI & RPZ report on the SSEPD website: www.ssepd.co.uk. To enhance accessibility, it will also be available on Ofgem's website: www.ofgem.gov.uk.

To provide an easily accessible and user friendly database, the ENA created the Smarter Networks Portal under the auspices of Ofgem and all GB DNO's. The Smarter Network Portal is a repository for all research, development and demonstration projects carried out by GB DNO's and is publicly available at www.smarternetworks.org

3. Scope

This document contains the reports for SSEPD for our distribution assets under two wholly owned subsidiaries:

- SHEPD
- SEPD

It details activities in the period from 1st April 2014 to 31st March 2015.

Separate IFI regulatory reports on expenditure have been provided for each licence area with a summary listing of all IFI project costs incurred this year along with one set of detailed individual project reports. For the distribution businesses, projects are generally developed for the benefit of both licence areas, reflecting our strategy of running both companies using one common best practice. All reports have been produced in accordance with the Regulatory Instructions and Guidance (RIGs) issued by Ofgem and the ENA Engineering Recommendation G85 Issue 2 – December 2007.

In addition to reporting on activities in 2014/15 we have included information on current projects and an outline of intended future developments.

4. IFI Report

Core to SSEPD is the fundamental belief that innovation is vital to our continued success as a business. Without innovation, organisations are overtaken and become uncompetitive. This belief permeates all parts of our organisation; as a result, innovation comes naturally to many of our staff and is well supported at all levels within the business. The impact of this has been demonstrated through the work undertaken to date within the IFI, RPZ and, more recently, the Low Carbon Networks Fund (LCNF) and RIIO Innovation Stimulus Package.

We engage in horizon scanning activities and explore the latest work on future scenarios but, core to our values as a business is the belief that innovation is principally about effective delivery and implementation.

Our programme of IFI projects in 2014/15 includes a number of projects involving academia as we believe that effective engagement and working collaboratively with a range of academic institutions can both help to inform our overall programme of activities, and tackle specific challenges and opportunities so that we accelerate the rate of learning from our portfolio of research and development projects.

The following lists some of the present academic initiatives in which we participate to support our horizon scanning and project development:

University of Strathclyde Endowed Fellowship

Work to date has delivered benefits by informing the development and application of asset risk management within SSEPD. The most recent focus of research under this Fellowship is on the themes of LV network analysis and DNO-demand side management. The main achievements to date are: a literature review on LV analysis, distribution load flow, stochastic load flow, and the impact of low carbon technologies on the LV network; development of MATLAB planning tools; the simulation of load data using various case study profiles; a paper published on “The Uncertainties of Probabilistic LV Network Analysis”.

Power Networks Demonstration Centre (PNDC)

We have collaborated with the University of Strathclyde and Scottish Power Energy Networks to establish the Power Networks Demonstration Centre (PNDC), with significant support from Scottish Enterprise and the Scottish Funding Council. This research, demonstration and testing facility is the first of its kind in the UK, comprising low-voltage laboratories and a realistic, controllable and fully operational distribution network. We believe the pooling of financial and human resources at the PNDC will facilitate the demonstration and deployment of many innovative solutions at a faster rate than could be achieved by any single institution.

IET Power Networks Research Academy (PNRA)

The IET PNRA was established through a strategic partnership agreement between the Engineering and Physical Sciences Research Council (EPSRC), electricity transmission and distribution companies, and related manufacturers and consultants. It funds and supports PhD researchers in power industry-related projects, and helps to maintain and improve the research and teaching capacity in power engineering subjects.

A range of projects are addressed in this programme, including:

- Overhead lines measurement system;
- Application of artificial immune system algorithm to distribution networks;
- Protection issues of inverter-interfaced DG;
- Chemical approaches towards intelligent insulation;
- Electrical network fault level measurement for DG and other applications;
- Reactive power dispatch using DG;
- Influence of oil contamination on the electrical performance of power transformers;
- Alternatives to SF_6 as an insulation medium for distribution equipment;
- Solid state devices for electrical power distribution;

Industry partners, the IET, and academia have all agreed that the projects are beneficial to both the DNOs through potential breakthroughs that could lead to new practices or products and to academia by raising the profile of power engineering.

SUPERGEN

We are an industrial partner in the SUPERGEN-funded HubNet consortium, which also includes eight universities and has the objective of coordinating research in energy networks in the UK. We were also an industrial partner in the previous SUPERGEN-funded asset management and performance of energy systems (AMPerES) project which involved six UK universities. AMPerES ended in 2010 but provides an early and effective example of our participation in multi-party academic collaborations. The subsequent SUPERGEN-funded flexible network technologies (FlexNet) project, which ended in 2011, is a similar example of a major collaborative project which we participated in and which involved universities, network operators, and equipment manufacturers.

EPSRC Grand Challenges

The timescale being addressed by these projects is looking towards 2050. This is out-with the scope of our present R&D activities so we do not engage fully with these projects but are involved via steering committees through which we advise on the projects, and seek to learn from the project outputs when this is possible.

Supply chain engagement

We work with a wide range of external service providers and R&D projects have arisen from our work with companies such as EA Technology Ltd (EATL) and Smarter Grid Solutions (SGS) whilst other projects have originated internally from our own analysis of areas of work which could benefit from an innovative approach.

We continue to see considerable amounts of renewable generation development and connection to our network in the SHEPD area, consisting mainly of wind farms. However, network issues and constraints have become apparent at both a distribution and transmission level and this has driven one of the key themes for our R&D strategy.

At distribution voltages, we believe ANM systems, and other innovative methodologies are accepted as viable elements of a distribution network and can be implemented in appropriate areas of the network to allow more generation to be connected to maximise the use of the existing infrastructure. SSEPD are continuing to research and develop further methodologies to maximise the use of the existing infrastructure and reduce the effect of network constraints. Earlier work to deliver an ANM system on Orkney has now matured and this work has also lead to further innovations and the application of ANM systems on other sections of our distribution networks as a business as usual activity.

5. RPZ Report

As of 31st March 2012, the RPZ incentive scheme ceased to apply to any new generation connecting onto the RPZ area of the network on Orkney. Following on from this, further developments in the former RPZ area are being reported on via the various IFI projects that continue to be developed to consolidate and improve the Orkney Smart Grid such as the Real-Time Java IFI project. The following sections provide an overview of activities to date in the Orkney RPZ.

5.1 Current Activities

The considerable renewable energy resource on the Orkney Isles has attracted significant levels of wind farm and marine development such that the connection of further renewable energy generation output is constrained by the existing capacity of the distribution network. An ANM scheme was developed in collaboration with the University of Strathclyde and delivered by Smarter Grid Solutions (SGS) in order to maximise the use of the existing infrastructure, thereby providing a quicker and lower cost alternative to network upgrading and reinforcement works. The ANM scheme is expected to enable a total of 72MW or more of generation capacity to be connected onto the Orkney network. At present, 47MW is already contracted on a firm or non-firm basis and a further 28.55MW of new non-firm generation output has been assessed as technically viable for management by the ANM scheme: original estimates considered that somewhere in the order of an additional 15MW would be economically viable but this expectation has been exceeded as contracts have been established for a total of 28.55MW of generation.

Current renewable generation capacity and real time output can now be viewed live on our website anm.ssepd.co.uk. Further background information about the ANM scheme and its development can be found at www.ssepd.co.uk/orkneysmartgrid.

5.2 Development of the ANM scheme

2005-2009

The ANM concept was assessed initially using Department of Trade and Industry (DTI) funding in 2004/05 then developed as an IFI project. Closed-loop system trials were run on the Orkney distribution network during 2006 and the information gained was analysed. The key outcomes from this analysis were the verification of the control logic and an understanding of the response of the participating DG. Additional analysis of wind farm behaviour on Orkney was carried out by the University of Strathclyde to further develop the design of the scheme. Other key outcomes during 2006/07 were the development of logic design rules for the full ANM scheme and creation of a generator constraint analysis tool to calculate the expected curtailment of new DG connecting to the scheme.

During 2007/08, contracts were placed for the development of the necessary software and hardware systems. These systems were developed and factory acceptance testing carried out.

In 2008/09, we made further progress in preparation for the installation of the scheme in 2009/10 to fit with the generation developers' construction programmes.

Commercial arrangements were developed to support the ongoing operation and optimisation of the ANM system with Smarter Grid Solutions.

2009 – 2010

Delays by generation developers in gaining planning consent and finance were outside our control and delayed the full commissioning of this project until 2009 when the first two wind farm developments of 900kW and 2.3MW were connected under the RPZ scheme.

2010 – 2011

The first full year of operation of the scheme enabled us to validate its operation and provided us with valuable learning. We connected a further 4.5MW of DG under the RPZ scheme.

2011 – 2012

A further 4.52MW of generation was connected during this financial year bringing the total DG within the RPZ to 12.22MW. An external review was completed by KEMA to consider the extent to which the project met its original objectives, and identify lessons learnt for applications elsewhere. Although communications links provided by external third parties were identified as not meeting expectations, the overall project was judged to have met or exceeded the original objectives and a number of useful learning points were detailed. The RPZ incentive ended for new generation connections after 31 March 2012.

2012 – 2013

Although RPZ incentive payments are no longer made to the DNO for additional generation connected after 31 March 2012, we have continued to connect further generation, increasing the total DG connected via the ANM technology to 18.49MW. The total amount of renewable generation contracted to connect via ANM has increased to 28.55MW which demonstrates the effectiveness of the innovative commercial and technical approaches deployed in the region.

2013 – 2014

Further to the paragraph above for 2012-2013, we continue to connect distributed generation within the RPZ using the ANM technology and have increased the connected generation to 25.25MW, and a further 3.3MW is contracted to connect.

2014 – 2015

Further to the paragraph above for 2013-2014, we have increased the connected generation to 25.75MW, and a further 2.8MW is contracted to connect.

5.3 Future Activities

Even though the RPZ framework was only valid for new connections up to the end of March 2012, further related works are continuing to take place in the RPZ area. We are continuing to evolve the ANM system on Orkney by ensuring that the system is resilient and scalable and also exploring the addition of further functionality. Our continued work on innovative solutions surrounding the connection of DG onto our Distribution networks will be reported via the individual research projects in this area.

6. Benefits achieved from IFI projects

We are able to identify some of the benefits from the development and implementation of innovative methodologies and equipment.

Active Network Management

We have now connected 25.75MW of DG (13.53MW of which was connected after the RPZ connection deadline on 31st March 2012), as stated above in the RPZ report, and have avoided the conventional reinforcement works which would otherwise have been required to connect these renewable generators.

We have validated the operation of the ANM scheme; including the network monitoring sites where we established new very high frequency (VHF) radio communications links and installed innovative technology on the rural network. Operational experience to date indicates that the ANM technology supplied by Smarter Grid Solutions is robust.

The problems experienced to date have mainly been due to faults on the sections of the communications network where we have not used the bespoke VHF radio system to transport the data which is essential for the operation of the scheme. This problem has been addressed by moving over to a microwave communication system and installing a backup for this should there be a fault on the primary system.

To summarise the benefits of the ANM scheme, it has allowed the connection of further renewable generation without the need to upgrade the existing Distribution network on Orkney along with the connections to mainland UK. Due to the ANM scheme, generators have been allowed to connect sooner than would have otherwise been possible, and without the need to fund a third distribution circuit at an estimated cost of £30 million.

The Real Time Java IFI project has replaced the Programmable Logic Controller (PLC) system with standardised HP server hardware running Red Hat Linux with Real Time Java extensions. This is now in BAU as part of the ANM scheme and is fully operational.

Live Line Tree Felling

Several thousand trees are due to be felled next to overhead power-lines in Scotland over the next ten years. Under current safety regulations tree felling contractors can only carry out tree felling outside two tree lengths of the overhead line.When carrying out work within two tree lengths, SSEPD is required to carry out a shutdown of the section of electricity network affected by the nearby trees. This can be time consuming for the working party therefore reducing efficiency and increasing the number of interruptions for customers.

SSEPD strives to reduce customer interruptions, customer minutes lost and we also seek to provide the most cost efficient processes on behalf of our customers. Another objective was the desire to reduce or eliminate extended periods of manual tree cutting within a challenging environment and so reduce the risk of injury to employees and contractors.

Thus, SSEPD set out to investigate and develop methodology which would allow work to be carried out safely and efficiently within two tree lengths by using innovative techniques involving mechanical harvesting equipment. This investigation was a national collaboration between SSEPD, the ENA and the agricultural and environmental consultancy ADAS.

This project has been successfully completed and integrated into 'business as usual'. To date we have carried out this procedure on a number of sites and confirmed the advantages of this innovative method such that we expect to see benefits in the order of £400-500k per year.

Hybrid Generator

The use of small scale diesel generation to give continuity of supply to domestic customers is particularly inefficient in terms of diesel fuel consumption. The requirement may arise due to storm situations, faults or planned maintenance. For large periods of the day the property may be unoccupied with minimal electrical demand but the generation must continue to run .A similar situation exists overnight.

In conjunction with Off-Grid Energy, SSEPD developed a combined generator/battery unit mounted on a trailer unit capable of being towed by a standard operational vehicle.This operates so that at times of low demand the load is fully serviced by the battery/inverter combination so the generator does not run. This is particularly advantageous overnight removing the problem of noise pollution.

As the battery becomes discharged the generator will restart and run at its optimum efficiency to recharge the battery. This packaged solution minimises noise and environmental pollution whilst minimising operating costs. This project has been successfully completed and integrated into 'business as usual'. We forecast benefits of approximately £100k over the RIIO-ED1 price control along with an improvement in customer service.

SF6 Leak location and Oxifree Coatings

SF6 gas is a very potent greenhouse gas widely used in power networks.

SSEPD operates a large number of assets that make use of SF6 gas and some of the SF6 gas from equipment may leak due to a variety of reasons. SSEPD set out to find a cost effective means of reducing the environmental impact of SF6 by embarking on this project to address the issue of SF6 leakage from plant and equipment in service. It was recognised that any meaningful mitigation for SF6 gas leakage on equipment depended largely on firstly being able to positively identify the sources of leakage then effect a repair. Present practices were not always successful such that some leakages were still remaining even after repairs due to the difficulty in obtaining an accurate and positive identification of the sources of leakage. As a result, this project was broken into two distinct work packages which were:

- SF6 leakage source pinpointing with FLIR optical gas imaging cameras
- A quick and non-invasive SF6 leak repair method using Oxifree coatings

Two FLIR cameras were procured and used on switchgear with SF6 gas leakage to identify the source of the leak. Oxifree coatings were then applied to the faulty area, wherever practicable, to attempt to reduce the leakage. The switchgear items were then monitored through the Network Management Centre event repository, Asset Management database and site checks to compare performance with previous held records. From this it was possible to evaluate the effectiveness of the solutions.

On the basis that SF6 has Global Warming Potential (GWP) of 23,900 times that of Carbon Dioxide and considering the Department of Energy and Climate Change's carbon valuation guidelines, each tonne of SF6 not emitted represents a financial saving of £693,000.

The project has now been successfully completed and the methods trialled have been converted to 'business as usual'. The business as usual implementation of Oxifree coatings takes into account the limited time the project had to evaluate its longevity hence it will be used as a temporary mitigation until the method has proven itself over a longer period.

Based on results to date and evaluation of savings from reduction in SF6 gas leakage, the methods employed in this project are expected to provide an annual saving of at least £10,000 per item of switchgear repaired successfully.

Lumen Weather Integration

Every year the winter brings stormy weather to the UK. The impact of a storm on the distribution network will vary according to a number of factors such as the strength of the winds, wind direction, rainfall and temperatures. The combination of soft ground and high winds can cause poles to move, leading to low wires, and high wind speeds and line icing can cause the wires to break.

Quickly getting our customers back on supply is a crucial focus of our work as a DNO, and during the winter months advance notice of potential damage is especially valuable to aid management decisions to plan in advance and mobilise resources to where the damage is likely.

In 2013 SSEPD carried out a proof of concept project under IFI to look at a new technology that had been developed by Bellrock Technology called Lumen, which allowed the quick and effective integration of data to produce a display of information created from several data sources with a display configured to suit the end user.

This project has developed a new statistical model, and Bellrock Technology have taken this and automated the input of weather data, and then made the results available through an easy to use web based user interface.

This project has been successfully completed and integrated into ‘business as usual’. Fortunately the number of weather related events that have happened since the system went live in March 2015 have been few, but for those that have occurred the new model and its improved access have been a valuable addition to the assessment of potential damage and decisions on effective deployment of resources.

The expectation is that the improvement in resource allocation will result in a reduction in time to repair, along with safety and environmental benefits resulting from reduced travel in adverse weather conditions. The overall cost savings are expected to be in the region of £100k per year as experience in using the system and the system itself evolves.

7. Financial Summary

The SSEPD R&D activities on distribution voltage level projects are operated from a common perspective across both distribution licence areas: the costs and benefits for these have been taken as applying across both licence areas in proportion to the size of each business area as determined by Regulated Combined Distribution Network Revenue. In round terms, this leads to 31% being allocated to SHEPD and 69% to SEPD.

Qualifying expenditure for the reporting period of 1st April 2014 to 31st March 2015 was £1,150,000 for SHEPD and £2,520,000 for SEPD, of which £251,000 and £551,000 relates respectively to internal costs.

Financial information on the IFI projects for the reporting year 1st April 2014 to 31st March 2015 is contained in the individual reports for SHEPD and SEPD as set out in the following sections and listed in Appendix 1.

8. Conclusion

SSEPD recognises the key role that R&D can play in enabling our industry to meet the challenges of an ageing infrastructure, a need for continuous improvement in customer service, and the challenges of a low carbon energy future with the growing importance of distributed energy resources (DERs).

Due to the scale of these challenges, it is important for us to continue to innovate and find new ways of delivering our services.

We are committed to the successful exploitation of our current programme of projects and will develop our portfolio to address areas that will deliver further benefits and add value in the future.

9. Regulatory Reports of IFI & RPZ Activities for April 2014 to March 2015

SHEPD IFI Report	
Combined Distribution Network Revenue	£254.60M
IFI Allowance	£1,273,000
Number of Active IFI Projects	60
Summary of benefits anticipated from IFI Projects.	Total net present value (NPV) of SSEPD projects is approximately £68M
	Various customer, safety, and environmental benefits will accrue along with more effective utilisation of existing assets
External Expenditure 2014/2015 on IFI Projects	£ 899,000
Internal Expenditure 2014/2015 on IFI Projects	£ 251,000
Total Expenditure 2014/2015 on IFI projects.	**£ 1,150,000**
Benefits actually achieved from IFI projects to date.	Generation connected through Orkney ANM avoiding costs in order of £30M Significant reduction of line survey through GIS tree clearance in excess of £5M. Reduction in tree cutting costs due to live line tree felling innovation in order of £200k
Regulatory Report for DG incentive, RPZs and IFI Reporting year 2014/2015 SHEPD	**£M**
Eligible IFI Expenditure (£M)	**1.150**
Eligible IFI Internal Expenditure (£M)	**0.251**
Combined Distribution Network Revenue (£M)	**254.60**

SEPD IFI Report	
Combined Distribution Network Revenue	£557.81M
IFI Allowance	£2,789,000
Number of Active IFI Projects	60
Summary of benefits anticipated from IFI Projects.	Total NPV of SSEPD projects is approximately £68M
	Various customer, safety, and environmental benefits will accrue along with more effective utilisation of existing assets
External Expenditure 2014/2015 on IFI Projects	£1,969,000
Internal Expenditure 2014/2015 on IFI Projects	£551,000
Total Expenditure 2014/2015 on IFI projects.	**£2,520,000**
Benefits actually achieved from IFI projects to date.	Significant reduction of line survey through GIS tree clearance in excess of £3M.
Regulatory Report for DG incentive, RPZs and IFI Reporting year 2014/2015 SEPD	**£M**
Eligible IFI Expenditure (£M)	**2.520**
Eligible IFI Internal Expenditure (£M)	**0.551**
Combined Distribution Network Revenue (£M)	**557.81**

SHEPD RPZ Report	
Name of RPZ	Orkney Active Distribution Network Management
DG Capacity	Total DG connected under the RPZ scheme at 31/3/15 is 9.02MW (with an additional 16.73MW generation capacity connected within the RPZ area on a business as usual basis)
Starting Year	2005/06
Description of project and technical details.	New generators accepted under the RPZ scheme are instructed to limit their output to match the available network capacity. Available capacity is derived from real time network measurements and will depend upon the rating of network, the level of Orkney demand and actual output of other local generation.
Expenditure for financial year	£ 69,060
Type(s) of innovation involved	Radical
Status (planned, under construction, operational) and operational starting year	Operational in 2009/10
Connection cost	£69,060
Expected benefit to customers when project was registered	Ability to connect an additional 15 MW of new renewable generation to the Orkney Distribution network. Avoided reinforcement cost of £ 30M

10. Individual Project Reports

2004_01: STP2 Overhead Networks Module

<table>
<tr><td>Project Title</td><td colspan="4">2004_01 Strategic Technology Programme (STP) 2 Overhead Networks module</td></tr>
<tr><td>Description of project</td><td colspan="4">A DNO research & development collaboration hosted by EATL.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £8,369
External £44,374
Total £52,743</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £49,115
External £436,161
Total £485,276</td></tr>
<tr><td>Project Cost
(Collaborative + external + SSEPD)</td><td>£329,000</td><td>Projected 2015/16 costs for SSEPD:</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">This module aims to optimise overhead network design, improve operational performance, maximise potential benefits, improve financial performance, and minimise risks associated with overhead networks, whilst having due regard for the environment and energy efficiency. The programme also aims to deliver continuous improvement in terms of safety and environmental performance of the overhead network to meet the individual business requirements of member companies. Several of the projects contribute to the industry’s knowledge of variation in the potential impact of climate change.
Updated information can be found at :- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Tech Transfer, Significant, and Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>16</td><td>9</td><td>25</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects in this module will significantly increase the performance and reliability of the network. In certain cases the asset life may also be extended.
If these projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each member DNO to gain benefits including:
• Improvements in network reliability by identifying root causes of faults and developing solutions;
• Safe early detection of potential defects that can then be repaired in a planned and timely fashion;
• Cost effective and early identification of damaged insulators and discharging components, which if not addressed would result in faults;</td></tr>
</table>

	• Development of tools, technology, and techniques to reduce risk or cost, as well as to increase speed of capital deployment of member company programme delivery; • A better understanding how OHL assets perform in service which can be used to determine the overall asset management policy; • Reduce levels of premature failure of assets; • Avoid redesign, reconstruction or refurbishment of OHL where this is driven by a perceived need to increase ratings or strengthen lines, and is required to conform with existing standards but which may be unnecessary; • Co-operation between European countries in the development of forecasting methods of atmospheric icing and for the exchange of forecasting tools; • Comparison of new covered conductor with known performance of older types; • Increasing scientific understanding of processes and climatic conditions leading to icing; • Extend the service life of poles and reduce potential levels of failures; • Reduce lifetime costs by the appropriate use of alternative materials; • Improved methodology for determining conductor ratings will provide greater confidence; • Positive impact on environmental performance and many have positive impacts on safety; • Give members a better understanding of novel conductors for new-build or re-conductoring lines that gives lower capital cost, minimum visual impact, and environmental acceptance.		
Expected Timescale to adoption	1-5 years dependent on project	**Duration of benefit once achieved**	3-5 years dependent on project
Probability of Success	49-95% dependent on project	**Project NPV = (PV Benefits – PV Costs) x Probability of Success**	Dependent on project

Potential for achieving expected benefits	There are a huge variety of projects within the second tier projects work programme for this module. A number of these projects are scientific based and will require further R&D to achieve improvements in operational performance and integration into the DNO's business environment. Projects in these areas are mainly stages of much larger multi-stage projects and require further work to optimise network design, financial performance, and operational performance from which the customer and stakeholders will benefit. Other projects were looking at better ways of improving the operational performance, management, and reliability of Overhead Networks by minimizing the impact on the environment and maximizing the safety of both the operators and the public, in a manner that could be implemented straight away. Collectively, the 14/15 work programme demonstrates the development of innovative products, processes and techniques that improve the management of Overhead Networks; in terms of safety, design, environment, reliability, security, and power quality.
Project Progress to March 2015	All projects or project stages started in the module during 14/15 have been completed and the STP5 programme has been closed. The outputs of individual stages which form part of larger multi-stage projects have provided some notable conclusions and recommendations which are available through EATL on request.
Collaborative Partners	Scottish Power Energy Networks, Northern Powergrid, Electricity North West, UK Power Networks, Western Power Distribution
R&D Providers	EATL

2004_02: STP3 Cable Networks Module

<table>
<tr><td>Project Title</td><td colspan="4">2004_02 STP3 Cable Networks Module</td></tr>
<tr><td>Description of project</td><td colspan="4">A DNO research & development collaboration hosted by EATL.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £8,737
External £91,131
Total £99,868</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £51,998
External £507,492
Total £559,490</td></tr>
<tr><td>Project Cost (Collaborative + external + SSEPD)</td><td>£374,640</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The STP Cable Networks programme for budget year 2014/15 was aimed at optimising underground cable network design, improving operational performance, maximising potential benefits, improving financial performance, and minimising risk associated with underground cable networks. This is whilst having due regard for the environment and energy efficiency. The programme also aimed to prevent cable failure modes and to deliver continuous improvement in terms of safety and environmental performance in all aspects of the underground cable network in order to meet the individual business requirements of member companies.

Several of the projects contribute to the industry's knowledge of variation in the potential impact of climate change.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Technology Transfer, Significant, and Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>14</td><td>8</td><td>22</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Projects in this module will significantly increase the performance and reliability of the cable network. In many cases the cable asset's life may also be extended.

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

• Use of an effective tool to improve the leak management of fluid-filled cable circuits, as well as reducing the risk of potential costly failures;
• Successful and practical methods for sealing ducts containing triplexed cable;
• A test that truly measures the mechanical robustness of a joint with an understanding of the performance between "green" resin-filled joints and conventional polyurethane (PU) filled joints. This could result in significant cost benefits;</td></tr>
</table>

	• Alternatives to current design and installation practices which offer benefits in lower lifetime cost, and higher performance (e.g. increased ratings); • Reduction of risk in environmentally sensitive areas; • A reduction in the number of accidents/incidents so increasing safety of staff and the public; • Reduced excavation required in locating leaks from fluid-filled cables, reducing the time and cost of leak location, and also reducing outage times; • A reduction in digging, causing less disruption to the public, as well as reducing the impact on the environment and avoiding disposal of soil to landfill; • Offsetting future increases in Capital Expenditure (CAPEX) and Operational Expenditure (OPEX); • Customer Interruptions/Customer Minutes Lost (CI/CML) savings per connected customer; • Reduced cable purchase costs; • Enforcing network resilience; • Implementation of strategies for reducing cable failures, resulting from excessive forces; • Reduction in number of cable faults; • Reduced design costs.		
Expected Timescale to adoption	1-2 years dependent on project	**Duration of benefit once achieved**	3-5 years dependent on project
Probability of Success	45-100% dependent on project	**Project NPV = (PV Benefits – PV Costs) x Probability of Success**	Dependent on project

Potential for achieving expected benefits	There are a huge variety of projects within the work programme for this module. A significant number of these projects are interlinked through the development of a scientific Fluid Filled Cable software tool to improve the leak management of fluid filled cable assets. This tool will reduce the risk of potential costly failures. This technical development described above consists of numerous single projects, but is only a part of much larger suite of projects over more than one financial year which require further R&D in order to optimise the financial performance, operational performance, and management of fluid filled cable assets from which the customer and stakeholders will benefit. Other projects were looking at better ways of improving the operational performance, management, and reliability of cable networks by minimizing the impact on the environment, and the safety of both the operators and the public in a manner that could be implemented straight away. Collectively, the 14/15 work programme demonstrates the development of innovative products, processes, and techniques that improve the management of cable networks; in terms of safety, design, environment, reliability, security and power quality.
Project Progress to March 2015	All projects or project stages started in the module during 14/15 have been completed and the STP5 programme has been closed. The outputs of individual stages which form part of larger multi-stage projects have provided some notable conclusions and recommendations which are available through EATL on request.
Collaborative Partners	SP Energy Networks, Northern Powergrid, ENW, UKPN, WPD
R&D Providers	EATL

2004_03: STP4 Substations Module

<table>
<tr><td>Project Title</td><td colspan="3">2004_03 STP4 Substations Module</td></tr>
<tr><td>Description of project</td><td colspan="3">A DNO research & development collaboration hosted by EATL.</td></tr>
<tr><td>Expenditure for 14/15 financial year</td><td>Internal £2,864
External £73,738
Total £76,602</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £54,529
External £395,624
Total £450,153</td></tr>
<tr><td>Project Cost
(Collaborative + external +SSEPD)</td><td>£332,896</td><td>Projected 15/16 costs for SSEPD</td><td>NIL</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The STP Substations programme for the budget year 2014/15 aimed to improve operational performance, maximise potential project benefits, improve financial performance, and minimise risk associated with substation assets whilst having due regard for the environment and energy efficiency. The projects aimed to provide cost effective solutions to increase reliability and deliver continuous improvements in terms of safety and environmental performance of existing and future substation assets in order to meet the individual business requirements of Member Companies.

Updated information can be found at :- https://www.stp.uk.net</td></tr>
<tr><td>Type(s) of innovation involved</td><td>Incremental, Tech Transfer, Significant, Radical</td><td colspan="2"><table><tr><th>Project Benefits Rating</th><th>Project Residual Risk</th><th>Overall Project Score</th></tr><tr><td>16.5</td><td>9.5</td><td>26</td></tr></table></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="3">Projects within this module will help improve reliability and safety of substations in distribution networks in line with government policy.

If the projects are technically successful and the findings and recommendations from the projects are implemented, then the projects will potentially enable each DNO Member of the programme to gain the following benefits, including:
Increased reliability and continuous improvement in terms of safety and environmental performance of existing and future substation assets;
Collaborative evaluation of battery installations and operational practice to ensure a safer and more reliable network;
CI/CML savings per connected customer;
Optimising safety and environmental requirements for management of insulating oils and SF_6;
Technical liaison with International Utilities to share new technology and failure modes;</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">Offsetting future increases in CAPEX and OPEX;
Development of condition based assessments, or tests, to determine asset condition;
Preventing failures of oil-filled equipment, tap changers, earth switches will improve safety and avoid unnecessary scrapping of serviceable components, which will alleviate environmental impact;
Extending serviceable life of switchgear and transformers;
Further developing technical understanding of protection system maintenance requirements;
Understanding the degradation and failure processes of substation plant and equipment, as well as quantifying the risks associated with those processes;
Further developing technical understanding of operational staff in complex electrical issues;
Mitigating risk to environment;
Increased safety of staff and public by reducing risk of fire and the number of accidents / incidents.
Reduced lifetime costs and improved functionality by the appropriate use of new technology.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1-4 years dependent on project</td><td>Duration of benefit once achieved</td><td>1-6 years dependent on project</td></tr>
<tr><td>Probability of Success</td><td>30-95% dependent on project</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£32,721</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">There are a huge variety of projects within the 2014/15 work programme for this module. A significant number of these projects are scientific based, researching technical developments in degradation monitoring and understanding the failure processes of substation plant and equipment, whilst quantifying the risks associated with those processes.

Projects in these areas are mainly single stages of much larger multi-stage projects which require further R&D in the areas of condition based assessments, tests, asset management tools, systems, and methodologies in order to optimise the financial, operational performance, and design of Substation plant from which the customer and stakeholders will benefit.

Other projects were looking at better ways of improving substation workings, the performance and reliability of substation plant, maintenance regimes, as well as minimizing the impact on the environment, and the safety of both the operators and the public, in a manner that could be implemented straight away.

Collectively, the 14/15 work programme demonstrates the development of innovative products, processes, and techniques that improve the management of Grid Transformers to enhance Peak Rating, evaluating Battery Monitoring Techniques</td></tr>
</table>

Project Progress to March 2015	All projects or project stages started in the module during 14/15 have been completed and the STP5 programme has been closed. The outputs of individual stages which form part of larger multi-stage projects have provided some notable conclusions and recommendations which are available through EATL on request.
Collaborative Partners	SP Energy Networks, Northern Powergrid, ENW, UKPN, WPD
R&D Providers	EATL

2004_04: STP5 Networks for DERs

Project Title	2004_04 STP5 Networks for DERs			
Description of project	DNO research & development collaboration hosted by EATL			
Expenditure for 2014/15 financial year	Internal £8,950 External £4,591 **Total £13,541**		**Expenditure in previous (IFI) financial years**	Internal £64,523 External £448,547 **Total £513,070**
Total Project Costs (Collaborative + external + SSEPD)	£461,910		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	The aim of the STP Networks for DERs programme for budget year 2014/15 was to maximise potential benefits and reduce costs and risks associated with facilitating the design, development, and operation of networks for the integration of low carbon technologies into future network designs, whilst having due regard for the environment and energy efficiency. The program is currently being reviewed in line with RIIO ED1 regulatory guidelines to ensure all projects comply with the requirements of Ofgem's Network Innovation Allowance (NIA). This will serve to cost-effectively improve the operational efficiency and business performance of Member Companies. Updated information can be found at :- https://www.stp.uk.net			
Type(s) of innovation involved	Various	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		13.5	8.5	22
Expected Benefits of Project	Projects within this module will be designed to qualify for DNO funding through the Member Company's Network Innovation Allowances. The objective of these projects will remain as improving the reliability and safety of distributed energy sources within the UK electricity network. If the findings and recommendations from the projects are implemented, the projects will potentially enable each DNO Member of the programme to gain benefits including: • Investigation of DG connection methods without undue reinforcement, while at the same time improving supply quality by reducing CMLs and improving voltage levels, etc; • Improvements on environmental performance and potential to develop positive impacts on levels of safety; • Increased understanding between all member companies on			

<table>
<tr><td></td><td colspan="3">technical, commercial, and regulatory issues together with the development of effective solutions to these issues;
• Developing an understanding of the implications of connecting low carbon technologies to the distribution network in terms of safety, design, reliability, security, and power quality;
• Where possible, optimising the Government's low-carbon strategy and accommodating the growth of embedded DG;
• Improved management regarding the implications of connecting distributed resources to the distribution network in terms of the statutory, regulatory, and commercial frameworks;
• Investigating low carbon network designs and planning the transition from passive to active networks;
• Developing Improvements in power quality issues due to dynamic load change;
• Enabling the development of strategies to manage power quality levels and customer expectations;
• Reduction in losses for DNOs;
• Highlighting the issues and benefits of Smart Grids, Smart Meters, and ANM Systems, ultimately improving CI/CML;
• Significant benefits in terms of enhanced knowledge and awareness of overseas best practice in DG system integration, which can be applied as appropriate in the UK;
• Ensure that all participants optimise network design, financial, and operational performance as the levels of storage, managed-demand, and DG increase on the distribution networks;
Developing emerging DG, demand-side management, and storage technologies in line with relevant NIA requirements.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1-3 years dependent on project</td><td>Duration of benefit once achieved</td><td>2-5 years dependent on project</td></tr>
<tr><td>Probability of Success</td><td>51-100% dependent on project</td><td>Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>Dependent on project</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">There are a variety of projects within the 2014/15 work programme for this module. A number of these projects are scientific based and will require further R&D to achieve improvements in operational performance and integration into the Network Operators business environment. Projects in these areas are mainly stages of much larger multi-stage projects and require further work to optimise network design, financial, and operational performance from which the customer and stakeholders will benefit.</td></tr>
</table>

	Other projects are looking at better ways of improving working and productivity for network planners, in a manner that could be implemented immediately as BaU. Collectively, the 14/15 work programme demonstrates the development of technical understanding in relation to connecting and integrating low carbon technologies onto the distribution network; in terms of safety, design, reliability, security, and power quality. One of ultimate objectives of all these segments is to draw up the policies required to define how these R&D concepts will be deployed in a BaU format to comply with the requirements of each DNO's NIA.
Project Progress **March 2015**	All projects or project stages started in the module during 14/15 have been completed and the STP5 programme has been closed. The outputs of individual stages which form part of larger multi-stage projects have provided some notable conclusions and recommendations which are available through EATL on request.
Collaborative Partners	SP Energy Networks, Northern Powergrid, ENW, UKPN, WPD
R&D providers	EATL

2004_06: Equipment – Protective Coatings Forum

Project Title	2004_06 Equipment – Protective Coatings Forum				
Description of project	The 'Protective Coatings Forum' deals with the specification and testing of approved paint systems for tower lines and plant. It approves paint supplies, provides technical and legislative updates affecting the use of protective coating paint systems and it provides field support to check the quality of contractors work for member companies.				
Expenditure for 2014/15 financial year	Internal £4,803 External £10,267 **Total £15,070**		**Expenditure in previous (IFI) financial years**	Internal £43,303 External £54,861 **Total £98,164**	
Total Project Costs (Collaborative + external + SSEPD)	£ 120,000		**Projected 2015/16 costs for SSEPD**	NIL	
Technological area and/or issue addressed by project	European Legislation affecting the use of Volatile Organic Compounds in 'Protective Coatings' and testing of alternative, more environmentally friendly paint systems.				
Type(s) of innovation involved	Incremental				
Expected Benefits of Project	This work facilitates the ongoing testing of paint systems in order ensure compliance with changes in European legislation. It also facilitates the process of monitoring and authorisation of paint suppliers. The work also ensures the maintenance of protective coatings paint specifications, and includes site checks and compliance testing of contractor paint.				
Expected Timescale to adoption	6 Years		**Duration of benefit once achieved**	40 Years	
Probability of Success	90%		**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£20,000	
Potential for achieving expected benefits	High				
Project Progress March 2015	Field trials seem to suggest that many of the new products being tested will enhance/prolong the protection of both towers and foundations going forward this will give benefits to the owners of the apparatus. Another product being tried may extend a rusted sections life by up to 40 years. The forum was closed down towards the end of DPCR5 but benefits from the projects created within it may have lasting effects on DNO's in to the future.				
Collaborative Partners	Paint suppliers and other DNOs.				
R&D providers	EATL				

2004_11: Collaborative ENA Projects

Project Title	2004_11: Collaborative ENA Projects			
Description of project	The Energy Networks Association (ENA) represents all the UK network operators. Several projects have been initiated by the ENA R&D Working Group and have been funded through the IFI.			
Expenditure for 2014/15 financial year	Internal £7,164 External £2,972 **Total £10,136**		**Expenditure in previous (IFI) financial years**	Internal £47,792 External £114,040 **Total £161,832**
Total Project Costs (Collaborative + external + SSEPD)	£140,000		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	The projects listed below address issues which have been identified by the ENA working groups as significant – requiring technical investigation and development. There are a number of projects that have been completed and reported in previous IFI years. The projects this year are: **Reactive Power (REACT):** In the last 2 years, there have been significant difficulties in managing voltage levels during minimum demand periods. Analysis of this issue has shown that the root cause is related to the significant decline in reactive power relative to active power. Whilst minimum active power demands have fallen by around 15% in the last 5 years, reactive power has declined by 50% in this time. Current trends for 2012 show that this reduction is continuing, broadly, across the country. In order to better understand the challenge of manage voltage levels within licence standards and to plan for additional future reactive compensation requirements, a thorough understanding of the reactive power trend needs to be developed. **DS2030:** The DECC/Ofgem Smart Grid Forum was created by the Department of Energy and Climate Change (DECC) and Ofgem to support the UK's transition to a secure, safe, low carbon, affordable energy system. The main issue discussed within the DECC/Ofgem Smart Grid Forum is how electricity network companies will address significant new challenges as they play their role in the decarbonisation of electricity supply. The Smart Grid Forum has established a number of Work Stream (WS) to examine particular aspects of future networks.			

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>6.2</td><td>-10</td><td>16.2</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">These projects have the potential to provide a wide range of benefits. In some cases, they will help to understand key asset-related issues and allow designs to be altered to address them. In other cases they will allow us to better understand risks to our network, whether from climate change or changes in demand. The smart metering project is already having a valuable input to the overall smart metering consultations.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2</td><td colspan="2">Duration of benefit once achieved</td><td>10-20 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£ 100,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">High</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="4">Reactive Power (REACT): The objectives corresponding to the First Year Report Stage 1 and the Second Year Six-month Report have been met within the last 12 months (May 2014 to May 2015) and the corresponding reports delivered. Two additional brief project status reports have also been delivered.

It is important to highlight that the project was initially planned to start in May 2013 but it actually did in August 2013. The Second Year Final Report Stage 2 is on track and will be completed by August 2015.

The outcomes of the project are in accordance with the initial objectives of the project proposal. More specifically, the following tasks have been accomplished:

• Identification of historic network and demand changes and trends.
• Quantification of effects on reactive demand during minimum load from different distribution-based factors (i.e., demand trends in primary substations, network changes, penetration of photovoltaics).
• Assessment of future reactive demand at transmission-distribution interfaces of different DNOs.
• Production of improved network models, which unlike original DNO models mimic transmission-distribution interfaces during periods of minimum load, to be used for further studies</td></tr>
</table>

	DS2030: Works during the second half of 2014 focussed on defining the four representative networks that will be used for the study and the future scenarios that will be applied. The base networks were finalised and agreed in November 2014 and, following additional development work, the scenarios were finalised in early 2015. In addition, an international review was conducted to capture learning from work in other countries and this was concluded in September 2014. An updated version will be produced towards the end of the study to ensure any more recent work is identified. Towards the end of 2014, the key questions the DS2030 project aims to answer were reviewed. Minor revisions were agreed with the project Steering Group and WS7 in February 2015. Since the start of 2015, efforts have focussed on defining the detailed methodologies to be used in the network analysis studies. These were presented as a series of discussion papers which were reviewed and agreed by the Steering group and WS7. This stage was largely concluded by May 2015 and studies are now commencing. Both projects have been transitioned to the NIA scheme. Further information is available at the Smarter Networks Portal, please see links below: http://www.smarternetworks.org/Project.aspx?ProjectID=1460#project-details http://www.smarternetworks.org/Project.aspx?ProjectID=1623#downloads
Collaborative Partners	National Grid, Scottish Power Energy Networks, Electricity North West, Western Power Distribution, Northern Powergrid
R&D providers	TNEI, Engage Consulting Limited, Imperial College London, Met Office, EA Technology Ltd, Earthing Solutions, KEMA, Redpoint Energy

2007_01: DG and ARM Strathclyde

Project Title	2007_01 DG and ARM Strathclyde			
Description of project	Sponsored endowment with University of Strathclyde for applied research and development of Distributed Generation (DG) and Asset Risk Management (ARM)			
Expenditure for 2014/15 financial year	Internal £6,435 External £55,853 **Total £62,288**		**Expenditure in previous (IFI) financial years**	Internal £44,348 External £347,585 Total **£391,933**
Total Project Costs (Collaborative + external + SSEPD)	£400,000		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	Increased and more controlled output from Distributed Generation. Improved management of distribution assets. The current focus of research under this Fellowship is on the themes of LV network analysis and DSO-DSM.			
Type(s) of innovation involved	Incremental, significant, technological substitution and radical	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		10	0	10
Expected Benefits of Project	Financial project benefits are expected. The benefits will be across a range of areas including construction, maintenance, refurbishment and operation.			
Expected Timescale to adoption	3 years	**Duration of benefit once achieved**		40 years
Probability of Success	25%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**		£321k
Potential for achieving expected benefits	Previous work delivered benefits by informing the development and application of asset risk management within SSEPD.			

Project Progress March 2015	This project has now finished and the following activities were completed during the project and the outputs associated with the various activities are listed below: **Elgin Heat Pump Data** Activities: • Initial analysis and interim report with early insights • Full year data sets accessed and imported to UoS • Data cleansing and pre-processing • Transformer performance evaluation • Heat Pump ADMD estimation • Comparison to other LCNF outputs • Identifying key insights from dataset and gaps in current knowledge Outputs • Final Report **NTVV Support** Activities • Establishing project scope with University of Reading team • Literature review (storage sizing and location on distribution networks) • Modelling case study feeders for testing UoR storage scheduling algorithms • Best location methodology for LV storage • Phase balancing and reactive power investigation • Initial case study results – presented at LCNI conference Oct 14 • Further storage scheduling algorithm development • Further case study modelling and impact analysis on Bracknell case studies Outputs • UoS/UoR joint Academic Paper 'Maximising the Benefit of Scheduled Battery Energy Storage Systems on LV Networks' • Internal report linking previous Fellowship LV networks research and potential applications of probabilistic impact analysis methodology within NTVV • Case studies, algorithms and impact analysis code have been developed in conjunction with UoR and will remain available within NTVV **Publications** • D. Frame, B. Potter, T. Yunusov. Maximising the Benefit of Scheduled Battery Energy Storage Systems on LV Networks. In Draft. • D. Frame, G.W. Ault. A Framework for Probabilistic Planning and Analysis of Low Carbon Technology Integration into LV Networks. Journal – under revision. • D. Frame, G.W. Ault. Probabilistic Operational Envelopes for Demand Response of New Low Carbon Loads on Low Voltage Networks. CIGRE General Session 2014. August 2014.

	• S. Huang, D. Infield, A. Cruden, D. Frame, D. Densley. Plug-in Electric Vehicles as Demand Response to Absorb Local Wind Generation in Power Distribution Network. EVS27 Nov 2013. • D. Frame, G. W. Ault. The Uncertainties of Probabilistic LV Network Analysis. IEEE Power & Energy Society General Meeting 2012. • D. Frame, G. W. Ault. Exploring the Uncertainties of Probabilistic LV Network Analysis. 22nd International Conference on Electricity Distribution (CIRED), May 2012. • D. Frame, G. W. Ault. A framework for low voltage network planning in the era of low carbon technology and active consumers. 22nd International Conference on Electricity Distribution (CIRED), May 2012. • M. Dolan, G. W. Ault, D. Frame, et al. Northern Isles New Energy Solutions: Active Network Management Stability Limits. IEEE PES Innovative Smart Grid Technologies, Oct 2012. • S. Gill, M. J. Dolan, D. Frame, G. Ault. The Role of the Electric Heating and District Heating Networks in the Integration of Wind Energy to Island Networks. International Journal of Distributed Energy Resources, July 2011. • Frame, D.F., G. Ault, and N. Hughes, Energy scenarios and implications for future electricity demand, in: The Future of Electricity Demand. 2011: Cambridge, UK. **Internal Reports** • Elgin Heat Pump Data Analysis Report. D. Frame. Jan 2015. • Low Voltage Network Analysis Review and Recommendations. D. Frame, G. Ault, Sept 2011. • Power system dynamic modelling of DSM operational envelope (Sheltand Case) – LCNF Support Project 1. D. Frame, M. Dolan, G. Ault. Aug 2010. • Shetland Wind Electric Heating Demand Response Study – LCNF Support Project 2. D. Frame, M. Dolan, G. Ault. Aug 2010. • Description of Shetland electrical system and prospective projection of NINES project results to GB – LCNF Support Project 4. D. Frame, M. Dolan, G. Ault. Aug 2010. • Assessment of LV network measurements and state estimation – LCNF Support Project 1. D. Frame, M. Dolan, G. Ault. Aug 2010. • Smart Grid Horizon Scanning Report. D. Frame, G. Ault, Jan 2010. • Active Network Management Roadmap. D. Frame, G. Ault, Oct 2009. • Smart Grid Project Register. D. Frame, G. Ault, Oct 2009.
Collaborative Partners	None
R&D providers	University of Strathclyde

2008_03: IET Power Networks Research Academy

Project Title	2008_03 IET Power Networks Research Academy			
Description of project	The Power Networks Research Academy has been established through a strategic partnership agreement between the Engineering and Physical Sciences Research Council (EPSRC), electricity transmission and distribution companies, related manufacturers, and consultants. The Academy funds and supports PhD researchers in power industry related projects and helps maintain and improve the research and teaching capacity in power engineering subjects.			
Expenditure for 2014/15 financial year	Internal £7,164 External £9,761 **Total £16,925**		**Expenditure in previous (IFI) financial years**	Internal £76,081 External £208,376 **Total £284,457**
Total Project Costs (Collaborative + external + SSEPD)	£ 1,915,000		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	• Enhanced performance of power utility networks with increasing levels of DG (Distributed Generation); • Reduction of static voltage control requirements in utility's networks; • To provide a means by which higher penetrations of DG can be connected to the network; to aid in 2020 renewable generation targets and the UK 2050 grid vision; • Protection of future power systems encompassing DG, converter interfaces and energy storage; • Investigation of sub synchronous resonance phenomenon in AC/DC meshed power networks; • State estimation for active distribution network ; • Overhead lines measurement system (OHMS); • Protection issues of inverter-interfaced DG; • Intelligent insulation systems; • Influence of oil contamination on the electrical performance of power transformers; • Using power electronics to increase power capacity without changing infrastructure; • Alternatives to SF6 as an insulation medium for distribution equipment; • Early Frequency Instability Measurement • Application of Artificial Immune System Algorithm to Distribution Networks • System Impacts and Opportunities of HVDC Upgrades • Effect of climate change on design and operation of meshed networks			

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant, Technological substitution, and Radical innovations</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>9.4</td><td>0</td><td>9.4</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">It is expected that the academy will:
promote a stronger, more active and robust R&D environment in power networks disciplines at UK universities;
provide capacity and capability to undertake the specialist research needed by industry and wider stakeholders;
strengthen the teaching capability at those institutions;
focus on building up the resource and expertise of a number of power research universities;
facilitate a resource of trained engineering staff with academic capability, who will be capable of tackling electrical power engineering challenges;
Deliver research output that is industrially relevant;
See online for further information at:
http://www.theiet.org/about/scholarships-awards/pnra/</td></tr>
<tr><td>Expected Timescale to adoption</td><td>Year 2012 onwards</td><td colspan="2">Duration of benefit once achieved</td><td>20 Years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£200,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Progress made to date indicates that the project’s potential for achieving expected benefits is high.</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="4">A range of projects have been pursued under the PNRA programme. Some of these were completed prior to 2014/15 and have previously been reported.

The latest progress reports are as follows:</td></tr>
</table>

	Reactive Power Dispatch for Distributed Generation A balanced voltage control algorithm has been developed. This algorithm has three significant control actions. Firstly, available reactive power reserves are utilised. Secondly, if required, DG active power output is curtailed. Finally, curtailment of non-critical site demand is considered. A merit order of selecting DG units to participate in reactive power support is assessed based on the sensitivity of the network to reactive power injection or absorption at the DG unit's point of connection. In practice, the merit order is also envisaged to acknowledge the speed of response of units in the dispatch process. The control algorithm which can be used on balanced networks has been developed and tested on a variant of the IEEE 13 bus distribution test feeder. Two conference papers have resulted from this work and are to be presented in June and July at Powertech, and the Power and Energy Society General Meeting respectively. The control algorithm has been modified to control voltages on unbalanced distribution networks, to work with the presence of existing network reactive power support and for a range of DG units. Present progress show that both power system losses and voltage profiles can be enhanced with the involvement of DG, as preformed on the IEEE system. As such it is believed that the expected benefits of the project can be realised, on the SSEPD Westray network, with suitable network monitoring and communications. Protection of future power systems encompassing DG, converter interfaces, and energy storage A new fault location algorithm for double circuit series compensated lines. This algorithm is novel in that it does not require any line parameters. It only requires the synchronised measurement samples of voltage and current and the fixed series capacitor reactance. The algorithm can also be applied to traditional double circuit lines. It is applicable to both transposed and untransposed lines. The completion of Journal Papers to be submitted to IEEE The work completed as a part of the project is to be submitted to IEEE journals. Thesis write-up

	State Estimation for Active Distribution Network Current tools in the industry do not handle discrete nature of transformer tap positions: • Causes nonlinear non-convex characteristics of the objective function • Reduce the performance of SE • Result in inaccurate estimation of transformer tap positions and inaccurate estimation of losses <u>Deliverables</u> • More accurate estimation of transformer tap positions • Accurate estimation of node voltages and angles • More accurate estimation of losses for unbalanced distribution system <u>Progress</u> 1. Transformer tap estimation using Hybrid particle swarm optimization (HPSO) technique for unbalanced Distribution State Estimation (DSE) which can estimate the transformer tap positions and node voltages and angles more accurate than other conventional methods of State Estimation (SE). The feasibility and robustness of the proposed method for SE has been demonstrated on the IEEE 123 bus test system. The results confirmed the potential of the HPSO method and showed its effectiveness in estimation of transformer tap positions with discrete values 2. Calculation of losses based on the estimated results which have been obtained from Hybrid particle swarm optimization (HPSO) algorithm. <u>Benefits</u> • More accurate estimation of transformer tap positions • Accurate estimation of losses • Accurate estimation of losses helps to devise a strategy to minimise them • It also helps to obtain fair allocation of the cost of losses to customers which is 6-8% of the total cost on the bill Paper availability: Final report will be available after PhD completion on 13/11/2015.

	Overhead Lines Measurement System (OHMS) The student submitted the thesis and passed the viva examination in December 2012.Between April and December 2012, the prototype system was further developed to the point where two prototypes have been tested and verified in laboratory conditions. Further to this, a journal paper titled "Fault Location using a Multi-Branched Approached" has been submitted. Two further papers are being finalised; one on communication over power lines and one detailing the hardware and technology used to create the prototypes. The project is being continued and field trials are planned. **Protection Issues of Inverter-Interfaced Distributed Generation** Two industrial deliverables during this period were: • work surrounding the topics of constant power loads in microgrids, • droop controller behaviour under fault conditions. Constant Power Loads in Microgrids: This work developed a small-signal stability model of a constant-power load and integrated the model into an existing microgrid network model. An interaction between the active load and the controllers of the inverter-interfaced generation was found from participation analysis of the model. Findings from this research were presented at two conferences and published in the journal IEEE transactions on Power Electronics. Resetting of inverter current limits: This work investigated and delivered design-rules on how inverter controllers should reset from current limiting mode to normal operation. An impedance-based method of detecting over-currents and faults for inverter controllers has been developed. This research was published in two papers. The first paper was published in the journal IEEE transactions on Power Electronics and the second paper was presented at the 15th European conference on power electronics and applications. Droop Controller Behaviour under Fault Conditions: The transient stability of droop controllers under fault conditions was investigated and delivered an understanding on the factors that affect the recovery of a droop controlled microgrid when subject to a fault. This research has been submitted to the 16th European conference on power electronics and applications.

Intelligent Insulation Systems

The project has been completed with industrial deliverables of:

- Investigation into the viability of a passive dielectric material which provides a visible response to a local electric field;
- A study of the behaviour of two classes of liquid crystals under an applied field (in terms of opaque-transparent switching in the presence of an electric field);
- Model of a passive multilayer voltage detection system with a focus on effect of material permittivity on sensitivity of equipment;
- Discussion of potential materials to fulfil model requirements: additional study of high permittivity micro- and nano-scale fillers included to fulfil high permittivity material requirements.

Influence of wind uncertainty on National Grid's Operating Reserve

Further review of the published literature within the fields of wind power forecasting and integration, power system reliability as well as stochastic and linear programming has been conducted. Based on this, a stochastic unit commitment model was developed and applied to a small test system to better understand the potential and limitations that such methods provide for reserve procurement.

Additional literature review related to the current UK electricity market structure and Electricity Market Reform (EMR) was conducted to enable adaptation of the stochastic programming models to reflecting the structure of the UK electricity market.

Furthermore, bi-level optimisation models have been developed in order to model the behaviour of generators and storage operators under market power in the electricity markets. This will be used later to model the effect of storage participation in reserve markets.

Other activities conducted involve poster presentations at the University of Strathclyde Faculty of Engineering Research day and the IET PNRA Scholar Event 15-16 October 2013 as well as attendance at the Energy Systems Week, 22-26 April 2013.

	The effect of Climate Change on the Design and Operation of Meshed Power Networks Research Area: Transmission networks security and reliability and the effects of weather and extreme storms. <u>Deliverables:</u> •Allow the operators to plan and manage the transmission network more effectively esp. when a storm is approaching •Allow them to look at the suitability of network design and allow relaxation of network security when certain weather types are forecast and be able to better plan depending on future weather conditions •To be able to better plan maintenance schedules if unable to complete all desired maintenance during the summer months due to more load in the summer months than before. Progress in the period April 2014 – March 2015 has been: •GB split into 4 areas to take into account the variations in weather from North to South •Four stage methodology developed to develop a relationship between different weather types and weather faults •Final loop of weather analysis taken place for Wind Gusts, Wind Speed, Snowfall, Snow Depth, Minimum Temperature and CAPE. •Final wind related fault probabilities have been calculated in a per area, per 100km, per hour (relationships, such as correlations per area have also been done)(Using Wind Gusts) •Final snow related fault probabilities have been calculated in a per area, per 100km, per hour (relationships, such as correlations per area have also been done)(Wind Gusts on Snow Days) •Final lightning related fault probabilities have been calculated in a per area, per 100km, per hour (relationships, such as correlations per area have also been done)(using CAPE) •Non-weather fault probabilities have been calculated in a per area, per 100km, per hour •Other Weather fault probabilities have been calculated in a per area, per 100km, per hour

	•Lightning strike data was collected from EA Technology •Weather analysis between lightning strike data and CAPE has taken place •Developed Matlab code to run the Monte Carlo simulation. This uses the probabilities to model the effects of weather based on probabilities previously calculated •Extreme weather modelling and probabilities included in the MC code •Future weather scenarios have been looked at and used to start developing possible test cases •Durational analysis has taken place for weather and faults •Simulations being run using a 150 bus model – line lengths have been calculated and include •Thesis plan developed – per chapter and section •Thesis writing started <u>Benefits</u> •To see the current effects of weather on the transmission network and what the future impacts could be due to climate change (more adverse weather, weather occurring more often etc.) and draw a comparison between the two •To assess the risk of disturbances on the transmission network due to weather. <u>Paper availability</u> Paper available after submission in July 2015

	Influence of oil contamination on the electrical performance of power transformers This project is particularly investigating the effect of insulating and conducting particles on HVDC converter transformers in terms of leakage currents, partial discharge, breakdown voltage, temperature, shape of electrodes/conductors etc. Progress Made 1. Covered electrode tests have been repeated with cellulose particle contaminated transformer oil under the influence of several levels of DC electric field. 2. Experiments have been repeatedly carried out with several levels of contaminated transformer oil under the influence of several levels of DC electric field with kraft paper barrier between bare spherical electrodes. 3. Numerical simulation of cellulose particle trajectory of charging and discharging phenomenon under the influence of DC electric field with sphere-sphere and needle-plane electrode systems. 4.PhD theses and viva have been completed. Benefits Further understanding of the effect of particle contamination on HVDC converter transformers. These results and mathematical simulation will be helping while designing future HVDC transformers. Paper availability Final report is preparation for National Grid after completion of final PhD thesis (May 2015). **Using Power Electronics to increase Power Capacity without changing Infrastructure** Future connection of electric vehicles (EV), electric heating and distributed generation (DG) will result in increased burdens on the low voltage (LV) distribution network. Power levels will increase with implications for network loading and voltage profiles. The latter will be made worse by EV's with Vehicle-Grid capable chargers and possible reverse power flows from DG.

	Point of use voltage regulation allows distribution network capacity to be increased by exploiting the full cable AC voltage rating (above 415V line) and removing the need for tight regulation of load voltage profile. The project has evaluated the potential gains in capacity/cable losses that can be achieved through the use of increased distribution voltage with voltage regulation. Potential point of use regulators have been investigated focusing on quantifying the cost and efficiency of these devices; allowing a full system level evaluation to be made. **Alternatives to SF6 as an insulation medium for distribution equipment** The project aimed to demonstrate the use of an environmentally friendly insulation gas known as Trifluoroiodomethane (CF3I) and its mixtures with carbon dioxide (CO2) for application in distribution equipment as an alternative to the global warming gas Sulphur Hexafluoride (SF6). At the end of the project a PhD Thesis on the findings of the research of the design, tests and performance of CF3I high voltage switches / RMUs with suitability recommendations for power companies has been produced. The main contributions of this work are: •A review of present day SF6 switchgear and an extensive appraisal of the properties of CF3I and CF3I gas mixtures. •Developing and implementing a novel test rig that can be used to test CF3I-CO2 as an alternative insulation medium in practical MV switchgear •Experimental investigation and demonstration of CF3I-CO2 insulation capabilities •Developing a simulation approach in COMSOL that can determine whether a specific mixture of CF3I-CO2 can insulate equipment. This uses calculated effective ionisation coefficients of various CF3I-CO2 gas mixtures. •A proposal for vacuum interrupters to use CF3I gas mixtures as replacement insulation to SF6 gas.

	Benefits A contribution to the growing research pertaining to CF3I and its insulation capabilities as well as an indication as to whether it can be used, if not partially, as a possible replacement for SF6 gas in distribution equipment. Paper Availability PhD Thesis Entitled: Investigation into CF3I-CO2 gas mixtures for insulation of gas-insulated distribution equipment - http://orca.cf.ac.uk/64853/ **Reducing the risk of Sub Synchronous Resonance in meshed power networks with increased power transfer capabilities** This project is now complete. The main findings can be found below. ▪ Two indices, one for torsional interactions and one for transient torques amplification, were developed to quantify the problem of SSR. Generators in a large network were ranked based on the severity of SSR problem using these indices and results were verified using electromagnetic transient simulations. ▪ A methodology for the risk evaluation of SSR was also developed. This methodology can identify the levels of SSR risk the generators in the network are exposed to, in each contingency considering the probability and severity of SSR problem. ▪ The influence of the voltage-source converter (VSC) HVDC system operating parallel to compensate lines in a large meshed network was also investigated. Studies were performed with different power transfers through the VSC link in various network configurations. ▪ It has been found that in normal network configuration, critically compensated system may become unstable with as low as ±5% uncertainty in the mechanical parameters. The probability of becoming unstable due to mechanical parameter uncertainty stays the same with both type of compensation schemes in the normal network configuration and reduces with asymmetrical compensation in N-1 and N-2 contingency

	Easing Future Low Voltage Congestion with an AC-AC Conversion Future connection of electric vehicles (EV), electric heating and distributed generation (DG) will result in increased burdens on the low voltage (LV) distribution network. Power levels will increase with implications for network loading and voltage profiles. The latter will be made worse by EV's with Vehicle-Grid capable chargers and possible reverse power flows from DG. Point of use voltage regulation allows distribution network capacity to be increased by exploiting the full cable AC voltage rating (above 415V line) and removing the need for tight regulation of load voltage profile. These potential gains must be balanced against the additional cost and losses associated with the power electronic converters required for point of use regulation. The project has evaluated the potential gains in capacity/cable losses that can be achieved through the use of increased distribution voltage with voltage regulation. Potential point of use regulators have been investigated focusing on quantifying the cost and efficiency of these devices; allowing a full system level evaluation to be made. <u>Deliverables</u> Thesis documentation providing an assessment of point of use voltage regulation distribution system as a means of increasing distribution network capacity. Progress in the period April 2014 – March 2015 has been: • Journal Paper Published: IET Journal Generation Transmission and Distribution • Conference Paper Published: PEMD 2014 • AC Chopper Prototype completed and results collected • Simulation work completed and results collected Chopper for selective harmonic elimination • Work completed and results collected on a novel circuit design incorporating auto-transformer • Thesis preparation (Target submission June 2015) <u>Paper availability</u> End User Voltage Regulation to Ease Urban Low Voltage Distribution Congestion - IET GTD http://www.crossref.org/iPage?doi=10.1049%2Fiet-gtd.2013.0323

	Strategic Behaviour and Ownership of Energy Storage Systems This project aims to develop tools to aid discussions on Energy Storage System (ESS) ownership and regulation. Modelling tools for generators with market power in electricity markets. Scheduling tools for ESS deployment for congestion management. <u>Progress</u> Further review of the published literature within the fields of Energy Storage System (ESS) regulation, ownership models, technical constraints and degradation was carried out. Based on this, a bi-level optimising model was developed to investigate the behaviour of ESS in congested power systems where it may have significant market power. The approach is being developed to reflect the new UK Balancing Market structure and applied to a small test system to better understand the potential behaviour of ESS in the current as well as a potential future locational priced BM. A similar approach may be used to investigate potential future conflicts between independent ESS operators at distribution level, their interaction with potential future Distribution System Operators (DSO) and the interaction between the DSO and Transmission System Operator (TSO). This may be used to set up penalty systems that will provide the right price signals to ESS operators to not operate their assets in a way that results in potential DSO violations of the contracts they have set up with the TSO. Other activities conducted since April 2014 includes poster presentations at the University of Strathclyde Faculty of Engineering Research day and poster presentation at the UK Energy Storage Systems conference in Warwick. <u>Benefits</u> Improved understanding of ESS behaviour in electricity markets, potential ownership structures and rules to aid ESS operation. Paper availability: Awaiting second round of review **Fault Location on Series Compensated Transmission Lines** Research Area: Fault Location on Series Compensated Transmission Lines <u>Deliverables</u> •Full thesis detailing all results obtained for studies carried out over the past 4 years. This includes details of a comprehensive line-parameter free fault location algorithm for single-circuit series compensated lines

	•A line-parameter free fault location algorithm for double-circuit series compensated lines. •An algorithm to account for shunt admittance of the line, in a line-parameter free manner. •The thesis also contains the relevant project background and a detailed literature review for fault location on series compensated transmission lines <u>Progress</u> Completion of PhD thesis: Increased generation to meet the anticipated future electrical power demand requires appropriate transmission infrastructure reinforcements. In such a rapidly changing power network, series compensation of transmission lines offers the advantage of increased power transfer capability without the need for building new transmission lines. Protection and fault location on such lines cannot be addressed sufficiently by conventional solutions developed for traditional uncompensated lines. The main objective of the research presented in this thesis was to develop accurate and reliable solutions for the fault location on series compensated transmission lines. By accurately locating permanent faults, the time required by crews in repairing the line can be minimised and prolonged disruption of service can be avoided. Therefore, these solutions are aimed providing an economic benefit to utilities. Line-parameters vary with loading and weather conditions, and therefore settings used for fault location may be erroneous. Line-parameter free solutions for fault location are therefore more reliable and accurate than conventional solutions that require such settings. Hence, line-parameter free fault location algorithms for single-circuit and double-circuit series compensated transmission lines were developed during the research project. Single-circuit lines and double-circuit lines both present unique challenges for fault location. Single-circuit lines and double-circuit lines also vary in the number of available measurements that can be used to arrive at a solution for distance to fault. Therefore, two distinct algorithms have been presented in this thesis, one for each of these types of series compensated transmission lines. A third algorithm is presented that allows the extension of existing short line algorithms to the case of long lines. This is done by providing a method for incorporating the line shunt admittance into these existing algorithms. The aforementioned three bodies of research work form the focus of this thesis. Completion and submission of paper for IEEE transactions on Power Delivery: This paper presents a new fault location algorithm for series compensated and uncompensated transmission lines using

	measurement data from both ends of the line. The algorithm is applicable to both transposed and untransposed lines. Line-parameter settings are only approximate and vary with aging, but also weather and loading condition. The key advantage of the algorithm is that it does not require the use of line-parameters making it more reliable and accurate when compared to conventional fault location algorithms. The algorithm takes the nonlinear nature of the Metal Oxide Varistor impedance into account in order to estimate the voltage across the series capacitor and thereby accurately calculate the distance to the fault. It involves the solution of six non linear equations in six variables. This approach mathematically expresses the distance to fault directly in terms of current and voltage phasors, and is thus a closed-form non-iterative solution. Success at Viva: The doctoral thesis has been successfully defended (Minor corrections) and the PhD awarded April-2014 <u>Benefits</u> •The algorithms are not affected by voltage inversion or current inversion: The FLAs use two-end voltage and current measurements. They are based on the mathematical relationship between the total voltage drop over the line length / fault loop and the phase currents. Thus, their accuracy is not affected by current inversion or voltage inversion at a given line terminal, as is the case with single-ended algorithms. •They make accurate assumptions about the faulted line: The algorithms do not assume a purely inductive reactance across the length of the line as is the case with a number of conventional algorithms for series compensated lines. They take both the capacitive reactances and the inductive reactances into account, and do not assume a proportionally increasing net inductive reactance of the fault loop with increasing distance to fault. They accurately take the MOV operation into account, and therefore the altered electrical behaviour of the series compensation unit as a whole •They are not affected by fault resistance. For SLG faults, the fault resistance is taken into account to describe the system mathematically, and algebraically eliminated. For other fault types, the voltage drop between the two ends of the line is used and thus the fault resistance is effectively eliminated. •Applicability of the algorithms: They are capable of locating various types of faults, for various different locations of SC installations on the line. They are capable of locating faults for lines of various degrees of series compensation, and are accurate even in the case of

	traditional uncompensated lines. In cases where the series compensation is at one or both ends of the line, the algorithms can be applied regardless of whether the VT is on the line side or the bus side of the series capacitor •They do not require synchronisation of measurements: They are capable of locating faults with synchronous phasors as well as with asynchronous phasors. •They are unaffected by source impedances: The algorithms are not affected by impedances outside the transmission system contained between the local and remote line-end busses. Thus, no settings for source impedances are required for the algorithm calculations. •They are line-parameter free: The algorithms described above are the first of their kind line-parameter free accurate FLA designed for series compensated lines. The advantage lies in the resulting real-world accuracy and reliability of the proposed algorithms <u>Paper availability</u> Z. Radojevic, V. Terzija, G. Preston, S. Padmanabhan, D. Novosel, "Smart Overhead Lines Autoreclosure Algorithm Based on Detailed Fault Analysis", IEEE Transactions on Smart Grid, vol.4, pp.1829-1838, Dec. 2013. S. Padmanabhan, V.Terzija, “Line-Parameter Free Novel Fault Location Algorithm for Series Compensated and Traditional Lines” (Submitted).
Collaborative Partners	EPSRC, National Grid, WPD, UKPN
R&D providers	Cardiff University, University of Manchester, Queens University Belfast (QUB), University of Southampton, University of Strathclyde, and Imperial College London.

2009_06: Power Network Demonstration Centre

Project Title	2009_06: Power Network Demonstration Centre			
Description of project	Construction of an extensive research facility incorporating actual overhead and underground distribution equipment as used on the utility network infrastructure.			
Expenditure for 2014/15 financial year	Internal £19,729 External £33,106 **Total £52,835**		**Expenditure in previous (IFI) financial years**	Internal £89,625 External £611,873 **Total £701,498**
Total Project Costs (Collaborative + external + SSEPD)	£8,000,000		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	Creating a representative power distribution network where prototype equipment can be installed without the risk of interrupting customers			
Type(s) of innovation involved	Significant	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		18	-3	21
Expected Benefits of Project	There are four strategic and financial benefits from this project: • The facility will encourage generator connections that contribute to government renewable energy targets; • Faster adoption of new technology will realise reinforcement savings in the period 2015-2020; • Reduction in the risks (customer service & operational) from trials of new technology on operational networks; • A significant enabler to reduce adoption timescales for related IFI projects.			
Expected Timescale to adoption	3 Years	**Duration of benefit once achieved**		8 Years
Probability of Success	50%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**		£4,986,391
Potential for achieving expected benefits	High			

Project Progress March 2015	This year saw the end of the project having completed its main objective of establishing a test centre. During this financial year project progress was centred around the establishment of a fully populated research programme as well using the centre for project testing outside of the research programme. As of the 31st of March 2015 the programme was operational and projects were starting to filter through that delivered value for the business. Included in this was communicable FPI testing and informing the asset management of towers.
Collaborative Partners	SP Energy Networks, Scottish Enterprise, Scottish Funding Council
R&D providers	University of Strathclyde

2009_14: LIVEALERT

<table>
<tr><td>Project Title</td><td colspan="4">2009_14 LIVEALERT</td></tr>
<tr><td>Description of project</td><td colspan="4">The Energised Alert is a high voltage detection device, currently capable of detecting voltages of above 2kV. The project's objectives are to:
To extend the voltage sensing range downwards from 2000 Volts
To undertake a full market appraisal
To undertake full evaluation of technology whilst in operation
This project aims to take the Energised Alert from TRL 4 to 8.</td></tr>
<tr><td>Expenditure for financial year</td><td colspan="2">Internal £5,667
External £4,980
Total £10,647</td><td>Expenditure in previous IFI financial years</td><td>NIL</td></tr>
<tr><td>Project Cost
(Collaborative + external + SSEPD)</td><td colspan="2">£10,647</td><td>Projected 2015/16 costs for SSEPD</td><td>NIL</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The Energised Alert senses any increase in electrical potential, above a predetermined threshold, of devices to which it is attached. Once triggered it is linked to an audible alarm, allowing the recognition and management of this potentially deadly hazard in a controlled manner. Its use will, therefore protect the operator, other employees and any members of the public in the vicinity from casual, but more importantly, avoidable electrocution.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>14</td><td>-5</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Successful development of the Energised Alert would:
Help prevent electrocution accidents and fatalities
Ensure 'live line' maintenance can be carried out in a safe manner
Allow operators to proactively respond to incidents on their network</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">1 year</td><td>Duration of benefit once achieved</td><td>25 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">75%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£227,017</td></tr>
</table>

Potential for achieving expected benefits	Medium
Project Progress to March 2015	• Stage One of the project, to design and develop the sensing system was completed successfully and met the deliverable set at the start of the project. • Stage Two, to design and develop a refined was completed successfully and met the deliverable set at the start of the project. • Stage Three, to manufacture and evaluate 10 energised alerts units is complete • Stage Four was completed and issues surrounding over sensitivity were identified. • The project was stalled pending legal authorisation to the extension of the project to solve the issues identified in Stage Four. • Stage Four extension was agreed and has now been completed, there are 10 prototype units ready for live trials. • Stage Five was added to the project during the stage 4 extension. This project is now closed.
Collaborative Partners	Northern PowerGrid, Electricity North West, SPEN, Energy Innovation Centre
R&D Providers	Live Alert

2010_01: Phasor Measurements

<table>
<tr><td>Project Title</td><td colspan="5">2010_01 Phasor Measurements</td></tr>
<tr><td>Description of project</td><td colspan="5">The project aims to transmit phasor measurements via the internet as a secure and reliable replacement for vector shift and ROCOF protection for the detection of loss of mains for use with embedded generators.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £7,413
External £3,252
Total £10,665</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £39,553
External £45,512
Total £85,065</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£514,476</td><td colspan="2">Projected 2015/16 costs for SSEPD</td><td>NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">The project is related to the area of nuisance tripping of existing loss of mains protection and potential failures to operate due to balanced load conditions</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>17</td><td>-1</td><td colspan="2">18</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">The project benefits will produce a secure loss of mains protection system which will be required to keep generation running during system wide frequency changes. Such a change in system frequency might be expected in the future as the inertia of the system decreases and the largest lost load value is increased in order to allow more renewable and nuclear generation on the system.</td></tr>
<tr><td>Expected Timescale to adoption</td><td colspan="2">Year 2014</td><td colspan="2">Duration of benefit once achieved</td><td>20 Years +</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£1,360,000</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">The potential is considered high considering the system has been proven in the lab using a motor generator set to provide the islanded LV network. The main challenge now is to reduce costs so that the technique can be deployed as an acceptably priced alternative to RoCoF.</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="5">No new work was carried out on the project during 2014/15. Some work was undertaken maintaining the existing installed PMUs which</td></tr>
</table>

	had started to fail due to small standby batteries within the computers running flat. The main reason for the lack of progress is that Queens University could not provide a researcher to carry out the work. While one was appointed in 2014 it was in a part time capacity and no new development was undertaken with the project prior to the researcher leaving to take up a post elsewhere. Costs are lower than expected for 2014/15 due to the lack of a researcher at QUB. This project was not suitable to be continued as an NIA project and it has therefore been closed down.
Collaborative Partners	None
R&D providers	Queens University Belfast

2010_05: Evaluation of Ford Focus/Tourneo EV on Network

Project Title	2010_05 Evaluation of FORD Focus/Tourneo EV on Network				
Description of project	Installation of charge point infrastructure and measuring equipment supplied by Chargemaster, as part of a larger EV trial, and lease of five electric Ford Tourneos to investigate the impact of EVs on electricity distribution network and evaluate in-service issues of EVs for possible use by our staff.				
Expenditure for 2014/15 financial year	Internal £1,333 External -£35,130 **Total -£33,797**		**Expenditure in previous (IFI) financial years**	Internal -£144,928 External £737,019 **Total £592,091**	
Total Project Costs (Collaborative + external + SSEPD)	£1,000,000		**Projected 2015/16 costs for SSEPD**	NIL	
Technological area and/or issue addressed by project	Impact of EVs on distribution network and behavioural aspects of EV charging.				
Type(s) of innovation involved	Incremental, Tech Transfer, Significant, Radical	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**	
		10	-2	12	
Expected Benefits of Project	Modelling EV demand minimising investment on network.				
Expected Timescale to adoption	5 Years	**Duration of benefit once achieved**	Ongoing		
Probability of Success	75%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£3,700,000		
Potential for achieving expected benefits	High: trials have produced the necessary charging point profiles and local network loading data required, and there is potential to implement learning.				
Project Progress March 2015	Final field demonstration with domestic customers was carried out in 2013/14 and final close down report produced. Expenditure for 2014/15 includes receipt of the final grant from TSB. Project is now complete.				
Collaborative Partners	Ford UK, University of Strathclyde				

R&D provider	Chargemaster, University of Strathclyde

2010_06: Orkney Active Power Network – Phase 3 Electrical State Estimation

Project Title	2010_06 Orkney Active Power Network – Phase 3 Electrical State Estimation			
Description of project	State Estimation is a system that takes a small number of physical measurement points and, by using power system analysis and mathematics, calculates the state of the surrounding network. This project aims to install a distribution state estimator for the Orkney distribution network. It will be located at Kirkwall power station and integrated with the existing Orkney ANM system which manages thermal constraints on the network. There are two key features of this project which will have significant impact on the wider application of ANM and other distributed intelligence methodologies in distribution networks across SSEPD's licensed areas. Firstly, distribution state estimation (DSE) can be applied to any distributed intelligence system, such as ANM, to make the decision making process more robust and resilient, for example by checking for bad data. Secondly, DSE can be applied to improve the ease of observing the network at a significantly lower cost when compared to establishing additional measurement points with the associated communications and data handing costs. DSE can also be more robust than larger numbers of individual transducers. This means control systems which use DSE will be more resilient in operation than those which use a large number of transducers alone.			
Expenditure for 2014/15 financial year	Internal £9,716 External £88,373 **Total £98,089**		**Expenditure in previous (IFI) financial years**	Internal £103,616 External £157,805 **Total £261,421**
Total Project Costs (Collaborative + external + SSEPD)	£514,362		**Projected 2015/16 costs for SSEPD**	Nil
Technological area and/or issue addressed by project	The ANM scheme in the Orkney RPZ relies on the provision of additional data from nodes on the network. State estimation will improve the robustness of the data used in the ANM process and improve ease of observing the network. This will provide redundancy for critical constraint points on the network during normal operating conditions should the communications or measurement device at a location fail. It will also provide insight into other circuits which, while not currently constraint points, will become so following a fault on one of the three Interconnections between Kirkwall and Scorradale. Following proving of the state estimation system, it could be applied to reduce the cost of deployment of ANM schemes, and make them more robust. For parts of the network not being managed by ANM schemes the methodology could improve the quality of information on the network at a reduced cost, leading to better network understanding and operational effectiveness.			

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>1</td><td>12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The system will allow power flows on all parts of the Orkney network to be visible and in many cases redundancy will mean that the system is still visible on the failure of a transducer. This will allow the system to be pushed more in terms of loading and make better use of the assets employed on the Orkney 33kV network. It will also allow for physical measurement points that have gone out of range to be detected and accounted for.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1</td><td colspan="2">Duration of benefit once achieved</td><td>10</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£473,926</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Unproven</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="4">Smarter Grid Solutions completed and successfully factory tested an initial set of algorithms for Distributed State Estimation.

As the implementation of state estimation is not presently a priority of SSEPD the decision was taken to terminate the project at a suitable point in the project plan. The project has now been closed.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">None</td></tr>
<tr><td>R&D providers</td><td colspan="4">Smarter Grid Solutions, Queens University Belfast</td></tr>
</table>

2010_13: Supply Point Monitoring

Project Title	2010_13 Supply Point Monitoring			
Description of project	SSEPD has a requirement for a Supply Point Monitoring Device to support the New Thames Valley Vision LCNF and NINES projects. It is proposed that the monitoring device will be installed as a retrofit unit located on the existing service termination equipment (cut out) at appropriate locations in the Bracknell, Shetland and other areas specified by SSEPD. The device will take the form of a replacement fuse carrier which maintains the existing electrical protection (HRC fuse) and incorporates additional functionality/ measurement elements. It is anticipated that the device will provide a range of customer/ network measurements associated with individual supply points. The scope of this project will cover the development of a small number of pre-production prototype devices.			
Expenditure for 2014/15 financial year	Internal £2,934 External £2,972 **Total £5,906**		**Expenditure in previous (IFI) financial years**	Internal £29,269 External £289,210 **Total £318,479**
Total Project Costs (Collaborative + external + SSEPD)	£378,290		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	The development of an end point monitor device that can be installed into customers premises as an alternative to the EDMI monitor provided by GE for use on the NTVV project. This will allow for more targeted monitoring to take place that was previously restricted by space.			
Type(s) of innovation involved	Development of End Point Monitor	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		17	2	19
Expected Benefits of Project	To allow more widespread use of monitoring of customers energy use, to better understand how energy flows around our electrical network and predict what future energy use might look like and help manage the network more efficiently.			
Expected Timescale to adoption	6 months	**Duration of benefit once achieved**		20 years
Probability of Success	90%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**		£25,018

Potential for achieving expected benefits	High
Project Progress March 2015	Testing to BS:7657 completed which enabled the device to be presented to the Engineering Policy team for sign off. The device was then signed off for use on the Thames Valley Vision Project. Customer engagement has been taking place, and to date there have been 25 devices installed in customers properties that are now collecting data for the project. At the outset of the IFI the goal was to develop the SPM, this has been achieved with devices now out on our network collecting real data for Reading University to use.
Collaborative Partners	Senical Ltd
R&D providers	None

2010_25: Plugged in Places

Project Title	2010_25 Plugged in Places			
Description of project	Installation of charge point infrastructure and measuring equipment supplied by Chargemaster, evaluating the use of public infrastructure and monitoring the use of this infrastructure compared to domestic infrastructure to better understand the charging behaviours.			
Expenditure for 2014/15 financial year	Internal £25,755 External -£8,709 **Total £17,046**		**Expenditure in previous (IFI) financial years**	Internal £297,398 External £206,460 **Total £503,858**
Total Project Costs (Collaborative + external + SSEPD)	£ 531,026		**Projected 2015-2016 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	The key issues to be researched are: timing and volume of vehicle recharging events and the potential impact on the distribution network. The amount of public recharging using publicly available infrastructure provided in this trial across the range of car parks equipped for EV charging. This will enable better planning of future EV infrastructure to better support the wide scale adoption of EVs in the future			
Type(s) of innovation involved	Incremental	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		12	-3	15
Expected Benefits of Project	Modelling EV demand minimising investment in network			
Expected Timescale to adoption	5 Years	**Duration of benefit once achieved**		Ongoing
Probability of Success	75%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**		£10m
Potential for achieving expected benefits	Medium			

Project Progress March 2015	Good data coming in from the charging points through the back office system. Investigative and data work carried out on the charge posts in the last year to fully understand the ongoing usage of the posts.
Collaborative Partners	Chargemaster, NCP Car Parks, Transport for London
R&D provider	Chargemaster

2011_03: LV Connected Batteries

Project Title	2011_03 LV Connected Batteries			
Description of project	SSEPD seeks to understand the benefits of installing electrical energy storage connected via four quadrant power conversion systems on the LV network. The selected storage technology is lithium-ion batteries. The increase in solar PVs and EVs does not currently pose a significant issue for network operators. However, should this trend continue, there is the potential to have reactive power flow issues and thermal and voltage constraints on significant numbers of LV feeder circuits. Energy storage has the potential to manage the reactive power flows and reduce the peak demand/generation through peak lopping. This will reduce the need for traditional cable replacement, thereby stopping the network from becoming a barrier to the deployment of low carbon technologies. SSEPD is proposing to install three single phase 25 kWh/25 kW peak lithium-ion batteries at strategic points on the LV network. In order to model the effect of the solar PV and peak demand, SSEPD has identified a site with considerable solar generation and EV charging points. SSEPD will model and analyse the benefits that this form of energy storage can provide to the LV network. This will be done using theoretical cable limits and will not pose any risk to security of supply.			
Expenditure for 2014/15 financial year	Internal £9,918 External £14,629 **Total £24,547**		**Expenditure in previous (IFI) financial years**	Internal £87,779 External £129,869 **Total £217,648**
Total Project Costs (Collaborative + external + SSEPD)	£405,000		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	At present the problem is not a significant issue for DNOs, however with the recent government incentives SSEPD believes that within the next five years this could pose significant issues for all DNOs in the UK. If there is a high uptake in solar PV and EVs the likelihood is this will be in a concentrated area. Early results from the Tier 1 LCNF project SSET1002: 'Demonstrating the Benefits of Monitoring LV Networks with embedded PV Panels and EV Charging Point' have revealed reactive power flow issues. Voltage and thermal constraints on LV feeder circuits are expected. The present solution is to replace the existing cable with one of a larger capacity, the downside being it causes significant disruption to customers, and requires full excavation with associated long lead times and high cost.			

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution from different application</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>18</td><td>-5</td><td>23</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Energy storage on the LV network could manage real power flows to reduce the peaks in demand and generation to keep the cable within thermal limits. It would also utilise the real and reactive power capabilities to keep voltage within supply guidelines. SSEPD wishes to understand the technical benefits of storage on the LV network and whether or not there is an economical case over traditional solutions.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>2 years</td><td colspan="2">Duration of benefit once achieved</td><td>25</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£5,749,325</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The data gathered to date has already helped to inform larger rollout of 25 LV connected batteries under the New Thames Valley Vision (NTVV) Tier 2 project. The intention is that after the NTVV project the devices will be suitable for business as usual rollout and the potential for expected benefits is high.</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="4">The full test plan has been completed. Multiple peak shaving scenarios have been demonstrated successfully, voltage manipulation has been proven with both real and reactive power, phase balancing and reverse power absorption have also been investigated. The learnings have been written up and captured within the SEPD Tier 1 project.

The learning has been passed onto the New Thames Valley Vision team to incorporate the learnings into the larger rollout of 25 units in the Bracknell area.

The site has now been fully de-commissioned and the batteries have been transferred to the Power Networks Demonstration Centre run by Strathclyde University. The PNDC will deliver additional research papers to further the potential learning from this energy storage system which will be beyond the scope of this project.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">None</td></tr>
<tr><td>R&D providers</td><td colspan="4">EA Technology, S&C Electric Europe Ltd.</td></tr>
</table>

2011_04: PhD Power Networks Asset Management

Project Title	2011_04 PhD Power Networks Asset Management			
Description of project	This is a PHD Project working on the development and methodology for the health and risk assessment of LV and HV distribution network assets. A key area of interest for SSEPD is in the area of asset management involving asset condition and health. Due to the current asset management system being unable to perform as required, the development of a new methodology can allow SSEPD to improve efficiency of planning and increase compliance with regulatory reporting. This can lead to enhancing asset lifespan, improving network security, and reducing the rate of asset replacement. This project will conduct a critical evaluation of transferable asset management practices from other asset-based industries, including areas of monitoring technologies, data analysis techniques, investment planning, and optimisation techniques. Appropriate solutions will be developed and integrated within the existing asset management system and allow SSEPD to potentially form a market leading model.			
Expenditure for 2014/15 financial year	Internal £5,610 External £17,582 **Total £23,192**		**Expenditure in previous (IFI) financial years**	Internal £8,716 External £57,159 **Total £65,875**
Total Project Costs (Collaborative + external + SSEPD)	£112,260		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	To create a monitoring tool in order to gain a better knowledge of asset condition, life expectancy, and risk. This will allow SSEPD to gain a better knowledge of assets and to assess and anticipate the impact of variations in asset condition, performance, and reliability. The project also looks into specific intervention methods on asset condition, and risk of failure. This will lead to maximising the useful lifetime and performance of assets, enhancing current methods of asset health and risk assessment, as well as improving network reliability.			

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>23</td><td>4</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Safety: Improvement of asset management techniques which would lead to improved safety for both staff and the public.

Financial: The implementation of this project would improve the general asset management regime and enable increased proactive replacement before plant can fail.

Network Performance: Proactive, rather than reactive, replacement will lead to lower costs, both for the replacement itself, and associated costs such as CI/CML.

Environmental: Improvement of asset management techniques would lead to a reduction in environmental incidences.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1-2 Years</td><td colspan="2">Duration of benefit once achieved</td><td>40 years</td></tr>
<tr><td>Probability of Success</td><td>90%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£578,520</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">If proven to be successful, the implementation of this method promises to save capital expenditure and improve regulatory and public perception of the company. There is also potential for enhancing asset lifetime, improving network security, and reducing the rate of asset replacement. Potential for achieving expected benefits is high.</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="4">The project is complete.

The following has been delivered:

HV Pole Model

Final Report

Model Guide

The HV Pole Model is being used as part of our Investment Management Process. The outputs and processes used during the project have been documented in order to enable the business to apply the researched method to other asset categories.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">None</td></tr>
<tr><td>R&D providers</td><td colspan="4">University of Strathclyde</td></tr>
</table>

2011_07: Assessment of Conducrete

Project Title	2011_07 Assessment of Conducrete			
Description of project	The objective of the project is twofold, firstly to establish whether a Conducrete earthing system is more effective than other systems using: a) bare earth rods; b) earth rods encased in traditional Marconite.			
Expenditure for 2014/15 financial year	Internal £1,312 External £2,972 **Total £4,284**		**Expenditure in previous (IFI) financial years**	Internal £15,714 External £31,636 **Total £47,350**
Total Project Costs (Collaborative + external + SSEPD)	£113,186		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	The scope of this project is to assess the earthing performance and anti-theft capability of Conducrete in power distribution networks which will be achieved by carrying out earthing resistivity tests, thermal shock tests, and mechanical impact tests. Traditional earthing methods are susceptible to theft and corrosion and due to certain ground conditions such as shale or rocky ground, effective power system earthing can be difficult. To overcome this challenge a conductive concrete compound called “Conducrete” which has a resistivity of approximately four times lower than any other product of this type is to be assessed. The assessment will be spilt into three parts; the first to assess whether a Conducrete-based earthing system is an improvement over traditional methods currently used; the second is to assess the effects of earth fault current which may flow through an earthing conductor embedded in Conducrete; and the third is to assess whether Conducrete is mechanically strong enough to protect the earthing conductors from theft.			
Type(s) of innovation involved	Incremental	**Project Benefits Rating** 14	**Project Residual Risk** -8	**Overall Project Score** 22
Expected Benefits of Project	A reduced requirement for copper tape and earth rods in substation earthing installations will lead to environmental and financial benefits.			

Expected Timescale to adoption	2 years	**Duration of benefit once achieved**	20
Probability of Success	50%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£80,189
Potential for achieving expected benefits	If these claims are proven to be accurate, the use of Conducrete would commence in areas of poor soil resistivity and should achieve the expected environmental and financial benefits.		
Project Progress March 2015	The testing of the thermal, mechanical, and resistivity characteristics of Conducrete was carried out. The earthing resistivity testing proved that Conducrete was more effective than bare earth rods and earth rods encased in Marconite. The thermal shock testing showed that Conducrete was unchanged when cyclically heated. Some localised damage was observed during mechanical testing but a good level of protection was maintained overall. The project has now been closed		
Collaborative Partners	SP Energy Networks		
R&D providers	EATL		

2011_09: Heat Pump Load Profile

Project Title	2011_09 Heat Pump Load profile				
Description of project	The use of heat pumps is becoming more widespread and new housing developments with large numbers of units are being constructed. There is limited knowledge as to the diversity of the compressor starting currents associated with the heat pumps.				
Expenditure for 2014/15 financial year	Internal £8,163 External £3,462 **Total £11,625**		**Expenditure in previous (IFI) financial years**	Internal £32,763 External £14,681 **Total £47,444**	
Total Project Costs (Collaborative + external + SSEPD)	£79,106		**Projected 2015/16 costs for SSEPD**	NIL	
Technological area and/or issue addressed by project	A survey will be carried out on feeders containing a high number of heat pumps in order to fully understand the load characteristics.				
Type(s) of innovation involved	Technological Substitution from different application	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**	
		11	0	11	
Expected Benefits of Project	It will enable feeders supplying heat pump clusters to be more accurately sized				
Expected Timescale to adoption	1 year	**Duration of benefit once achieved**	10 years		
Probability of Success	50%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£129,867		
Potential for achieving expected benefits	The site survey should identify the diversified load allowing feeder sizing to be re-evaluated. Medium				
Project Progress March 2015	Following 2 winters of monitoring, data has been collected that following analysis has provided information that will lead to an assessment of diversified load that can be applied in these situations. The project has now closed.				
Collaborative Partners	None				
R&D providers	None				

2011_10: Asset Management of LV Cables

<table>
<tr><td>Project Title</td><td colspan="5">2011_10 Asset Management of LV cables</td></tr>
<tr><td>Description of project</td><td colspan="5">This project will explore the correlation between the number of incipient arc or fault events, and the impact on LV oil impregnated paper insulated cables. This is with the goal of defining criteria and indicators for the circuits that are most likely to fail in service, thus aiding in the asset management of the LV network and life extension decisions.

The project was designed to study the onset of intermittent faults in paper insulated cables to allow development of assessment tools to more efficiently manage LV paper insulated distribution cables. Early detection of issues, combined with an absolute or relative assessment of cable life will enable network planners to target cable replacement programs where issues are most likely to occur in the future.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £917
External £47,232
Total £48,150</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £11,695
External £33,572
Total £45,268</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£154,000</td><td>Projected 2014/15 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Fault anticipation and detection for asset management and life extension of cables.</td></tr>
<tr><td>Type(s) of innovation involved</td><td rowspan="2">Technological transfer, Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>18</td><td>1</td><td colspan="2">17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Delivery of software and hardware detection and monitoring products which are capable of evaluating the likelihood of the failure of an LV cable.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>4 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>25%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td colspan="2">£321,339</td></tr>
</table>

Potential for achieving expected benefits	Medium.
Project Progress March 2015	A cable monitoring facility has been produced and is actively monitoring low voltage cables as they degrade and fail. The current events that have been captured and analysed are likely to be a snapshot of the possible features that could be detected as cables degrade. There is a significant amount more research required to identify and categorise these events. While present technology may be capable of detecting the largest of the events seen so far, dedicated devices may be required for detailed analysis of electricity network data, such that effective asset monitoring can be accomplished. The TRL at the beginning of this project was TRL 2: Basic principles observed, no experimental proof or detailed analysis of conjecture. The TRL at the completion of this project is TRL 3: Active R&D initiated. Laboratory studies to validate predictions. The project is now closed down and final reports are available.
Collaborative Partners	None
R&D providers	Kelvatek

2011_12: Harmonics Investigation

Project Title	2011_12 Harmonics Investigation			
Description of project	The project aims are to identify the high frequency voltage distortions caused by modern high power electronic equipment which may be installed in domestic premises, and to understand the propagation and attenuation of these effects on a real LV network installed at Imperial College London. It will also look at the impact of these distortions on customers' equipment and produce information which will allow the calculation of these effects on large LV networks. Ten energy and micro-generator manager (EMMA) units which can handle 3kW each are to be studied on a small network at Imperial College London, comprising 100 metres of mains cable and 16 services arranged to allow balanced and unbalanced loading conditions to be studied.			
Expenditure for 2014/15 financial year	Internal £2,355 External £47,231 **Total £49,586**		**Expenditure in previous (IFI) financial years**	Internal £16,574 External £60,858 **Total £77,432**
Total Project Costs (Collaborative + external + SSEPD)	£151,000		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	The use of high-powered electronic devices in domestic premises and potential interference with other equipment. Also the effect of high penetrations of these devices.			
Type(s) of innovation involved	Incremental	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		17	0	17
Expected Benefits of Project	The project benefits will be that DNOs have a good understanding of the effects of these high-power electronic devices on their networks and the results can feed into the development of standards with respect to high frequency voltage distortions above those considered by current standards (2kHz for equipment standards and 2.5kHz for DNO planning standards).			
Expected Timescale to adoption	N/A	**Duration of benefit once achieved**		N/A

Probability of Success	50%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£1,360,000
Potential for achieving expected benefits	Work and research carried out by Imperial College London in this area has been promising so far, leading us to conclude the potential for achieving the expected benefits in this project are high.		
Project Progress March 2015	The project work has been completed but there are still some outstanding issues with the final report which Imperial college are addressing. The outcome of the work is clear that at the moment the use of multiple EMMA units has not resulted in adverse effects which would at this time justify DNOs preventing these devices to be operated on their networks, but that additional work should be undertaken to develop standards with respect to voltage distorting loads and generation, so that the available capacity of DNO networks to absorb these voltage distortions in the frequency range of 2kHz to 150kHz can be effectively managed.		
Collaborative Partners	None		
R&D providers	Imperial College London		

2011_14: Hybrid Generator

Project Title	2011_14 Hybrid Generator			
Description of project	This project is aimed at investigating the use of hybrid generators for fault duty and as a temporary and alternative power supply during routine maintenance or delayed connections.			
Expenditure for 2014/15 financial year	Internal £22,945 External £119,904 **Total £142,849**		**Expenditure in previous (IFI) financial years**	Internal £33,051 External £243,336 **Total £276,387**
Total Project Costs (Collaborative + external + SSEPD)	£186,200		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	To provide an alternative to diesel generators which have high fuel inefficiency, running costs, and CO_2 emissions.			
Type(s) of innovation involved	Incremental innovation and technological substitution	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		10	-2	12
Expected Benefits of Project	Reduced cost, reduced CIs and CMLs, and reduced CO_2 emissions.			
Expected Timescale to adoption	6 Months	**Duration of benefit once achieved**		20 Years
Probability of Success	50%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**		£21,580
Potential for achieving expected benefits	High			
Project Progress March 2015	The Mark 3 has completed its round of testing at the PNDC. This has now been accepted as BAU within SSEPD and other DNO's. Further developments of small units have been implemented on by other DNO's. Project is now complete.			
Collaborative Partners	Off-Grid Energy Ltd			
R&D providers	Power Networks Demonstration Centre			

2011_16: Advanced Radio Control

Project Title	2011_16 Advanced Radio Control				
Description of project	This project aimed to test and evaluate a radio solution which could meet the needs of the Intellirupter/Intelliteam project on the Isle of Wight.				
Expenditure for 2014/15 financial year	Internal £39,604 External £23,754 **Total £63,358**		**Expenditure in previous (IFI) financial years**	Internal £103,679 External £499,594 **Total £603,273**	
Total Project Costs (Collaborative + external + SSEPD)	£500,000		**Projected 2015/16 costs for SSEPD**	Internal £25,000 External £75,000 **Total £100,000**	
Technological area and/or issue addressed by project	The original communications system installed did not provide sufficient bandwidth and reliability for their purpose. A new radio was provided by the vendor, which was evaluated for regulatory compliance and tested on the Isle of Wight.				
Type(s) of innovation involved	Incremental	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**	
		17	-7	24	
Expected Benefits of Project	The bespoke radio solution will facilitate the Intellirupter equipment to function as intended and therefore it will lead to a saving in outages, and savings through CML and CI payments. The radios have the potential to offer a robust high bandwidth communication solution to various smart grid applications in areas where hard-wired communications is not a feasible or economic option. The intellirupter can function in a limited way to restore a faulted network without communications. Allowing the communications between the intellirupters will allow the autonomous sectionalising of parts of the network under fault conditions thereby improving performance. The Intelliteam software can be configured to maintain supplies to strategic customers whilst leaving low risk customers without supply where there is a conflict of load management.				
Expected Timescale to adoption	Ongoing	**Duration of benefit once achieved**		Ongoing	

Probability of Success	35%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£290,359
Potential for achieving expected benefits	Medium		
Project Progress March 2015	The new radio solution has enabled Intelliteam to function and can therefore lead to a reduction in CI/CML (outages). The project has been completed and a closedown report is available. A follow on NIA project will further trial and evaluate the radio system.		
Collaborative Partners	None		
R&D providers	S&C Electric		

2012_03: High-Medium Voltage Primary Substation Protection

<table>
<tr><td>Project Title</td><td colspan="5">2012_03 High-Medium Voltage Primary Substation Protection</td></tr>
<tr><td>Description of project</td><td colspan="5">This project will install Locamation’s HMV protection solution at one of SSEPD’s primary substations in order to investigate its capability in terms of detecting faults on the distribution network.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £3,207
External £4,280
Total £7,487</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £54,367
External £98,770
Total £153,137</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£134,520</td><td colspan="2">Projected 2015/16 costs for SSEPD</td><td colspan="2">Internal £20,750
External £7,500
Total £28,250</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Reduction in hardware required for full substation protection, whilst moving the protection system to a more centralised digital solution.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>12</td><td>1</td><td colspan="2">11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">A new style of protection will be available for use on our distribution system, with the potential to reduce hardware costs, and allow centralised access to all items of plant from a remote location.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 years</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">20 years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td colspan="2">£115,759</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">High</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="5">Full system trial is now in process, and fault detection monitoring is ongoing. A follow on NIA project will evaluate the technology.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="5">None</td></tr>
<tr><td>R&D providers</td><td colspan="5">Locamation</td></tr>
</table>

2012_04: Mobile Generation with Battery Storage

<table>
<tr><td>Project Title</td><td colspan="4">2012_04 Mobile Diesel Generator with Battery Storage</td></tr>
<tr><td>Description of project</td><td colspan="4">This project is aimed at evaluating the use of hybrid battery/generator option as opposed to conventional diesel generation to provide power to small islands and communities.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £17,669
External £186,350
Total £204,019</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £48,305
External £77,029
Total £125,334</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£ 123,060</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="4">A cost-effective and environmentally friendly mobile hybrid battery/generation unit for use during repairs of submarine cables to small islands and communities.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>-2</td><td>13</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Cost effective and environmentally friendly solution for providing temporary power to small islands and communities.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 Year</td><td colspan="2">Duration of benefit once achieved</td><td>20 Years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£76,157</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">High</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="4">A prototype unit was produced comprising a 325kVA generator with 200kWh storage via lead acid battery storage. The unit has been tested at the PNDC but due to the topology of the AC/DC rectifier, battery type and control of the battery charging, this design has been found to be inefficient. Changes to the design are necessary to lead to a viable unit.</td></tr>
</table>

Collaborative Partners	None
R&D providers	PNDC and Generator Power

2012_06: Orkney Sub-50kW

<table>
<tr><td>Project Title</td><td colspan="5">2012_06 Orkney Sub-50kW</td></tr>
<tr><td>Description of project</td><td colspan="5">One of the guiding principles of installing the Orkney ANM system was that generators could gain confidence in the long-term financial viability of their project through a constraint study completed during the connection process. These studies gave financiers the confidence to invest in a project as they had an understanding of what the long-term generation profile would be. However these figures are being eroded by sub-50kW generators connecting on Orkney as they do not require approval to connect but do have an impact on the export of the larger wind farms. The aim of this project is to investigate what can be done to reduce this erosion and to allow sub-50kW generators to connect in a fair and sustainable manner.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £1,534
External £2,381
Total £3,915</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £44,248
External £40,552
Total £84,800</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£190,000</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">The project aims to address the erosion of the generation capacity available to the existing Orkney ANM generators by sub-50kW generators.</td></tr>
<tr><td>Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>10</td><td>-4</td><td colspan="2">14</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Financial - Deferment of reinforcement leading to a saving of capital expenditure;
Knowledge Transfer - Transfer of how to incorporate a low cost control option into an ANM system to control small-scale generators. The method, impacts, and benefits of this will be transferred in full;
Environmental - A small increase in the amount of small-scale renewable generation that can export to the SSEPD network.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 year</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">20 years</td></tr>
</table>

Probability of Success	35%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£3,629,043
Potential for achieving expected benefits	Low/Medium, with the security of the viable method of communication with these sub-50kW generators posing a technical issue.		
Project Progress March 2015	The project was closed before the objectives could be completed due to technical issues with low cost IP based communications systems connecting into the SSEPD real time and corporate communication networks. Technically the project aims were achievable but the IT Security element meant that the work could not progress.		
Collaborative Partners	None		
R&D providers	SGS		

2012_07: RPZ Phase 2

Project Title	2012_07 RPZ Phase 2			
Description of project	The Orkney Islands are a rich source of renewable energy and as a result, all capacity for conventional connection of generation was exhausted in 2003. Due to the smaller scale of the generators and the high cost for conventional connection, circa £30M, another method for connecting generation needed to be developed to unlock the full renewable energy potential. Using an intertrip scheme, a further 21MW was allowed to connect which was quickly taken up by generators. However, there was still a strong desire from generators to get access to the Orkney network but this was insufficiently strong to cover the reinforcement cost. To allow further connection, an ANM system was designed and installed that took into account the difference between the minimum and maximum demand on the islands and the diversity amongst the connected generation portfolio. The ANM scheme monitors the identified network constraint points and dynamically controls the new non-firm connected generators' output to ensure that the operating limits at the constraint points are not breached. This aim of this project is to improve the resilience of the ANM system so that it effectively manages the connected generation and is ready for transfer to BaU. This will allow more widespread use of the learning from this project and ensure that the ANM methodology can be applied to other network constraints by SSEPD and other DNOs. The scope is to assess the system, define how to improve its resilience, and lastly to transfer the technical and associated commercial systems over to the main business including the operation and maintenance of the ANM system.			
Expenditure for 2014/15 financial year	Internal £21,670 External £149,698 **Total £171,368**		**Expenditure in previous (IFI) financial years**	Internal £105,096 External £261,833 **Total £366,929**
Total Project Costs (Collaborative + external + SSEPD)	£517,760		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	This project will assess the ANM system as it currently stands and identify where amendments are required to bring it in line with company and UK standards. With this complete, the system will be handed over from R&D to BaU to allow the system to be rolled out across SSEPD's networks.			

Type(s) of innovation involved	Radical	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		7	1	6
Expected Benefits of Project	Allow ANM systems to be applied across SSEPD networks which will realise the following benefits: **Financial** - Deferment of reinforcement leading to a saving of capital expenditure; **Knowledge Transfer** - Transfer of knowledge of how to implement an ANM system into BaU which will also help with understanding how to transfer an R&D project into BaU; **Environmental** - An increase in the amount of renewable generation that can export onto SSEPD's distribution network.			
Expected Timescale to adoption	1 year	**Duration of benefit once achieved**		20 years
Probability of Success	90%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**		£2,991,373
Potential for achieving expected benefits	High			
Project Progress March 2015	The project was successfully completed. All the requirements laid out as necessary to consider the Orkney ANM scheme as part of BaU, were completed. This included delivery of new comms links, changing the system platform from PLC to servers, setting up BaU support process, creation of a website and delivery of training to the relevant parties, amongst others. Continuing on from this approach, ANM is now being rolled out by the business into a new location on the Isle of Wight as BaU.			
Collaborative Partners	None			
R&D providers	SGS and Cable & Wireless Worldwide			

2012_09: Real Time Java

Project Title	2012_09 Real-Time Java			
Description of project	The original Orkney ANM scheme (developed through other IFI projects as detailed in this report) was deployed on PLCs and consists of Smarter Grid Solutions Smart Grid platform, SGcore, the real-time power flow management application, SGi and their CommsHUB product. The next generation of the SGcore platform and SGi algorithms, SGcore Java has now been developed by Smarter Grid Solutions. SGcore Java makes use of leading edge real-time systems software in the form of Real Time Java which should allow the SGi Java algorithm to exhibit the same determinism and reliability as that of SGi PLC. The real-time specification for Java is concerned with providing the capability to perform mission-critical control within defined time periods and has found application in defence and process control industries. When deployed on Orkney, this project will represent the first deployment of the Real Time Java to manage an ANM system in the UK. The deployment of this software platform to perform ANM provides additional benefits to SSEPD in that a more powerful computing platform will exist that can undertake more advanced computational tasks and has significant scalability and interoperability that cannot be provided within a PLC-based environment. The successful conclusion of this project will facilitate the wider roll-out of this technology. This project will also be used for the further development of the Orkney Smart Grid: projects 2009_11 Distribution Dynamic Line Ratings, 2010_02 Orkney Active Power Network-Voltage Control, and 2010_06 Orkney Active Power Network-Phase 3 Electrical State Estimation depending on the hardware provided.			
Expenditure for 2014/15 financial year	Internal £77,061 External £78,851 **Total £155,912**		**Expenditure in previous (IFI) financial years**	Internal £143,584 External £295,068 **Total £438,652**
Total Project Costs (Collaborative + external + SSEPD)	£ 529,760		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	The ANM system architecture will be improved to offer a more scalable and interoperable system configuration that will benefit future smart grid projects.			

<table>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution from outside industry</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>1</td><td>9</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Financial – Deployment of this system to help further defer reinforcement works;
Knowledge Transfer – It is highly probable that ANM schemes in the future will operate within a real-time Java (RTJ) environment. This project will allow SSEPD to gain knowledge in the implementation of a RTJ-based ANM scheme in a very low risk manner;
Environmental – This will allow an increase in renewable generation;
Network Performance – There may be network performance benefits as this type of ANM scheme is applied elsewhere on the network and integrated with advanced distribution-automation functions.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 Year</td><td colspan="2">Duration of benefit once achieved</td><td>5 years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£984,231</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Medium</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="4">Transition to phase 3, full RTJ control, completed Feb 2015. ANM now operating under server control. Project closed.
See Appendix 2 for further information.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">None</td></tr>
<tr><td>R&D providers</td><td colspan="4">Smarter Grid Solutions</td></tr>
</table>

2012_12: GENDRIVE

Project Title	2012_12 GENDRIVE			
Description of project	The distribution network controlled using transformers and tap-changing has proven reliable, however controllability of voltage is limited at best and faces the greatest challenge in remote and rural areas. An active series voltage regulator is proposed to provide a more stable and smarter local supply. The unit proposed will in effect prevent or at worst delay the cost of reinforcing problematic distribution circuits.			
Expenditure for financial year 14/15	Internal £6,266 External -£27,489 **Total -£21,223**		**Expenditure in previous IFI financial years**	Internal £15,405 External £49,963 **Total £65,368**
Project Cost (Collaborative + external + SSEPD)	£ 227,720		**Projected 15/16 costs for SSEPD**	NIL
Technological area and / or issue addressed by project	Voltage control on the LV network where voltage control through primary transformer tap changers is no longer sufficient. I.e locations where there are high levels of load or distributed generation			
Type(s) of innovation involved	Technological Transfer	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		12	-3	15
Expected Benefits of Project	• The Creation of a system that can control the voltage on an LV feeder • Will be able to balance voltage across the phases • Will be able to correct power factor on each phase • Will reduce Total Harmonic Distortion • Neutral currents will be regulated and controlled			
Expected Timescale to adoption	2 years		**Duration of benefit once achieved**	20 years
Probability of Success	10%		**Project NPV = (PV Benefits – PV Costs) x Probability of Success**	£76,055

Potential for achieving expected benefits	The first stage of the project identified the limitations of the initial GenDrive approach which would have had limited ability to achieve the benefits sought. However a second design has been created that exceeds these. There is a high level of optimism that this project will deliver the technical benefits sought.
Project Progress to March 2015	The project had successfully been completed to the end of stage 2 and stage 3 was due to commence however the company was placed in Administration in March 2014. As a result the project was placed on hold and to date no further work has been carried out on it. Various options are being investigated to continue the project or end it. There has been no change in the project status since March 2014.
Collaborative Partners	SPEN, UKPN, ENWL, NPG
R&D Providers	GenDrive Ltd supported by EATL.

2012_13: Gnosys Self-Healing Cables

Project Title	2012_13 Gnosys Self-Healing Cables			
Description of project	There is a recognised need in the UK electricity distribution network for extruded polymeric cables to be cable of self-repair if the protective outer sheath is damaged during installation or operation. An initial study will be undertaken to review, rank and lab trial a number of candidate material technologies that may be able to support self-repair. This will be followed by laboratory trials on one or more of these technologies. If successful commercial development of an improved performance MV cable system could follow in collaboration with one or more cable manufacturers.			
Expenditure for financial year	Internal £5,701 External £68,699 **Total £74,400**		**Expenditure in previous IFI financial years**	Internal £11,174 External £90,922 **Total £102,096**
Project Cost **(Collaborative + external + SSEPD)**	£226,910		**Projected 15/16 costs for SSEPD**	NIL
Technological area and / or issue addressed by project	This project addresses the need for a cable system that can self-repair sheath damage thus removing a significant source of faults in cables.			
Type(s) of innovation involved	Significant	**Project Benefits Rating** 15	**Project Residual Risk** -2	**Overall Project Score** 17
Expected Benefits of Project	If successful this project will identify a number of materials that have the potential to be incorporated into a cable systems to allow self-repair in situ.			
Expected Timescale to adoption	4years		**Duration of benefit once achieved**	25 years
Probability of Success	10%		**Project NPV = (PV Benefits – PV Costs) x Probability of Success**	£7,553
Potential for achieving expected benefits	High			

Project Progress to March 15	• 4 specific repair technologies have been identified and tested • A number of cable manufacturers have shown significant interest in the project including the provision of material samples and cable samples • Several material suppliers have engaged positively in the project including the provision of material samples • 3 test rigs have been built and used for testing • The project has made good progress and identified further work with a new stage 4 to be carried out. This looked at the merging of two different repair technology classes to gain the best possible self-repairing mechanisms. • All stages of the project are now complete with the Final Report Issued detailing the following: - Results of the trialling and evaluation of land-based and undersea cable self-repair technologies - Economic assessment on what technologies to adopt - Recommendation on best route to commercialise and deliver self-repair cables to DNO's - Best approach to exploit the technology for wide adoption in global markets Project is now successfully completed.
Collaborative Partners	SPEN, Energy Innovation Centre, GnoSys Ltd
R&D Providers	GnoSys Ltd

2012_14: Radio Tele-Switching Phase 2

Project Title	2012_14 Radio Tele-Switching Phase 2					
Description of project	This project is building on the conclusion of a previous project 2011_08 RTS and will investigate the time shifting of electric storage and water heating to remove overloads or potential overloads.					
Expenditure for 2014/15 financial year	Internal £23,837 External £3,281 **Total £27,118**		**Expenditure in previous (IFI) financial years**	Internal £15,858 External £10,756 **Total £26,614**		
Total Project Costs (Collaborative + external + SSEPD)	£176,500		**Projected 2015/16 costs for SSEPD**	NIL		
Technological area and/or issue addressed by project	Network overloading due to water and storage heating.					
Type(s) of innovation involved	Incremental	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**		
		9	-3	12		
Expected Benefits of Project	Improved reliability by avoiding network peak loads, and reduced cost by deferring network reinforcement.					
Expected Timescale to adoption	3 years	**Duration of benefit once achieved**	20 years			
Probability of Success	90%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£332,026			
Potential for achieving expected benefits	High					
Project Progress March 2015	The trial in Inveraray has been completed and shows a peak load reduction of around 10%. These results clearly show a significant difference in the peak loads caused by the Radio-Tele Switches. And thus this trial was deemed a success.					

	Further, more granulated and targeted changes will be made by the business going forward to even out the evening peak further but this has shown that through small labour costs you can reduce the requirement for reinforcement on substations with significant amounts of Radio-Tele Switches. The project allowed us to create internal policy documents on the guidance of load shifting using Radio-Tele Switching and also guidance on changing group codes at the meter. These policy documents are readily available to staff who wish to use Radio-Tele Switching for load management.
Collaborative Partners	None
R&D providers	None

2013_02: CES Knowledge Transfer Partnership

<table>
<tr><td>Project Title</td><td colspan="5">2013_02 CES Knowledge Transfer Partnership</td></tr>
<tr><td>Description of project</td><td colspan="5">Community energy schemes are forecast to continue to grow in number, individual capacity and aggregate capacity in the coming years aided by government support, as well as regulatory and incentive arrangements. This growth will make community energy a greater consideration in distribution network planning and operations with its potential upsides and downsides.

This project is aimed at evaluating new approaches (technical and commercial) to manage barriers to grid connection and operation for community energy schemes, and to exploit potential network services that communities can offer for network operations through flexible generation and demand.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £11,969
External £44,440
Total £56,409</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £17,391
External £32,363
Total £49,754</td><td colspan="2"></td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£80,625</td><td>Projected 2015/16 costs for SSEPD</td><td>NIL</td><td colspan="2"></td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Integration of community energy schemes with the grid.</td></tr>
<tr><td>Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>4</td><td>-8</td><td colspan="2">12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Environmental : this project will facilitate an increase in renewable energy generation from community-based energy systems

Knowledge Transfer: the partners will work together to exchange ideas and insights on the applicability of technical, commercial, and regulatory innovations that support community-based energy systems.

Network Performance: development of new mechanisms to enable the connection of community energy schemes through the use of new and traditional technology in conjunction with new commercial and regulatory solutions.</td></tr>
</table>

	Financial : this project will evaluate the commercial viability of different solutions that will promote community energy integration		
Expected Timescale to adoption	1 year	**Duration of benefit once achieved**	1 year
Probability of Success	75%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£-61,739
Potential for achieving expected benefits	High		
Project Progress March 2015	The project has successfully completed. Project progress within the year included: • Creation of a secondary data feed to constrained community generators to allow them to complete demand side management • Approval of Tollgrade sensors on the SSEPD network and for their application through live line techniques • Arrangement of resource for installing Tollgrade units at selected locations in the Argyll and West area of SHEPD		
Collaborative Partners	Community Energy Scotland		
R&D providers	University of Strathclyde		

2013_03: Vehicle to Grid

<table>
<tr><td>Project Title</td><td colspan="5">2013_03 Vehicle to Grid</td></tr>
<tr><td>Description of project</td><td colspan="5">With consumer and governmental pressure to reduce transport CO2 emissions, and with dwindling world oil supplies, automotive manufacturers are spending vast sums of money on developing alternatively-fuelled vehicles. Electric vehicles and associated hybrids have seen a number of manufacturers products launched or about to be launched.

One of the additional benefits of having increasingly large numbers of electric vehicles is the potential to assist the grid in load/frequency management.

The aim of this project is to investigate the potential of battery powered vehicles to use their excess rechargeable battery capacity to provide power to the electric grid in response to peak load demands.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £23,588
External -£63,275
Total -£39,687</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £19,222
External £328,489
Total £347,711</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£653,000</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Electric vehicle integration to the grid.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>14</td><td>-1</td><td colspan="2">15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">If successful will see electric vehicles return power to the grid and assist in stabilising voltage levels and enhancing power quality</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>20 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">35%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£1,313</td></tr>
</table>

Potential for achieving expected benefits	The potential application of this technology as a form of energy storage to complement the increasing development of renewable technologies is significant. Delaying/avoiding the construction and also the deployment of existing fossil fuelled power plant indicates the high potential for this technology to be implemented.
Project Progress March 2015	The project successfully produced a prototype electric vehicle with the ability for charge/discharge to be scheduled remotely. In addition EV batteries were automatically cycled under laboratory conditions to determine the effect of the charge/discharge cycle on the battery life. The batteries under test showed no significant deterioration in performance as a result of this test schedule. Reports are available on request.
Collaborative Partners	SPEN, ENW, WPD, UKPN
R&D providers	Future Transport Systems

2013_06: Green Running Load and DG detection

Project Title	2013_06 Green Running Load and DG detection			
Description of project	The pressure on LV resources and capability will be grow continually in the years ahead. The ability to understand the nature of loads on the network as well as smaller scale DG will become increasingly important in informing network reinforcement decisions, outage planning, and reconfiguration This project seeks to prove whether a technology developed for the building energy management profession can work successfully in identifying network loads and energy sources on the distribution network.			
Expenditure for financial year	Internal £11,875 External £22,587 **Total £34,462**		**Expenditure in previous IFI financial years**	Internal £5,538 External £83,175 **Total £88,713**
Project Cost **(Collaborative + external + SSEPD)**	£167,460		**Projected 15/16 costs for SSEPD**	NIL
Technological area and / or issue addressed by project	Load and DG detection, being able to identify types of load on a Network from their signatures.			
Type(s) of innovation involved	Tech Transfer	**Project Benefits Rating** 15	**Project Residual Risk** 1	**Overall Project Score** 14
Expected Benefits of Project	• The Creation of a system that can identify the types and size of loads and DG on a network.			
Expected Timescale to adoption	3years		**Duration of benefit once achieved**	20 years
Probability of Success	25%		**Project NPV = (PV Benefits – PV Costs) x Probability of Success**	£1,800,000
Potential for achieving expected benefits	The system has been used in building management settings already and is seeking to develop their prototype for DNO so there is a high level of confidence the system will be successful.			

Project Progress to March 15	Stage 1 – Upgrade prototype system using real DNO data, completed Stage 2 – DNO discussion and direction meetings, completed Stage 3 – Develop a prototype (i.e. custom software, FPGA solution or using existing DNO hardware) completed Stage 4 – 1st Stage prototype – trial development of a number of prototypes for each DNO, completed Stage 5 – 2nd Stage prototype DNO trials, completed Project is now complete.
Collaborative Partners	SPEN, EIC
R&D Providers	Green Running

2013_08: Electric Bus for Glasgow

<table>
<tr><td>Project Title</td><td colspan="5">2013_08 Electric Bus for Glasgow</td></tr>
<tr><td>Description of project</td><td colspan="5">Electrification of public transport has the potential to reduce CO_2 emissions from transport, and improve air quality in cities. However, pure electric buses have range limitations so this project is for an inductive recharge range extended hybrid bus. It was planned to demonstrate this on a suitable route in Glasgow. The inductive recharge equipment recharges the bus at the ends of the route to recharge the batteries to allow EV only running. However, the inductive technology is at an early stage of development and may impact power quality on the distribution network. The key research elements of this project from a networks perspective will be focussed on the demand profiles and power quality issues (voltage and harmonics) to ensure that a wider roll out of this technology can be done with minimum impact. The project will also test technologies for billing bus operators for use-of-system via the charging infrastructure.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £8,771
External -£133,016
Total -£124,245</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £14,664
External £154,789
Total £169,453</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£185,000</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Inductive charging systems for high power transfer, rapid charging of batteries, power quality with inductive charging, safety implications of electromotive forces emitted while operating inductive charger, and testing of bus operator billing methods.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Tech Transfer, Significant, Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>12</td><td>-3</td><td colspan="2">15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Understanding the impact of electric bus routes and high power chargers on the distribution network.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>5 Years</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">Ongoing</td></tr>
</table>

Probability of Success	75%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£60,933
Potential for achieving expected benefits	Medium		
Project Progress March 2015	Charging point installed at the PNDC demonstration centre and tested. Main project involving the testing of a bus route in Glasgow did not proceed under this project. An alternative larger EU project (ZeEUS) attempted to follow on from this project but did not progress.		
Collaborative Partners	Alexander Dennis Ltd, Johnson Matthey, BAE Systems		
R&D provider	University of Strathclyde		

2013_09: Copper Theft Detection

Project Title	2013_09 Copper Theft Detection						
Description of project	Facilitating the development of and trialling a copper theft detection system that monitors and detects the theft of substation site earthing.						
Expenditure for 2014/15 financial year	Internal External **Total**	£3,499 £15,797 **£19,296**	**Expenditure in previous (IFI) financial years**		Internal External **Total**	£4,414 £34,764 **£39,178**	
Total Project Costs (Collaborative + external + SSEPD)	£148,400		**Projected 2015/16 costs for SSEPD**		NIL		
Technological area and/or issue addressed by project	Detection of theft of copper earthing from a substation site.						
Type(s) of innovation involved	Significant		**Project Benefits Rating**		**Project Residual Risk**		**Overall Project Score**
			15		0		15
Expected Benefits of Project	The benefits include the quicker detection of earthing removal from substation site, allowing the possibility of intervention of thefts which has the benefits of limiting the damage to the site and acting as a deterrent to people carrying out similar acts in the future. It also brings a safety benefit by highlighting earthing removal at an earlier stage than would otherwise be the case, allowing for more immediate remedial works to remedy this otherwise unsafe network operating condition.						
Expected Timescale to adoption	2 years		**Duration of benefit once achieved**		Ongoing		
Probability of Success	50%		**Project NPV=(PV Benefits-PV Costs) x Probability of Success**		£148,805		
Potential for achieving expected benefits	Medium: system alarms proven to output separately and able to connect into SSEPD's communication systems. Issues remain regarding the accuracy of these outputs without the ability to log on to the unit to assess the analogues.						

Project Progress March 2015	Trial work previously being run was completed and the project closed by the end of the financial year.
Collaborative Partners	Scottish Power Energy Networks
R&D providers	Cresatech

2013_10: Establish the Affordability of ADR

<table>
<tr><td>Project Title</td><td colspan="5">2013_10 Establishing the Affordability of Automated Demand Response (ADR)</td></tr>
<tr><td>Description of project</td><td colspan="5">Distribution networks are traditionally designed with an in-built capability to deal with the credible worst-case operational conditions. ADR is envisaged to establish a paradigm change, since it can mitigate network constraints through real-time control of consumers' demand. Consequently, the reinforcement of network assets can be deferred or avoided, with significant economic benefits for DNOs.

The real-time controllability of ADR can also yield improvements in operational aspects of distribution networks. These include the level of network losses, as well as the reliability and quality of supply.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £0
External £1,000
Total £1,000</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £4,204
External £72,313
Total £76,517</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£91,800</td><td>Projected 2015/16 costs for SSEPD</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">Identification of optimal combination of ADR deployment and conventional network reinforcement, by balancing relevant network investment and ADR costs and benefits; quantification of the value of ADR by comparing across different future scenarios.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>15</td><td>-7</td><td colspan="2">22</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Work in this area will reveal benefit streams from ADR for the DNO and to parties responsible for balancing services.</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>2 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">35%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£334,288</td></tr>
</table>

Potential for achieving expected benefits	Medium
Project Progress March 2015	The project "2013_10 Affordability of ADR" was closed down in April 2014 and learnings reported. It was a desktop study primarily conducted by Imperial College, EATL and SSEPD. The analysis demonstrates that the value of ADR to DNOs will depend on cost of ADR; as the cost of ADR deployment is reduced, the benefits of ADR in terms of maximum regret reduction are increased. Specifically, for relatively low cost of ADR, ADR is deployed at the beginning of the planning horizon (when the DNO planner faces uncertainty regarding future demand growth) and leads to very significant maximum regret reductions by postponing capital-intensive network reinforcement decisions to later epochs, where information is gained regarding the emerging evolution of uncertain parameters. In other words, ADR provides interim solutions "buying time" until uncertainty is partially/fully resolved allowing a "wait-and-see" strategy that reduces investment risks. In the case of higher cost of ADR, flexible demand based solutions may not be competitive enough to displace network reinforcement at the first epoch; it may be however still deployed at later stages (epochs) under some scenarios and reduces regret associated with stranded capacity and/or reinforcing network assets multiple times, leading to lower but still notable maximum regret reductions. A very significant outcome is that in some of the examined studies, the min-max regret plan adopts ADR deployment actions that are not adopted by any of the deterministic plans corresponding to the considered scenarios. This result indicates that deterministic planning may tend to favour large-scale network upgrades while a stochastic planning framework reveals the value of ADR in providing flexibility against the undeniable uncertainty and reducing the regret experienced by the DNO planner.
Collaborative Partners	None
R&D providers	Imperial College London, EATL

2013_11: DISCERN Knowledge Transfer

Project Title	2013_11 DISCERN Knowledge Transfer			
Description of project	The primary focus of this IFI project is Knowledge Transfer. Experience gained from SSEPD's New Thames Valley Vision (NTVV) project together with broader knowledge of the UK DNO operational and regulatory frameworks will be fed into the DISCERN European Union Seventh Framework Programme (FP7) project to shape the outcomes and recommendations made by this major EU funded project. Accordingly, participation in the project provides access to knowledge and experiences gained by collaborating DISCERN partners for further dissemination to UK DNOs. The DISCERN (Distributed Intelligence for Cost-Effective and Reliable Distribution Network Operation) project itself draws together complementary demonstration projects established by DNO partners from across Europe to investigate innovative technological solutions for the enhanced monitoring and control of distribution networks. Additional project partners include research organisations and consultancies able to build on the findings from the demonstration trials though software simulation and analysis. DISCERN will investigate the different technologies, architectures and operational methodologies required to support the reliable and efficient operation of MV and LV distribution networks as they adapt to meet changing demands. Knowledge will be shared through workshops, structured questionnaires and interviews, reports and web based portals, with work streams progressing fewer than eleven different Work Packages. This IFI project facilitates participation in the DISCERN project to leverage SSEPD's NTVV project to access wider knowledge and experience and to shape the development of smart grid solutions in Europe. By leveraging the NTVV project SSEPD will draw on the €7.9m DISCERN project, for which 60% funding is provided from the European Commission via the FP7 framework with the remaining cost being met by the DISCERN partners. The IFI project will have a duration of three years in line with the DISCERN project itself. Further details of the DISCERN project, including project deliverables, can be found at www.discern.eu/index.html.			
Expenditure for 2014/15 financial year	Internal £64,680 External £2,972 **Total £67,652**		**Expenditure in previous (IFI) financial years**	Internal £16,258 External £118 Total **£16,376**
Total Project Costs (Collaborative + external + SSEPD)	£248,751		**Projected 2015/16 costs for SSEPD**	Internal £100,026 External £0 **Total £100,026**

<table>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="4">SSEPD’s involvement in DISCERN will contribute to all project objectives, including:
• development of an assessment framework based on KPIs that allows the comparison of technical solutions for monitoring and controlling the distribution network
• identification, assessment and comparison of the technological (technical, operational, organisational & ICT infrastructure) options for monitoring and control systems in the distribution network
• testing and validation of optimal technological solutions in various countries and circumstances by means of both field tests and computer based simulations
• knowledge exchange between innovative European DNO projects trialling various smart grid functionalities relating to network monitoring and control
• development of recommendations for the cost-effective application of advanced distributed sensors, monitoring and control systems to increase the intelligence of electricity distribution networks
• development of the Smart Grid Architectural Model (SGAM) concept and supporting software tools for the enhanced communication and comparison of technological solutions for achieving smart grid functionalities
• identification and mapping of relevant standards to contribute to European standardisation activities.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, Tech Transfer, Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>20</td><td>-3</td><td>23</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Through this IFI project, information obtained from SSEPD’s NTVV project will be combined with learning from four further European demonstration projects in addition to software based simulations and analysis.
Participation in the DISCERN project will provide access to data collected on the technological, financial and operational issues and benefits associated with monitoring MV and LV networks, the requirements for optimal monitoring and the potential benefits of proposed monitoring systems which have been validated in differing deployment situations.
SSEPD’s knowledge and experience will influence the development of recommendations, standards and supporting systems architecture methodologies to be provided to the European Commission via the DISCERN project. Such deliverables will inform the EC’s future plans and guidance issued to European DNOs, and the development of</td></tr>
</table>

	supporting standards by European standards organisations. The outputs from DISCERN will also provide information and guidance for DNOs wishing to implement various smart grid functionalities, with findings available for dissemination to UK DNOs.		
Expected Timescale to adoption	2 - 5 years dependent on Work Package/project deliverable	**Duration of benefit once achieved**	Continual Benefit
Probability of Success	35% - 90% dependent on Work Package/project deliverable	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£3,505,451
Potential for achieving expected benefits	Various monitoring systems, including enhanced communications and control algorithms, have already been installed in trial locations on the MV and LV networks of the DISCERN DNO project partners. This project will look to build on these implementations by cataloguing information on the systems available, investigating the replicability and scalability of the solutions implemented, investigating the costs associated with optimal solutions, making recommendations and providing communication tools to facilitate replicability of the solutions. The collaborative nature of the project and range of solutions deployed provides a wealth of information from which to draw, and mitigates the risks associated with issues which may arise in any individual project. Further, the use of simulations provides an increased base of information to support further assessment, analysis and comparison. As such, participation in DISCERN has a high potential to provide significant additional knowledge over and above that obtained from SSEPD's NTVV project alone with regard to the enhanced monitoring of MV and LV networks in an optimised and cost effective manner. As the DISCERN project itself reports to the European Commission, the recommendations on standards, supporting systems architecture methodologies and other frameworks required for the successful future implementation of smart grids across Europe will reach those responsible for decision making and issuing guidance to DNOs within the EU.		
Project Progress March 2015	The DISCERN project is in its final year, and this IFI project will transition into the NIA framework for the remainder of the project. Further project deliverables have been published over the course of the second year, and the second periodic review has been completed by the EC.		

	SSEPD continues to actively participate in all ten original Work Packages, in addition to a further Work Package established to provide tools and a repository for collating data gathered in smart grid projects from across Europe, thereby supporting knowledge sharing, avoiding duplication of project efforts and ensuring efficient use of resources. Key activities over the past year include: • informing development of suitable assessment methodologies and data collection templates across a range of project activities, including business case analysis, cost benefit analysis, SWOT analysis & assessment of the regulatory context • data collection & analysis to support KPI assessment • review of the standards & protocols used within the project's smart grid solutions • work on the CIM (Common Information Model) semantic model mapping & extension to represent new smart grid functionalities, building experience of CIM & its application • trialling the SGAM and Use Case Management Repository software tools developed for comparing and communicating smart grid solutions between interested parties (DNOs/vendors/industry bodies) • review of Use Case & SGAM representations prepared by project partners, building experience of SGAM & its potential future uses and informing internal business use of SGAM as part of a procurement process • assessment of the replicability & scalability of various smart grid solutions • informing the use of simulations to investigate implementation of selected smart grid functionalities on reference grids, and provision of network data and load profiles to facilitate the simulations • development of a methodology to allow partner DSOs to learn from other partner's demonstration sites and appraise the usefulness of the material developed within DISCERN to share knowledge of the solutions implemented • ensuring a clear understanding is provided on the GB regulatory framework • peer review through a second external experts workshop, and preparation of a deliverable capturing the discussions held during the workshop • participation in workshops across the various work packages, both teleconferenced and face to face • participation in the project steering Technical Board Meetings and General Assembly

	• reviewing & commenting on draft deliverables prior to publication • contribution to the 2nd Periodic Report provided to the European Commission • presentations on SGAM to the UK Smart Grids Forum and an ENA SGAM workshop, and sharing DISCERN SGAM toolbox & Use Case Management Repository material with third parties in the UK (DNOs/vendors/industry bodies)
Collaborative Partners	RWE, ABB AB, CIRCE, IBERDROLA, DNV GL, KTH, OFFIS, UNION FENOSA, VATTENFALL, ZIV
R&D providers	SSEPD

2013_13: SF6 Leak location and Oxifree Coatings

<table>
<tr><td>Project Title</td><td colspan="5">2013_13 SF6 Leak location and Oxifree Coatings</td></tr>
<tr><td>Description of project</td><td colspan="5">Sulphur Hexafluoride (SF6) gas is extensively used in switchgear as an insulator medium and arc quenching medium. It is also a green house gas with a Global Warming Potential (GWP) that is 23,900 times that of Carbon Dioxide (CO2) if emitted into the atmosphere. Every year, small amounts of SF6 gas are inevitably lost through leaking switchgear but due to the gravity of its environmental impact, all practicable measures have to be taken to reduce these emissions to as low as possible. Typical measures include invasive repair and replacement of problematic switchgear. However, both methods are financially costly and time intensive. If a switchgear item is identified as having SF6 gas leakage, the first step in mitigation is to identify the source of the leak to enable repairs. It is a difficult process which requires outages with some impact on network security and tends to be inconclusive. This project involves trial of a non-contact means of pin-pointing leaks together with a non-invasive method of reducing identified gas leaks.

The trial for non-contact means of pin-pointing SF6 leaks makes use of FLIR infrared gas detection cameras which are capable of visually detecting SF6 gas from a distance and showing it on a display as a dark smoke plume. After each pin-pointing exercise, a non-invasive method of reducing the leak is tried through encapsulation of the switchgear component with Oxifree TM198 resin, a new product which is currently utilised mainly for corrosion protection. This methodology is expected to be more cost effective than current practice and to result in significant environmental benefits.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £24,236
External £13,488
Total £37,724</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £37,290
External £139,370
Total £176,660</td><td colspan="2"></td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£216,663</td><td>Projected 2015/16 costs for SSEPD</td><td>NIL</td><td colspan="2"></td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Reduction of SF6 emissions from switchgear will reduce the environmental impact of power systems.</td></tr>
<tr><td>Type(s) of innovation involved</td><td rowspan="2">Technological Substitution from outside industry</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td><td></td></tr>
<tr><td></td><td>15</td><td>0</td><td>15</td><td></td></tr>
</table>

Expected Benefits of Project	**Financial** – On the basis that SF6 has Global Warming Potential (GWP) of 23900 times that of Carbon Dioxide and considering the Department of Energy and Climate Change's carbon valuation guidelines, each tonne of SF6 not emitted represents a financial saving of £693,000. **Knowledge Transfer** – Training on the techniques for use of optical gas imaging for maintenance staff is provided as part of this project, this knowledge transfer will completely remove the need for investigation visits by repair companies. Avoided outages will save money and minimise environmental impact. **Environmental** – There is an expectation of a marked reduction in total SF6 emissions should the method prove successful. With the potency of SF6 gas being that high, any reduction in emissions has a high corresponding improvement in environmental performance. **Network Performance** – Use of gas detection cameras enables inspection on live equipment from a safe distance. Sources of gas leakage can therefore be pin-pointed without investigation outages. Oxifree coating is non-invasive hence it can be rapidly deployed thereby reducing outage times further.		
Expected Timescale to adoption	1	**Duration of benefit once achieved**	40
Probability of Success	90%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£4,188
Potential for achieving expected benefits	Medium		
Project Progress March 2015	The project has successfully completed and closed. The methods have now been adopted as part of business as usual. The longevity of Oxifree coatings continues to be assessed as part of routine inspection.		
Collaborative Partners	None		
R&D providers	Acute Sales and Oxifree UK		

2013_14: Remote Access Solutions

<table>
<tr><td>Project Title</td><td colspan="5">2013_14 Remote Access Solutions</td></tr>
<tr><td>Description of project</td><td colspan="5">A number of Future Networks R&D projects have required 3rd party suppliers, academics, and /or joint venture partners to have access to the SSEPD networks. Some of the requests for access have been unacceptable to IT Security, and workarounds have had to be found, often at short notice, in order for the projects to continue. There are especial issues in allowing external connectivity to SSEPD's SCADA networks, because of the sensitivity and function of the devices on this network.
There are risks in allowing 3rd parties access to SSEPD’s networks, for example: Exposure and loss of function of Control Systems, Financial Loss, Exposure of Confidential Information, Outage of Grid Equipment, and Curtailment of Contracted Generators, are some of the most severe. The resultant financial and/or reputational loss could be measured in millions of pounds.
This project is being set up in order to protect the networks, whilst at the same time allowing necessary access. The project is looking at standardising remote access to the SSEPD data network taking into account all of the latest IT Security policies and procedures, and by having the solution penetration tested, it will demonstrate the level of cyber security that has been achieved so that the results can be presented to IT Security for approval. Following the approval of the IT Security Manager, then the solution will be available for R&D project managers to incorporate into their project plans to accommodate current and future requests from 3rd parties.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £35,853
External £18,728
Total £54,581</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £25,145
External £19,209
Total £44,354</td><td colspan="2"></td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£176,500</td><td>Projected 2015/16 costs for SSEPD</td><td>NIL</td><td colspan="2"></td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Ensuring secure access to the data network such that exposure to cyber attack is minimised.</td></tr>
<tr><td>Type(s) of innovation involved</td><td>Technological Substitution from different application</td><td>Project Benefits Rating
13</td><td>Project Residual Risk
-6</td><td>Overall Project Score
19</td><td></td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Third party access via a secure system that minimises the attack vectors on the SSEPD Data networks.</td></tr>
</table>

Expected Timescale to adoption	18 months	**Duration of benefit once achieved**	5 years
Probability of Success	35%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£129,029
Potential for achieving expected benefits	Medium		
Project Progress March 2015	Following discussions with IT architecture, an initial level 0 architecture design was produced. Based on this design, discussions took place with IT Security and they had no objections to the proposals, and were interested to see the results. The design called for two servers and associated software to be procured, along with monitoring software for up to 10 simultaneous sessions. This was purchased. A request for network addresses within the company DMZ was met with address space allocated. The project was then informed that corporate IT now had their own remote access solution, based within an IT only DMZ. As SSEPD were able to negotiate the use of this system, the project was halted at that point. The software purchased will be used within the IT environment for its original intention of monitoring vendors access and usage. The two servers purchased will be used for other innovation projects.		
Collaborative Partners	None		
R&D providers	None		

2013_15: ZeEUS

Project Title	2013_15 ZeEUS			
Description of project	Demonstration of high power inductive transfer systems on electric bus route. This project builds on an earlier project to include more buses and an additional charge point to prove the technology in a commercial environment, and higher power transfer taking the technology to the next TRL level.			
Expenditure for 2014/15 financial year	Internal £11,486 External £1,760 **Total £13,246**		**Expenditure in previous (IFI) financial years**	Internal £2,169 External £118 **Total £2,287**
Total Project Costs (Collaborative + external + SSEPD)	£362,000		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and/or issue addressed by project	Network impact of high power inductive transfer systems on the power network for a schedule d bus route. The key research elements of this project from a networks perspective will be focussed on the demand profiles and power quality issues (voltage and harmonics), and safety issues regarding the electro magnetic fields (EMFs).			
Type(s) of innovation involved	Incremental, Tech Transfer, Significant, Radical	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**
		10	-1	11
Expected Benefits of Project	Successful implementation would lead to increased electrification of urban transport, leading to higher network utilisation, and put SSEPD at the forefront of inductive charging technology			
Expected Timescale to adoption	2	**Duration of benefit once achieved**	20	
Probability of Success	50%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£60,590	
Potential for achieving expected benefits	Medium			
Project Progress March 2015	The project failed as the bus operator (First Group) was unable to reach agreement with Strathclyde Partnership for Transport as to which routes and bus station stances were to be used.			

Collaborative Partners	Alexander Dennis Ltd (ADL), Strathclyde Partnership for Transport (SPT) , Transport Research Laboratory (TRL)
R&D providers	TRL

2013_16: Network Damage Reporter

Project Title	2013_16 Network Damage Reporter				
Description of project	During Storm events it can be difficult to keep track of where and how much damage is occurring to the overhead network, due to the prevailing weather conditions. This project is to develop and introduce a smart phone application that can be used by members of the public, the Emergency Services, as well as company staff to record damage sites, and report them back to a central repository. This allows for quicker network damage recording by opening up the reporting of damage to a much wider constituency. By speeding up the recording the damage to the network, a quicker response can be implemented reducing the CMLs, by getting customers back on supply quicker.				
Expenditure for 2014/15 financial year	Internal £13,912 External £42,377 **Total £56,289**		**Expenditure in previous (IFI) financial years**	Internal £2,624 External £40,118 **Total £42,742**	
Total Project Costs (Collaborative + external + SSEPD)	£228,000		**Projected 2015/16 costs for SSEPD**	Internal £88,125 External £25,000 **Total £113,125**	
Technological area and/or issue addressed by project	Improves customer engagement by allowing them to report accurate network issues. Provides a communication methodology that should allow a speedier response to network issues by DNO repair teams.				
Type(s) of innovation involved	None	**Project Benefits Rating**	**Project Residual Risk**	**Overall Project Score**	
		19	-1	20	
Expected Benefits of Project	Reduction in CML of 0.01% through accurate network issue reporting and speedier response by repair teams.				
Expected Timescale to adoption	Ongoing	**Duration of benefit once achieved**	10 years		
Probability of Success	25%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£805,821		
Potential for achieving expected benefits	Medium				

Project Progress March 2015	Smartphone app has been developed and is available for download as a beta test version. Testing has been carried out by company staff, both IOS and Android versions, to allow a broad set of testing, and stress of the server. The project has now closed, and an NIA project has been raised to develop the back end server base to take in the reports and integrate them into the OMS.
Collaborative Partners	EIC, ENW
R&D providers	Open Grid Systems

2013_17: Orkney ANM Critical Circuits

<table>
<tr><td>Project Title</td><td colspan="5">2013_17 Orkney ANM Critical Circuits</td></tr>
<tr><td>Description of project</td><td colspan="5">The Orkney Active Network Management (ANM) Scheme has been operational on the Orkney islands since 2009. In 2012 the project was sufficiently demonstrated to allow the process of handing it over to the Business to commence. This roll out across other relevant areas would allow SSEPD to get maximum value for their customers through using the ANM concept. As part of the handover the system was analysed to make sure that it fitted within company process and policy. As part of this review it was decided to automate some of the functionalities of ANM when responding to 33kV network configuration changes, which as a current practice is currently completed manually.

Whilst completing this work it was discovered, due to the proliferation of the micro generators, that more than just the ANM controlled generators were required to reduce their export during certain network outage conditions. As such the decision was taken to incorporate the intertrip scheme that controls the tranche of generators installed prior to the deployment of ANM. This incorporation will allow the network to stay within its operational limits, whilst at the same time ensuring that a maximum amount of generation can be allowed onto the network in a co-ordinated manner.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £18,279
External £41,054
Total £59,333</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £2,078
External £14,091
Total £16,169</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£72,270</td><td colspan="2">Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Managing network within operational limits in a real time manner</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>14</td><td>-4</td><td colspan="2">18</td></tr>
</table>

Expected Benefits of Project	**External Benefits :** The solution should reduce the chance of a fault occurring due to overload conditions on the main 33kV network, which could have a significant impact on the generators operating under the control of the ANM system. **Knowledge Transfer:** Solution will be developed in conjunction with an external party to fit onto an SSEPD owned and operated system allowing SSEPD to understand how to apply this elsewhere **Network Performance:** The network will not be subjected to overload conditions following certain reconfigurations and as such will be better managed		
Expected Timescale to adoption	6 months	**Duration of benefit once achieved**	10 year
Probability of Success	90%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£819,056
Potential for achieving expected benefits	High		
Project Progress March 2015	The project has been successfully completed and closed. The system was created, tested and deployed onto the network. This demonstrated that ANM can be directly interfaced to existing intertrip scheme whilst ensuring that the network stays within operational limits. This will now become a standard option for future deployments of ANM in the SSEPD area.		
Collaborative Partners	None		
R&D providers	Smarter Grid Solutions		

2014_01: Overhead Line Vibration Monitoring

<table>
<tr><td>Project Title</td><td colspan="5">2014_01 Overhead Line Vibration Monitoring</td></tr>
<tr><td>Description of project</td><td colspan="5">Overhead lines are susceptible to inadvertent contact by vehicles, fishing rods and even kites, depending on where they are situated geographically.
The most likely locations for a hazardous situation involving an overhead line are road or track crossing points, next to rivers/lakes/lochs and next to playing fields. Where overhead lines are close to, or cross these areas, the locations are known as critical crossings. The danger is that a 33KV, 11Kv or LV overhead line could be struck by an object that could result in serious injury or a fatality of the person or person involved in the incident.
This project is working on the assumption that it is possible to discriminate between incidents where the circuit needs to be de-energised, and remain so until checked, and those incidents where no action is required.
The intention is to have a device created, installed and tested to prove that the assumption is correct.
If it can be shown that it is possible to discriminate between inadvertent cable strikes by members of the public and natural hazards, then a further phase of the project may be initiated to develop prototypes of such devices for further testing.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £18,621
External £696,928
Total £715,549</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £3,790
External £95,119
Total £98,909</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£710,000</td><td colspan="2">Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">The detection of overhead line collisions by vehicles so that automated reclose mechanisms can be over-ridden and avoid fatalities.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>18</td><td>1</td><td colspan="2">17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Reduction in injuries and fatalities due to electrocution by coming into contact with overhead lines.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 year</td><td colspan="2">Duration of benefit once achieved</td><td colspan="2">10 years</td></tr>
</table>

Probability of Success	35%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£722,562
Potential for achieving expected benefits	Medium		
Project Progress March 2015	Phase 1 of the project, 3 stages, completed. Initial prototypes produced and tested, and detection and reporting algorithms developed. Project closed, with further work being considered for NIA registration.		
Collaborative Partners	None		
R&D providers	Tollgrade Communications Inc		

2014_02: Field Team Support Tool

<table>
<tr><td>Project Title</td><td colspan="5">2014_02 Field Team Support Tool</td></tr>
<tr><td>Description of project</td><td colspan="5">During Storm events it can be difficult to keep track of where and how much damage is occurring to the overhead network, due to the prevailing weather conditions. It may be several days after the storm before scouting can be completed on the ground or helicopters are able to be flown to trace damage.
The GridView system as developed by Open Grid is a network schematic lain over a geographic map of the area. These are combined by taking the Network schematic from the SCADA system, and combining it with Google maps. There is potential for the resulting map of the network to be delivered to field teams handheld tablets and also for the field operatives to photograph and send damage reports back to the central database for insertion into the SCADA system.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £17,911
External £137,405
Total £155,316</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £4,958
External £249,617
Total £254,575</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£630,000</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">Internal £82,170
External £220,000
Total £302,170</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Improvements to provision of documentation to field staff, and reduction in the requirement for paper maps and forms.
Reduction in CHLs</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>16</td><td>-1</td><td colspan="2">17</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">Improved provision of Data to field staff, more effective response to Storm events.</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>10 years</td></tr>
<tr><td>Probability of Success</td><td colspan="2">50%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£540,963</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="5">Medium</td></tr>
</table>

Project Progress March 2015	The GridIView app is in use by 71 users, some field staff, and also back office staff and managers. The app is universally liked, and good feedback has been provided from users. The app continues to be developed to meet the needs of the user base, with improved mapping to 1:10,000 in beta. This project is closed; however, a NIA project has been raised to develop the Common Information Model that will combine data from GIS, DMS, OMS, and Asset Management, so that the data displayed by the app is continuously updated.
Collaborative Partners	None
R&D providers	Open Grid Systems

2014_03: Fault Passage Indicator Consolidation

<table>
<tr><td>Project Title</td><td colspan="5">2014_03 Fault Passage Indicator Consolidation</td></tr>
<tr><td>Description of project</td><td colspan="5">Fault Passage Indicators (FPI), as a stand-alone device have been commercially available for a number of years to the UK DNO population. They work by monitoring the electric and magnetic fields surrounding overhead lines and by understanding what will happen to these fields, following a fault, they can detect whether fault current has past them or not. In this way Customer Minutes Lost (CMLs) could be reduced as circuit restoration would be more efficient.

The scope of this project is to consolidate the learning from SSEPDs previous FPI projects involving communicable FPIs, as well as learning from other UK DNOs, to inform the business case for the mass roll out of FPIs. If the decision is taken to roll out FPIs in a large scale programme then SSEPD 'Business as Usual' (BaU) resources will be used.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £12,077
External £8,106
Total £20,183</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £3,551
External £7,769
Total £11,320</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£63,065</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Better identification of fault locations on the distribution overhead network</td></tr>
<tr><td>Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>12</td><td>1</td><td colspan="2">11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">External Benefits : Fault outages should be reduced and it will help in all fault environments, i.e. one off and storms

Knowledge Transfer: Solution will inform policy for how, when and how to apply overhead FPIs

Network Performance: Project looks to deliver a sustainable improvement on the pin pointing of faults and thus reduce the CMLs experienced by SSEPD customers.</td></tr>
</table>

Expected Timescale to adoption	6 months	**Duration of benefit once achieved**	10 year
Probability of Success	90%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£214,812
Potential for achieving expected benefits	Medium		
Project Progress March 2015	The project has been successfully completed and closed. It delivered a full scale deployment plan for communicable FPIs that covered everything from Procurement Processes, evaluation criteria, required architecture to get information into a central location, installation locations, methods of installation and benefits case for their wide scale use. This is now available as business as usual.		
Collaborative Partners	None		
R&D providers	Nortech		

2014_04: Data Matching for Smart Registration

<table>
<tr><td>Project Title</td><td colspan="4">2014_04 Data Matching for Smart Registration</td></tr>
<tr><td>Description of project</td><td colspan="4">To trial novel ways to match data required for registration with the DCC with internal data and the arbitration rules associated with improving the quality of data matches. By matching UPRN with MPAN data we will for the first time be able to align MPAN with GIS. The alignment of geospatial data will allow for better future network connectivity models. More accurate network connectivity models are crucial in management of the forecasts for increase in LCTs on the distribution network.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £6,001
External £1,728
Total £7,729</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £2,252
External £22,118
Total £24,370</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£33,370</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="4">Use current tools (x88 Pandora) in novel ways and define the approach and process for matching registration data in 3 stages. The geographical data used will be Ordnance Survey uPRN data with PAF compliant postal data made available to SSEPD and the premise data will be provided from internal systems with address and MPAN. This will be trialled in a small area first (RG1 post codes) to build the stages of the data matching and then expanded.
Stage 1 involves a fuzzy match (~50% certainty), Stage 2 improves the fuzzy match with some transformation rules making the matches better (~80%) and Phase 3 consolidates the results and uses bespoke logic valid for all scenarios (target 95% certainty).
Once the RG1 address data is around the 95% certainty matching the rules and all associated documentation on the approach will be collated and made available to SSEPD. It will then be tested on 2 further geographical areas not previously targeted (one South and 1 North) to prove its efficacy and to stabilise the formulae used. The documentation will at that point be updated and verified.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>5</td><td>1</td><td>6</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The data mapping and transformation documentation will form the key learning from this and no personal data will be shared as knowledge but rather just the approach and the evaluation criteria. An internal deliverable will be points of concern with the data in the remaining 5% of data where the data is missing or incomplete.</td></tr>
</table>

Expected Timescale to adoption	6 months	**Duration of benefit once achieved**	10 years
Probability of Success	25%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£40,334
Potential for achieving expected benefits	Medium		
Project Progress March 2015	Using the expertise of Pandora consultants X88, the staff in Mapping Services learnt how to use Pandora to examine and compare MPAN and UPRN data, and developed a process to follow to carry out the data matching for the PO and AB post code areas. The project is now closed.		
Collaborative Partners	None		
R&D providers	X88		

2014_05: Cable Core Temperature Sensor

Project Title	2014_05 Cable Core Temperature Sensor			
Description of project	This project is to validate a concept for an easily retro-fitted sensor for measuring and/or deducing the temperature of the core of a 3-phase electricity network power cable. Using cable temperature to infer the current in a cable offers the possibility to use this approach to provide a lower cost, more easily installed alternative to current transformers. It also provides a retro-fit alternative to fibre-optic cable temperature sensing. Additionally the measurement of the core temperature can be used to gauge when a cable reaches its temperature tolerance levels independent to the power being transferred.			
Expenditure for financial year 14/15	Internal £7,593 External £1,728 **Total £9,321**		**Expenditure in previous (IFI) financial years**	Internal £1,378 External £41,318 **Total £42,696**
Project Cost **(Collaborative + external + SSEPD)**	£ 334,276		**Projected 2015/16 costs for SSEPD**	NIL
Technological area and / or issue addressed by project	The problem being addressed by this project is to measure the cable core temperature at regular intervals using a sensor attached to the outer sheath of a cable. The sensor ideally is to be small, easily retro-fitted and will be of relatively low cost to manufacture. Two potential methods of temperature measurement were to be under consideration as follows: Direct temperature measurement of the cable sheath with a computational model inferring a virtual temperature sensor at the cable core. The computation would be based on a cross-sectional thermal model of the cable components and materials. Direct heat flux measurement to quantify the amount of heat exiting the cable, using the thermoelectric effect - also known as the Peltier and Seebeck effects depending on the direction of conversion between heat and electricity.			
Type(s) of innovation involved	Technological substitution from outside industry	**Project Benefits Rating** 18	**Project Residual Risk** -3	**Overall Project Score** 21
Expected Benefits of Project	It is expected that the development of such a sensor would give the networks the increased ability to manage peak currents. The sensors would improve the understanding of the network condition to help with network utilisation and deferral of capital expenditure (by extending the life of cables through peak temperature management), potentially also reducing the costs of outages.			

Expected Timescale to adoption	3 years	**Duration of benefit once achieved**	25 years
Probability of Success	10%	**Project NPV = (PV Benefits – PV Costs) x Probability of Success**	£194,965
Potential for achieving expected benefits	High		
Project Progress to March 15	The project started in December 2013. Stage 1 – (Analytical and experimental proof of principle work) has been completed. The direct temperature measurement technique has been adopted as the favoured method. Stage 1 (Analytical and experimental proof of principle work) has shown that cable core temperature can be predicted with reasonable accuracy from easily accessed measurements of the cable exterior, and there may be techniques to improve the impacts of thermal lag so that a temperature sensing method can provide a range of useful measurements to assist with network management. Stage 2 (Proof of Concept Laboratory Prototype) was successfully completed in July 14. Stage 3 (Proof of Concept & Live Trial) began in Sept 14 with a Site trial in March 15. Project is now complete.		
Collaborative Partners	SPEN, ENWL, NPG, UKPN, Energy Innovation Centre		
R&D Providers	The Technology Partnership Ltd		

2014_06: VTOL

<table>
<tr><td>Project Title</td><td colspan="5">2014_06 VTOL</td></tr>
<tr><td>Description of project</td><td colspan="5">The use of helicopters to inspect overhead line assets is an expensive exercise and significant cost savings could be realised by the deployment of unmanned aerial systems. One or two of the UK DNOs are already successfully using unmanned aerial systems (UAS) for inspection tasks. However these systems are not suited to Beyond Visual Line Of Sight [BVLOS] operations.

To achieve this demanding goal of BVLOS, requires an expert approach to addressing the following three critical issues for electricity overhead-lines:

• Clearly defining BVLOS operations for which Civil Aviation Authority Approval [CAA] can be sought and secured.

• A financial analysis that can provide a clear indication as to where categorized BVLOS operations will provide the best Return On Investment [ROI] for the DNOs and be viable for current and/or as yet undefined future operations.

• Specifying a Remotely Piloted Aerial System [RPAS] that can provide a long endurance capability and fly BVLOS as well as meeting CAA regulatory requirements.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £11,036
External £1,728
Total £12,764</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £1,380
External £69,450
Total £70,830</td></tr>
<tr><td>Project Cost
(Collaborative + external +SSEPD)</td><td colspan="2">£567,111</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">Internal £10,000
External £0
Total £10,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="5">The goal of this project is to be able to define an industry standard electricity specification for Remotely Piloted Aircraft Systems (RPAS) operating Beyond Visual Line Of Sight (BVLOS) for electricity distribution network aerial inspection operations, confirmed by the UK Civil Aviation Authority. By the end of the project, the industry will be in a position to decide whether it wants to invest in such systems and if affirmative, fund acquisitions or development as necessary and with the goal of starting to introduce such systems into service for BVLOS operations in a stepwise manner, in close co-operation with and as agreed by the CAA.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>18</td><td>2</td><td colspan="2">20</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">A UAS offers significant cost savings when compared to helicopter deployment. Being able to operate beyond the visual line of sight will result in significantly more circuit kms being surveyed during inspection</td></tr>
</table>

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

Other benefits that unmanned aerial systems will bring include:

• Minimising environmental impact with greatly reduced fuel consumption.

• Minimised disruption to land owners, livestock and local residents during inspection.

• Reduced risk to life and limb by using un-manned apparatus to retrieve data.

• Reduced Civil Aviation restrictions in the vicinity of airports, chemical plants, MOD land etc.

• Limit the effect of stand down time due to bad weather or strong winds.

Reduced numbers of “missed towers” by not having to avoid motorways, railways or housing estates etc.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 Years</td><td>Duration of benefit once achieved</td><td>30 Years</td></tr>
<tr><td>Probability of Success</td><td>10%</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of Success</td><td>£128,728</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">The approach of this project is designed to address the CAA requirements at every stage in order increase the potential for achieving expected benefits.</td></tr>
<tr><td>Project Progress to March 2015</td><td colspan="3">The project has progressed and is now at stage 4. This stage is reviewing the concept of operations (ConOps) simulations and finalising the RPAS specifications confirmed by network operators and CAA. The other stages have delivered the milestones of establishing the BVLOS operational requirements, establishment of base operational simulation environments and development of the ConOps.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="3">UK Power Networks, Northern Powergrid Limited, Northern Gas Networks, Scotland Gas Networks plc, Southern Gas Networks plc.</td></tr>
<tr><td>R&D Providers</td><td colspan="3">VTOL</td></tr>
</table>

2014_07: Ultrapole

<table>
<tr><td>Project Title</td><td colspan="4">2014_07 Ultrapole</td></tr>
<tr><td>Description of project</td><td colspan="4">There are currently several invasive instruments on the market for detecting wood rot in wooden poles used by the distribution network operators (DNOs) which are based on both acoustic (hammer in nail, tap and listen) and ultrasonic (slice shadow) technologies. Current products on the market adopt a variety of techniques but all are restricted to detecting rot in very close proximity to the point at which the measurements are being taken.

To satisfy the DNOs objective of assessing the condition of their pole assets, there is a need for an instrument that is easy to use in the field, takes non- intrusive measurements, and has the ability to operate at ground level over the entire length of the pole. Such an instrument would prevent the need for digging around the base of the pole disturbing previously good ground conditions, or climbing the pole to take measurements at height.

This project is to conduct a study into the feasibility for such a device.</td></tr>
<tr><td>Expenditure for financial year 14/15</td><td>Internal £7,606
External £8,394
Total £16,000</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £1,380
External £15,120
Total £16,500</td></tr>
<tr><td>Project Cost
(Collaborative + external + SSEPD)</td><td>£90,120</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">Internal £10,285
External £15,363
Total £25,648</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Testing of wood poles by existing methods such as hammer test can be subjective in nature and result in the inappropriate replacement of poles with residual life.

As the result of testing is localised to the point of test, abnormalities elsewhere along the length of the pole can go undetected which can result in the failure of the overhead line under adverse weather conditions leading to CI and CML penalties for the company.</td></tr>
<tr><td>Type(s) of innovation involved</td><td rowspan="2">Technological Substitution from different application</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>16</td><td>-3</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• The ability to scan very rapidly long pole lengths for the presence of ‘acoustic anomalies’ such as the presence of rot in the pole.

• Increased knowledge and understanding of condition of wood poles, allowing targeted maintenance and replacement based on condition of asset.</td></tr>
</table>

	• Reduced costs of surveying poles (no climbing of pole). More accurate rot assessment (scanning whole pole) therefore less waste from misdiagnosis. • Reduced failure of wood poles leading to reduced CIs/CMLs from overhead lines and improved network performance. • If this non-intrusive testing methodology is proven it will reduce risk exposure for linesmen, operational staff and third parties.		
Expected Timescale to adoption	3 years	**Duration of benefit once achieved**	25 years
Probability of Success	10%	**Project NPV = (PV Benefits – PV Costs) x Probability of Success**	£802,753
Potential for achieving expected benefits	Project started in January 2014, potential for achieving expected benefits is low as per above probability of success.		
Project Progress to March 2015	The project started in January 2014. Initial kick off meeting completed. Supply of test material established and test equipment ordered. Stage 1 Exploration, Science Review/Technology Assessment was completed in September 2014, there were some significant delays due to legal issues when ENW & NPG wished to drop off from the project, preventing moving to Stage 2. Stage 2 is now currently running under NIA funding with SSEPD, SSEPD & UKPN.		
Collaborative Partners	SPEN, ENWL, NPG, UKPN, Energy Innovation Centre		
R&D Providers	Acuity Products Ltd		

2014_08: Monitoring of Conductors and Poles

<table>
<tr><td>Project Title</td><td colspan="4">2014_08 Monitoring of Conductors and Poles</td></tr>
<tr><td>Description of project</td><td colspan="4">There is a potential risk to public health and safety due to low ground clearance high voltage (HV) conductors. This is especially the case near areas accessible to the public such as footpaths, recreational areas and where the line is located close to roads or railways. CNIguard has been invited to propose a low cost system to monitor the integrity of power distribution overhead conductors and supports used to distribute electricity to homes and businesses. The key features will be the determination of excessive sag or breakage due to damaged or failed insulators, theft of conductor sections and the state of the poles themselves to determine early failure. The system will alert the Company’s Security Management Centre (SMC) if an event occurs that could result in danger to public health and safety or network outage. This will allow a faster response time to attend sites once they have been identified by the system. The potential for using these alerts to control auto reclose functionality will also be considered.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £9,215
External £288,218
Total £297,433</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">NIL</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£297,433</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="4">The aim of this project is to develop a low cost monitoring system that will provide alerts to the DNOs when a conductor has developed excessive sag, due to pole failure or objects impacting the pole or conductor. The monitoring system needs to be intelligent enough to minimise false alarms but sensitive enough to provide authentic alarms very quickly in the event of a dangerous situation developing.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>20</td><td>1</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The data mapping and transformation documentation will form the key learning from this and no personal data will be shared as knowledge but rather just the approach and the evaluation criteria. An internal deliverable will be points of concern with the data in the remaining 5% of data where the data is missing or incomplete.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 year</td><td colspan="2">Duration of benefit once achieved</td><td>10 years</td></tr>
</table>

Probability of Success	25%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£666,106
Potential for achieving expected benefits	Medium		
Project Progress March 2015	The project has developed a line mounted sensor, and communications modules for mounting on the overhead network. Signal processing algorithms have also been developed to analyse the vibrations detected and produce the alarm signal. The system has been tested on varying diameters of overhead cable, and demonstrated to produce alarms when a suitable stimulus has been applied to the wire. The project is now closed and close down report is available.		
Collaborative Partners	None		
R&D providers	CNI Guard, PNDC		

2014_09: 33kV Hot Glove Working

Project Title	2014_09 33kV Hot Glove Working		
Description of project	In 1998 SSEPD received approval from the Health and Safety Executive (HSE) that mitigation actions proposed allowed the requirements of Section 14 of the Health & Safety Act 1974 to be adhered to whilst performing live line work at 11kV. This was received following submission of a case detailing the justification as well as the mitigation measures that would be employed. 33kV hot glove working wasn't requested at the time as the justification wasn't deemed to be sufficient at the time. Circumstances have now changed and the purpose of this project is to examine the use of 33kV hot glove working to determine if there is sufficient justification to get dispensation to be able to perform hot glove work at 33kV. To deliver the project aim the following methodology will be used: ● Defining/quantifying the risk associated with 33kV hot glove working; ● Defining whether EMF exposure will constitute a problem in getting the approval required; ● Finalise safety case; ● Engage with HSE; ● Enable suitable training for trainers and staff; ● Purchase relevant equipment; and ● Draft and have approved the required policies and procedures.		
Expenditure for 2014/15 financial year	Internal £24,428 External £26,865 **Total £51,293**	**Expenditure in previous (IFI) financial years**	NIL
Total Project Costs (Collaborative + external + SSEPD)	£322,294	**Projected 2015/16 costs for SSEPD**	Internal £123,000 External £148,000 **Total £271,000**
Technological area and/or issue addressed by project	Under current procedures any refurbishment works on 33kV overhead lines is required to be done ‘dead’ i.e. supply is cut off to the respective circuits. In certain areas of the SHEPD and SEPD networks we have a number of circuits which do not have the relevant backfeeds necessary for a continuous supply due to the costs involved being seen as un-justifiable.		

<table>
<tr><td></td><td colspan="4">This means that customers will be affected by interruptions and minutes lost because of the requirement to have an outage before connecting diesel generation. The need for diesel generation in some circumstances can cause the works carried out to be seen as inefficient. Not only will this have an extra cost to the customer but it also may carry a significant carbon footprint.

If the project is successful we will have the ability to carry out required works on these circuits ‘live’ i.e. electrically charged. This will show a large benefit not only on supply reliability but also to work efficiencies and environmental issues.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological Substitution from different application</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>15</td><td>0</td><td>15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Extensive analysis of our 33kV network, in particular the way, in which we carry out refurbishment works on our 33kV radial feeders, has found there is the potential to realise considerable savings to our customers by eliminating the need for costly mobile diesel generation and reducing labour costs through carrying out 33KV refurbishment works live. Improved customer service will be achieved through reducing interruptions.

The following is an example where this procedure can be used;
The binding wires which are used to fasten the conductors to the insulators on a line section on the west of Scotland were constructed in steel core rather than using solid brass preforms. As a result severe decay has set in causing them to fail and trigger faults throughout the circuit.

The costs of these faults and the associated interruption in supply to customers mean that the rebinding of this conductor has become a critical project. The use of 33kV hot glove working would reduce the cost of this refurbishment work on this example section of line by approximately 60%. .</td></tr>
<tr><td>Expected Timescale to adoption</td><td>22 months</td><td colspan="2">Duration of benefit once achieved</td><td>20 years</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£8,631,175</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Potential for achieving the benefits is high.</td></tr>
</table>

Project Progress March 2015	At March 2015 we had completed a number of the objectives set at the creation of the project. A business case was defined before the project commenced which showed significant potential benefits on the successful completion. Through the use of an external risk assessment consultants and electromagnetic radiation analysts we were able to create a safety case for submission to the HSE. The safety case is still under evaluation with the HSE. Alongside this we are currently drafting policies and procedures to create a manual of 33kV Hot Glove working. A training schedule has been defined and will be given by experienced Class 4 trainers from an external company. The training will be arranged once we have agreed the safety case with the HSE. An in depth review of the PPE currently available for use on 33kV live conductors shows that there is no such equipment CE marked for use within the European Union. We are in discussions with a number of companies on resolving this issue.
Collaborative Partners	None
R&D providers	Edif ERA, EMF Commercial

2014_10: Study into the 2030 Distribution System

<table>
<tr><td>Project Title</td><td colspan="5">2014_10 Study into the 2030 Distribution System</td></tr>
<tr><td>Description of project</td><td colspan="5">The project will perform studies as per Work Stream 7 of the Smart Grid Forum.

The DECC/Ofgem Smart Grid Forum was created by the Department of Energy and Climate Change (DECC) and Ofgem to support the UK's transition to a secure, safe, low carbon, affordable energy system. The main issue discussed within the DECC/Ofgem Smart Grid Forum is how electricity network companies will address significant new challenges as they play their role in the decarbonisation of electricity supply. The Smart Grid Forum has established a number of Work Stream (WS) to examine particular aspects of future networks.

WS7 is addressing a very important question of how the whole system might operate most efficiently and resiliently in a 2030 scenario with a clear focus on the impacts for our distribution networks. The purpose is to gain knowledge and confidence in our network/system development options to deliver a secure and affordable system and to feed this back into the development of commercial and regulatory analysis.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £3,418
External £23,006
Total £26,424</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£750,000</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">Internal £6,000
External £82,000
Total £88,000</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="5">Essentially, this study is addressing the modelling compromises that are inherent in Transform's parametric network modelling approach. Transform's parametric representation of typical distribution networks are to be converted into nodal models in order to explore, through appropriate network studies, how the Transform solutions 'work' and what currently unforeseen challenges might emerge.</td></tr>
<tr><td>Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td colspan="2">Overall Project Score</td></tr>
<tr><td>17</td><td>1</td><td colspan="2">16</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="5">This project seeks to validate work carried out under WS3, which examined the potential of smart solutions to reduce capital expenditure on network infrastructure.</td></tr>
</table>

	This project, if successful, has the potential to validate the savings calculated by the transform model which are in excess of £1B. The project financial benefits are derived from being able to refine and more effectively target investments required to deliver DECCs decarbonisation targets. The estimated project costs are £780k. If, through delivery of this project, the £1B savings projected by the Transform model could be increased by 1% (by more efficient investment) over the 15 year period 2015 to 2030, the project NPV would be £5.283M		
Expected Timescale to adoption	2	**Duration of benefit once achieved**	15
Probability of Success	75%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£714,000 (across all funding DNOs)
Potential for achieving expected benefits	A full specification was produced and open tender process run by ENA. All DNOs are collaborating in the project and are committed to ensuring the work is fully implemented in future business investment decisions and as such the potential for benefits is high.		
Project Progress March 2015	During this year the following activities have been completed: • Full formal tender to select a delivery consortium and agree the relevant modelling tools, techniques, data sources, proposed approach, depth and content of deliverables. • Development and agreement of 2030 scenarios, and the sensitivity testing to be applied • Selection of the whole system models. • Selection of test use cases. This work has been continued via the collaborative NIA project NGET0154_2716		
Collaborative Partners	National Grid, NPG, SPEN, ENWL, WPD, UKPN		
R&D providers	DS2030 Consortium (Parson Brinckerhoff, Ricardo-AEA, University of Manchester, Chiltern Power, Grid Scientific)		

2014_11: Swedish Neutral Arc Suppression Technology

<table>
<tr><td>Project Title</td><td colspan="4">2014_11 Swedish Neutral Arc Suppression Technology</td></tr>
<tr><td>Description of project</td><td colspan="4">This project scope is to determine the benefits and viability of installing Arc Suppression and Ground Fault Neutraliser technology. This will provide a resonant earthing system with fault current reduction into areas of our own network.

The project will aim to improve our network performance due to single phase faults to earth.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £23,444
External £3,633
Total £27,077</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>NIL</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£27,077</td><td colspan="2">Projected 2015/16 costs for SSEPD</td><td>NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="4">A cost effective alternative way of supplying customers whilst sustaining a fault on the network.

With the network not losing supplies to the customers during a fault no customer reputation, CI and CHL’s cost would be incurred to the business.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Technological substitution</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>23</td><td>-3</td><td>20</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Lower CML and CI Costs and customer reputation</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 year</td><td colspan="2">Duration of benefit once achieved</td><td>20</td></tr>
<tr><td>Probability of Success</td><td>75%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£0</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">High</td></tr>
</table>

Project Progress March 2015	Due to the limited number of suitable locations identified by our network planning review, a cost benefit analysis concluded that the method would not be cost effective for SSEPD.
Collaborative Partners	None
R&D providers	PNDC, Swedish Neutral, HSE Labs

2014_12: Network Monitoring by Satellite

<table>
<tr><td>Project Title</td><td colspan="4">2014_12 Network Monitoring by Satellite</td></tr>
<tr><td>Description of project</td><td colspan="4">During storm situations, the importance of information on the state of the overhead network cannot be overestimated. The speed with which the condition of the overhead network can be relayed back to the control centre/storm room can allow pragmatic decisions on priority for repairs to be made.
Current methods of assessment of actual damage are Line patrol, Helicopter flights, and telephone reports from public services and customers. All of which will have varying timeframes to report damage. Outside of Urban and semi urban areas, exact locations of storm damage may not be reported for many hours after the storm. This can mean that customers are off supply for extended periods whilst damage is located and repaired.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £4,615
External £121,728
Total £126,343</td><td>Expenditure in previous (IFI) financial years</td><td colspan="2">NIL</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£126,343</td><td>Projected 2015/16 costs for SSEPD</td><td colspan="2">NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="4">This project aims to reduce the time taken to pinpoint storm damage by using Synthetic Aperture Radar (SAR) images from satellites to produce snapshots of the state of the overhead network. By taking a series of images before the storm season, and using them to produce an accurate image of the overhead network, and then taking another image post storm, and carrying out a comparison, it should be possible to identify sections of the overhead line that have moved, and are likely to have suffered damage.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>20</td><td>1</td><td>19</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The project is a Proof of Concept to enable SSEPD and Selex-ES to examine the current level of image resolution, and develop algorithms that may enable the discrimination between images to take place automatically.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>1 year</td><td colspan="2">Duration of benefit once achieved</td><td>10 years</td></tr>
<tr><td>Probability of Success</td><td>25%</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£27,447</td></tr>
</table>

Potential for achieving expected benefits	Medium
Project Progress March 2015	The concept of using satellite SAR images has been proven to work, and algorithms to carry out the discrimination between images have been developed. However, the cost of obtaining the images has meant that the financial benefits are not sufficient for SSEPD to progress this innovative approach. The project is now closed.
Collaborative Partners	None
R&D providers	Selex ES

2014_13: Aberdeen Hydrogen Project – Locating and Owning an Electrolyser

<table>
<tr><td>Project Title</td><td colspan="3">2014_13 Aberdeen Hydrogen Project – Locating and Owning an Electrolyser</td></tr>
<tr><td>Description of project</td><td colspan="3">The use of fuel cell electric vehicles (FCEV) powered by hydrogen has the potential to replace fossil fuelled vehicles. As a result the UK H²Mobility project predicts that there could be over 1.5 million such vehicles in the UK by 2030 and up to 330 refuelling stations by 2025.

This project will support the Aberdeen Hydrogen Bus Project (AHP) which will see 10 hydrogen fuel cell electric buses operational in an inter-urban environment. The project will see the installation of a 1 MW electrolyser in Aberdeen and the relevant sites selection and assessment criteria will be captured.

It is expected that the AHP will provide learning which would be applicable to all DNOs on the costs of uncontrolled electrolyser operation, and operational profiles for controlled operation. It is expected that controlled operation could significantly reduce network reinforcement costs and potentially create additional capacity for generation to connect.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £5,210
External £73,140
Total £78,350</td><td>Expenditure in previous (IFI) financial years</td><td>NIL</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£78,350</td><td>Projected 2015/16 costs for SSEPD</td><td>NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="3">Assess the requirements for locating and owning a 1 MW Electrolyser
List the technical requirements for locating a 1MW Electrolyser
Define the Health and Safety considerations for locating a 1MW Electrolyser
Define the security considerations for locating a 1MW Electrolyser
Define the environmental considerations for locating a 1MW Electrolyser
Identify the required permissions for locating a 1MW Electrolyser
List the site assessment criteria for locating a 1MW Electrolyser
Define a method to apply the site assessment criteria for locating a 1MW Electrolyser
Apply the method of site assessment criteria for locating a 1MW Electrolyser</td></tr>
</table>

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

Analyse the site assessments for locating a 1MW Electrolyser
Evaluate the site assessment analysis for locating a 1MW Electrolyser
List the risk assessment criteria for building a 1MW Electrolyser
Identify the HR (training & resources) requirements for operating a 1 MW Electrolyser
Identify the H&S requirements for operating a 1 MW Electrolyser
Identify the technical requirements for operating a 1 MW Electrolyser
Identify the commercial requirements for operating a 1 MW Electrolyser
Identify the environmental requirements for operating a 1 MW Electrolyser
Identify the security requirements for operating a 1 MW Electrolyser
Define the roles and responsibilities to support the operation of the 1MW Electrolyser

</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>8</td><td>-1</td><td>9</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The purpose of this IFI project is to gather the requirements for owning and operating a state of the art re-fuelling station with the intention that future sites can be developed more readily and without the same level of consultancy costs.

It will also help other DNOs to make better informed decisions to ascertain whether such a solution is viable in their network area or specific location.</td></tr>
<tr><td>Expected Timescale to adoption</td><td>3 years</td><td colspan="2">Duration of benefit once achieved</td><td>11 years</td></tr>
<tr><td>Probability of Success</td><td>70 %</td><td colspan="2">Project NPV=(PV Benefits-PV Costs) x Probability of Success</td><td>£8,305</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">Medium</td></tr>
<tr><td>Project Progress March 2015</td><td colspan="4">In identifying suitable sites for potential hydrogen production and refuelling most of the technical requirements can be engineered to suit the site. However, this comes at increased cost. Therefore, to minimise costs site selection should be prioritised as demonstrated in this project.</td></tr>
</table>

	In the context of the electricity network the capacity of the network to absorb the substantial loads created by these stations will be a significant consideration and potential barrier to the successful rollout as described in the H2mobility report The plant installed on the Kittybrewster site required significant power factor correction equipment to enable it to be connected to the electrical network without reinforcement, which added to the overall costs. The wider impact of electrolysers on a national scale will be the subject of the T1 project. The electrolyser has been commissioned and all the relevant learning has been published in the closedown report and is available on request.
Collaborative Partners	BOC, Scotia Gas Networks (SGN), Stagecoach, First Group, Element Energy, AREG, Aberdeen City Council (ACC)
R&D providers	BOC

2014_14: CRM Supporting Innovation

<table>
<tr><td>Project Title</td><td colspan="4">2014_14 CRM Supporting Innovation</td></tr>
<tr><td>Description of project</td><td colspan="4">The project aimed to establish innovative methods of engaging customers and the means by which SSEPD can provide outstanding service whilst dealing with future challenges. This was borne out of frustration experienced by various teams who attempted to engage with customers at all stages of dealing with network operations/issues, whether planned or not. Primarily the issue has been deemed to be a lack of visibility of historical engagement with customers, no single view of the customer and their interactions with the business to date, and concerns over how the business can meet expectations to use customer and network data to provide rapid updates/management of operational duties, especially en masse such as during major power cuts. The project sought to establish the value of using a Customer Relation Management system (CRM) along with identifying innovative ways in which the business can improve its processes/use of data to improve customer service, with the sole aim of enabling SSEPD's customer service to be industry-leading.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td colspan="2">Internal £38,010
External £268,399
Total £306,409</td><td>Expenditure in previous (IFI) financial years</td><td>NIL</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td colspan="2">£306,409</td><td>Projected 2015/16 costs for SSEPD</td><td>NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="4">Accurate and consistent methods of engaging customers and recording activities</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Service management</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>15</td><td>-7</td><td>22</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Improved efficiency of managing customer interactions will lead to a reduction in labour required (internal and external) to perform these tasks. Additionally with financial benefits (avoided penalty and/or gained rewards) through improvements to Customer Satisfaction scores as a result of improved management of customer connection requests, general enquiries and communications in relation to interruptions to supply providing significant financial benefits across the business</td></tr>
</table>

Expected Timescale to adoption	2 years	**Duration of benefit once achieved**	10 years
Probability of Success	75**%**	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£ 3,700,000
Potential for achieving expected benefits	High		
Project Progress March 2015	The project was completed by March and detailed findings can be found in the report 'CRM detailed findings report Issue 1' which is available upon request. In summary, upon completion of the project it was found that significant value can be achieved from using the CRM to support activities, ensuring confidence and traceability from having a central source of information on customers, sites, assets and projects. Following further development work it appears that significant value can be achieved for more teams within the business, yet it is likely that this will reach a point where a full Enterprise Resource Planning system along with a CRM and integration with a number of systems will be required.		
Collaborative Partners	None		
R&D providers	Microsoft		

2014_15: Slips, Trips and Vehicle Runaways

<table>
<tr><td>Project Title</td><td colspan="3">2014_15 Slips, Trips and Vehicle Runaways</td></tr>
<tr><td>Description of project</td><td colspan="3">Scottish and Southern Energy Power Distribution (SSEPD) introduced their “Safety Family” in 2011, an ambitious programme to drive improvement in safety performance across the organisation. Although very successful, there remains an issue with frequent slips, trips and falls, near-misses and accidents. There are also incidents related to vehicles rolling away when parked and unattended.

This project outlines a review process which would deliver a clearer understanding of the underlying causes of these issues, bringing together both human factors and engineering factors delivered through the Health & Safety Laboratory (HSL). On the basis of this insight, HSL would make recommendations for enhancing existing interventions as well as new interventions. These will take due account of resourcing and business needs to ensure that they are practicable and proportionate.

The value targeted through this project will be reduction of incidents involving staff either falling or having their vehicles run away. The value expected is to deliver a reduction in incidents involving slips, trips, falls and vehicle runaways.

The approach suggested by HSL focuses on two areas, the engineering causes and the human factor causes. The two teams will work closely together so that the final report and, crucially, the recommendations will take account of the complete picture. The human factors approach will use the Organisation, Job and Individual framework. The engineering approach will look at the controls in place to prevent both slips & trips and vehicle roll-aways. The full project is due to run for 3 and half months with the final output being a report summarising all the findings and recommendations and a presentation for summary purposes. This report will include quantification on expected savings if recommendations are implemented. This will then be used as a base for the ongoing CBA.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £8,822
External £51,048
Total £59,870</td><td>Expenditure in previous (IFI) financial years</td><td>NIL</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£59,870</td><td>Projected 2015/16 costs for SSEPD</td><td>NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="3">Area addressed is safety of staff either from their own powered movement or whilst travelling in a vehicle.</td></tr>
</table>

Type(s) of innovation involved	Technological Substitution from outside industry	**Project Residual Risk**	**Overall Project Score**	**Project Benefits Rating**
		4	14	18
Expected Benefits of Project	Assume that this review will allow SSEPD to reduce the chance of a fatality of either staff or external parties, over a 5 year period.			
Expected Timescale to adoption	1 year	**Duration of benefit once achieved**		10
Probability of Success	35%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**		£1,195,204
Potential for achieving expected benefits	Medium			
Project Progress March 2015	The project was closed during this financial year and was considered a success. The main output was a system level review of the safety incidents affecting SSEPD and what could be done to reduce these incidents. This was drawn together into a report split over short, medium and long term recommendations.			
Collaborative Partners	none			
R&D providers	Health & Safety Laboratory			

2015_01: Lumen Weather integration

<table>
<tr><td>Project Title</td><td colspan="4">2015_01 Lumen Weather Integration</td></tr>
<tr><td>Description of project</td><td colspan="4">Under IFI project 2006_05 Network Analysis (St Andrews), a statistical model for predicting the level of faults on the OHL network from weather forecasts was created. The project did not include an easy to use graphical user interface (GUI), and although it has been in use for a number of years, it is still restricted to a single expert user who has full understanding of it. The model was created by dividing Scotland into 6 geographical areas, and manually inputting the weather data from the Meteogroup supplied weather forecasts. Some further work has been carried out to improve the user experience, but the weather data still has to be manually inputted, and the geographical areas now used by the NMC have changed so are aligned to the nine Power Distribution depots in Scotland.
IFIT Project 2012_01 Bellrock Lumen, looked at ways of presenting complex data to users in an easy to use format. The project demonstrated how the Lumen Technology Framework could be used to assist in analysis of data following further development by the developers, Bellrock Technology.
This new project will look to integrate the weather analysis statistical model with the display functionality of the Lumen framework, with input of data files direct from Meteogroup, to produce an easy to use, accurate method of predicting the level of faults that can be expected on the overhead network prior to a storm arriving in our licence areas.</td></tr>
<tr><td>Expenditure for 2014/15 financial year</td><td>Internal £1,138
External £23,580
Total £24,718</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>NIL</td></tr>
<tr><td>Total Project Costs (Collaborative + external + SSEPD)</td><td>£24,718</td><td colspan="2">Projected 2015/16 costs for SSEPD</td><td>NIL</td></tr>
<tr><td>Technological area and/or issue addressed by project</td><td colspan="4">Weather events can have major impacts on the overhead network, and it can be very difficult to plan the allocation of resources to resolve arising issues, across a large land mass like Scotland. Using statistical analysis should provide a more robust resource allocation process for use by managers prior to high impact weather events.</td></tr>
<tr><td>Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td></td><td>15</td><td>0</td><td>15</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">Ease of use, and multiple users, so that fault forecasts can be generated as required by storm managers.</td></tr>
</table>

Expected Timescale to adoption	3 months	**Duration of benefit once achieved**	10 years
Probability of Success	50%	**Project NPV=(PV Benefits-PV Costs) x Probability of Success**	£1,171
Potential for achieving expected benefits	High		
Project Progress March 2015	DMP Stats have produced the new model, and passed it to Bellrock Technology. Bellrock have integrated into their Lumen platform, along with a weather data feed, and able to display via a web service. Users have been set up with accounts to access the platform, and it is in use by both the North and South NMCs. The project is closed.		
Collaborative Partners	None		
R&D providers	DMP Stats, Bellrock Technology		

Appendix 1: Summary Listing of IFI Project Costs

Distribution Projects:

Reference	Project Title	SSEPD Internal	SSEPD External	SSEPD Total
2004_01	STP2 Overhead Line Module	£8,369	£44,374	£52,743
2004_02	STP3 Underground Cable Module	£8,737	£91,131	£99,868
2004_03	STP4 Plant Module	£2,864	£73,738	£76,602
2004_04	STP5 Networks for DER Module	£8,950	£4,591	£13,541
2004_06	Equipment Coatings Forum	£4,803	£10,267	£15,070
2004_11	ENA Collaborative Projects	£7,164	£2,972	£10,136
2007_01	DG&ARM Endowed Fellowship	£6,435	£55,853	£62,288
2008_03	Power Networks Research	£7,164	£9,761	£16,925
2009_06	PNDC	£19,729	£33,106	£52,835
2009_14	LIVEALERT	£5,667	£4,980	£10,647
2010_01	Phasor Measurement Units	£7,413	£3,252	£10,665
2010_05	Ford Electric Car	£1,333	-£35,130	-£33,797
2010_06	Orkney RPZ State Estimation	£9,716	£88,373	£98,089
2010_13	Supply Point Monitoring	£2,934	£2,972	£5,906
2010_25	Plugged in Places	£25,755	-£8,709	£17,046
2011_03	LV Con'd Energy Storage	£9,918	£14,629	£24,547
2011_04	PHD Power Net Asset Man	£5,610	£17,582	£23,192
2011_07	Assessment of Conducrete	£1,312	£2,972	£4,284
2011_09	Heat Pump Load Profile	£8,163	£3,462	£11,625
2011_10	Asset Man Of LV Cables	£917	£47,233	£48,150
2011_12	Harmonic Investigation	£2,355	£47,231	£49,586
2011_14	Hybrid Generator	£22,945	£119,904	£142,849
2011_16	Advanced Radio Control	£39,604	£23,754	£63,358
2012_03	SASensor HMV Primary Substation Provider	£3,207	£4,280	£7,487
2012_04	Mobile Diesel Generation with Battery Storage	£17,669	£186,350	£204,019
2012_06	Orkney Sub 50kW	£1,534	£2,381	£3,915
2012_07	Orkney RPZ Phase 2	£21,670	£149,698	£171,368
2012_09	Real Time Java	£77,061	£78,851	£155,912
2012_12	GENDRIVE	£6,266	-£27,489	-£21,223
2012_13	Gnosys Self Healing Cables	£5,701	£68,699	£74,400
2012_14	Radio Teleswitch Phase 2	£23,837	£3,281	£27,118
2013_02	CES KTP	£11,969	£44,440	£56,409
2013_03	Vehicle to grid	£23,588	-£63,275	-£39,687
2013_06	Green Running Load and DG Detection	£11,875	£22,587	£34,462
2013_08	Electric Bus Project for Glasgow	£8,771	-£133,016	-£124,245
2013_09	Copper Theft Detection	£3,499	£15,797	£19,296
2013_10	Establish the Affordability of ADR	£0	£1,000	£1,000
2013_11	DISCERN	£64,680	£2,972	£67,652
2013_13	SF6 Leak Location and Coating	£24,236	£13,488	£37,724

2013_14	Remote Access Solution for FN	£35,853	£18,728	£54,581
2013_15	ZeEUS	£11,486	£1,760	£13,246
2013_16	Network Damage Reporter	£13,912	£42,377	£56,289
2013_17	Orkney ANM Critical circuits	£18,279	£41,054	£59,333
2014_01	Overhead Line Vibration Monitoring	£18,621	£696,928	£715,549
2014_02	Field Team Support Tool	£17,911	£137,405	£155,316
2014_03	FPI Consolidation	£12,077	£8,106	£20,183
2014_04	Data Matching for Smart Registration	£6,001	£1,728	£7,729
2014_05	Cable Core Temperature Sensor	£7,593	£1,728	£9,321
2014_06	VTOL	£11,036	£1,728	£12,764
2014_07	Ultrapole	£7,606	£8,394	£16,000
2014_08	Monitoring of conductors and poles	£9,215	£288,218	£297,433
2014_09	33KV Hot Glove Working	£24,428	£26,865	£51,293
2014_10	Study into the 2030 Distribution System	£3,418	£23,006	£26,424
2014_11	Swedish Neutral Arc Suppression Technology	£23,444	£3,633	£27,077
2014_12	Network Monitoring by Satellite	£4,615	£121,728	£126,343
2014_13	AHP Locating and Owning an Electrolyser	£5,210	£73,140	£78,350
2014_14	CRM Supporting Innovation	£38,010	£268,399	£306,409
2014_15	Slips, Trips, Falls and Vehicle Runaways	£8,822	£51,048	£59,870
2015_01	Lumen Weather Integration	£1,138	£23,580	£24,718
	Total	£802,095	£2,867,895	£3,669,990

NB: Negative costs shown in the above table are the result of income received from grants that apply to certain projects being approved and designated in this financial year.

Appendix 2: Real Time Java

Scottish Hydro Electric Power Distribution Ltd (SHEPD) has an existing Active Network Management (ANM) scheme on Orkney, based upon Programmable Logic Controllers (PLCs) developed and supported by Smarter Grid Solutions (SGS).

SHEPD contracted SGS to deploy a server-based ANM scheme to replace the existing PLC-based system with leading edge real-time systems software in the form of Real Time Java (RTJ); this allows the SGS power flow Java algorithm to exhibit the same determinism and reliability as that of the PLC-based SGS power flow.

The deployment of this software platform to perform ANM provides benefits to SHEPD in that a more powerful computing platform will exist, that can undertake more advanced computational tasks, and has significant scalability and interoperability that cannot be provided within a PLC based environment. This will create a platform for further smart grid development.

Objectives

1. Compare and contrast open loop and 'lab' testing techniques;
2. Evaluate the effectiveness of the RTJ platform in terms of safety, cost, determinism, availability and reliability;

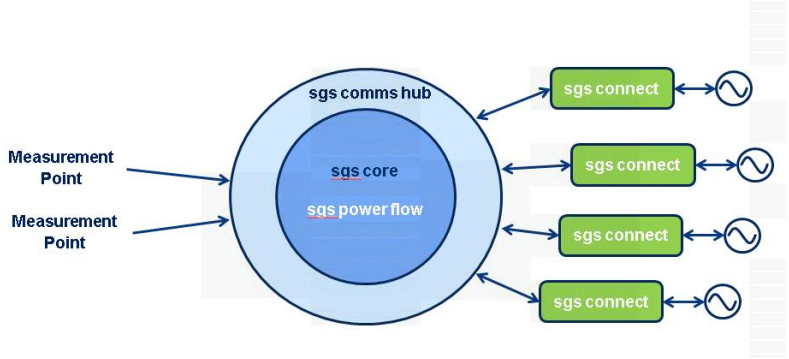


Figure 1: ANM Structure

The Project was split into several stages:

Phase 1: Run the server based ANM scheme in open loop alongside the PLC-based scheme to allow for comparison of the two systems. The PLC-based system remains in control;

Following development of the SGCore Java software, full functional tests were carried out at the developers premises (Factory Acceptance Tests, FAT). The software was then installed on 2 test systems that run in parallel in the SSEPD test room, and further testing was carried out on these systems (Pre-production Acceptance Testing, PAT). These systems are identical replicas of the servers that would be fitted in the operational environment, with identical hardware and software versions. Following comprehensive testing, and a period of test running in the test room, the software was installed on the 2 operational systems installed in Kirkwall Power Station. These operational systems were then subject to the same level of testing as carried out in the test room (Site Acceptance Testing, SAT).

After comparing the results of the SAT with the PAT, a decision was taken to carry out phase 1. The outputs from the SGCore Java servers were collected and after a 3 month period a comparison exercise was undertaken by SGS, and the results presented to SSEPD.

Appendix 2: Real Time Java (contd.)

Phase 2: The server based ANM scheme will assume control sending commands to PLC-based comms hub;

SSEPD decided to proceed to Phase 2, as the differences between the RTJ server control outputs and the PLC system control outputs were minimal, with the RTJ outputs allowing slightly less curtailment than the PLC system. This was accounted for by the difference in the way that the curtailments were lifted by each system. The RTJ system was able to use finer set points when removing curtailment, resulting in slightly more generation being allowed, whilst keeping the network parameters within operating bounds.

Phase 2 was run for a 3 month period, the SGCore Java servers now controlling the ANM and the outputs monitored, and compared with the outputs that the PLC system produced. This phase was also successful, as the end of phase review found that there was no disturbance to the ANM regime, with the Generators operating normally.

Phase 3: The PLC-based comms hub is decommissioned; with the server based ANM scheme fully replacing the PLC based system;

Following the review the decision was made to transition the ANM system to full RTJ server, Phase 3. This work was carefully planned as the risks need to be fully mitigated to avoid unnecessary disruption to the existing Generators. The work to carry out the transition needed to be done at Kirkwall Power Station, and at the generators sites, as it was the changeover of communications links. After several days work, it was discovered that a software driver for the communications links between servers and Generators was not able to respond in a timely manner, and the transition was rolled back.

SGS and SSEPD then examined why this failure was not picked up during the several stages of testing that had been carried out, and came to the conclusion that the Pre-production test facility, although accurately replicating the live servers, did not adequately replicate the communications links between the 20 generators and the servers. The test room was then upgraded to take into account the need to stress the communication links. Further tests were carried out, and the opportunity taken to upgrade the SGCore Java suite of software to the latest version. This version had already undergone FAT, and was put under PAT using the new test facility. A new communications driver was sourced from the manufacturer, and put under test. The tests was successful, and the test servers were run for a 4 week period with no errors, using the enhanced communications systems, and an automated test suite to continually simulate network conditions in the live environment.

A new transition to full RTJ server ANM was planned, and the lessons learned from the previous phases used to develop both the hardware changes necessary, and the software installs. The Kirkwall servers had the new version of the software installed, and tested, then the new communications driver installed and tested, and the communications from Generator to servers was switched over to the RTJ servers. The system was then closely monitored for the next day, and monitoring continued for the next 4 weeks, with no issues discovered during this time.

Appendix 2: Real Time Java (contd.)

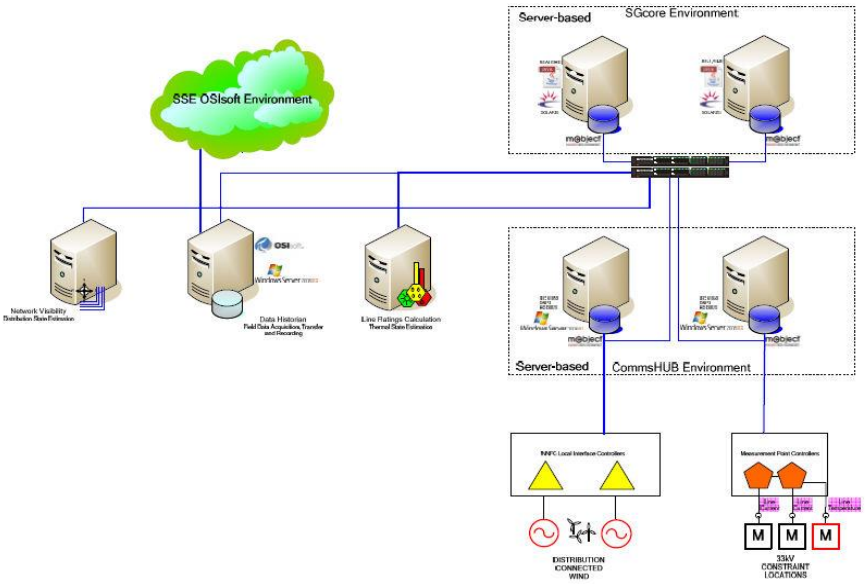


Figure 2: Real Time Java Architecture

Project Results

Objective 1: The laboratory environment is designed to give a close representation of the operational environment. However, due to time, space and cost constraints there are some differences between to two environments. The biggest of these is simulation of generators in the laboratory. Because many generators are simulated on a few devices it is hard to fully represent the complexities of the live environment. The open loop testing, was a way of fully testing and comparing the RTJ system in the exact live environment without compromising safety before allowing the RTJ system to take control.

Objective 2: The server-based system, has been demonstrated to be safe, reliable and offer performance advantages over the PLC-based system.
Some of the benefits of the server based system vs PLC:

- PLC system is based on old technology and approaching end of life;
- Supporting the PLCs will become increasingly hard and expensive;
- The Server based system allows SHEPD to add more functionality that would not be possible with the PLCs;
- PLC system does not scale well, we are currently pushing the limit of this technology on Orkney;
- Cost of upgrade and replacement hardware for the server system is considerably less than for the PLCs;
- Improved performance potential with the server based system.

Appendix 3: Hybrid Generator

SSEPD are investigating methods to provide electricity supply to customers in the event of a fault or, in limited cases, where new connections can't meet required timescale targets. It is hoped that providing temporary power in such events will not only improve customer satisfaction, but also help improve CML scores.

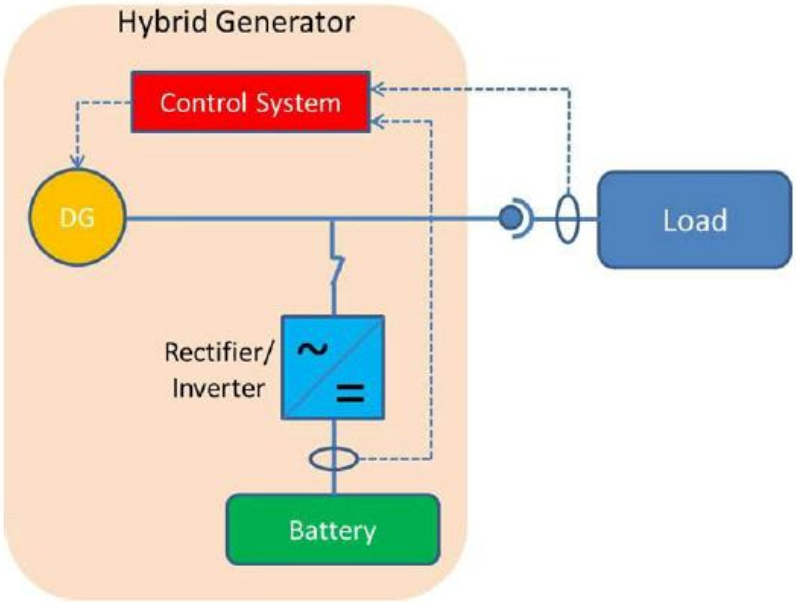
One method to provide temporary power to individual houses is to use standard diesel generators. The main problem associated with the use of diesel generators to provide temporary supply solutions is that they are extremely fuel inefficient. The generator set requires to be sized for the peak load resulting in the unit running well below capacity for most of the time. Consequently the running cost and CO2 emissions are in excess of what could be achieved with a more efficient method of generating temporary power.

The proposed solution is to use a more efficient hybrid unit that combines diesel generation with a battery/inverter unit. In conventional generator-only applications, the diesel generator must "load follow" and therefore operates at off-optimal conditions for the vast majority of time – the battery system alleviates this requirement.

The hybrid generator (HG) technology is offered as a solution for off-grid power supply requirements in remote locations and can be used to provide power for residential, construction, telecom towers and disaster relief applications. Other benefits include low/no noise through noise insulation and operation in battery-only mode, less carbon emissions through operation of the DG at optimal conditions and use of battery, generally more efficient operation of the DG and reduced cost of ownership since the engine has to run less often.

Learning Objective

To investigate the suitability of a hybrid generator for fault duty and also its suitability as a temporary supply where SSEPD has failed to provide connections within the required timescale;



Appendix 3: Hybrid Generator (contd.)

Fuel Efficiency Background

For a comparison between the standard generator and Hybrid, we need to compare the running operational cost of the two units. This means testing the two units which optimise both of the qualities and weakness to get an overall comparison.

Demand Profile: The demand profile for a standard unit requires the standard generator to operate at close to 95% loading rate. The 95% loading means the standard generator produces the most KW for the least amount of diesel used per hour (L/Hr). As a domestic house demand cycles, this 95% loading rate is compromised at different times of the day. Therefore the standard generator operates at low load ratings for long periods of the day and is not as efficient.

The hybrid generator will also want to operate at the 95% loading rate when the demand is high on the generator function, and similarly operate in battery function when the demand is low. The battery will only have a set amount of stored energy. This stored energy will last longer with lower demand levels. The inefficient time for operating the hybrid will be in the charging of the battery and not supplying a domestic load. The charging of the battery can be more efficient when used in loading of the generator. This period of charging moves the over all domestic load + battery load up toward the standard generators efficiency point.

Project Results

Mode	Average Energy Produced [kWh]	Average Fuel Consumed [L]	Fuel Efficiency [kWh/L]	Generator Run Time [Hours]
Gen + Inv	90.3	36	2.5	9
Gen only	90.3	60.5	1.49	24

From the table above we can see that a typical generator consumes 24.5 Litres more and operates 15hrs longer. It should be noted that depending upon the demand curve, these times and fuel consumptions can vary.

Determining these values has helped to benchmark them against RIIO-ED1. We are looking at minimum running time of 16 hours, a minimum utilisation of 60% at a fuel savings of 24 Litres. This will allow us to breakeven in the overall costs of the additional units.

Lessons Learned

Commercial: For the unit to be commercially viable and have a benefit, it has to compete with a standard single generator being deployed and reduce the amount of fuel consumed. We have covered that the unit does operate more efficiently compared to a normal generating unit. However, the cost of this unit is two times the price of a standard generator. Therefore the utilisation, $C0_2$ savings and fuel saved must offset the additional cost. It was found that if the HG generator operates at a minimum of 50% load at all times this will make it a commercially viable option.

Appendix 3: Hybrid Generator (contd.)

Environment: The hybrid unit reduced the run time of the diesel generator by utilising the battery for 15 hrs. This reduced diesel usage by 24.5 litres over 24 hours, which reduces overall $C0_2$ outputs. While running on hybrid mode, the unit also reduces decibel noise levels.

Financial: The Whole life cost of running a hybrid has to be more efficient than a standard generator supplied. A standard generator against a hybrid generator requires the hybrid to be more efficient to return on investing in the battery and control modules. We can see the normal generator produces 1.5kwhr and the hybrid has shown to produce 2.5kwhr. The total fuel saved through our tested amounts to 25 litres and a reduction of running hours. This then offsets the maintenance cost of the generator. All these factors combine to produce a savings during the amount of times it is used. Current deployment runs at 25% and with RIIO-ED1 plans this is to increase to reduce CI and CML's.