Innovation Funding Incentive Annual Report 2013-14

July 2014

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Contents

2013/14 IFI annual report

July 2014

Executive Summary

1. This report has been prepared by Northern Powergrid to inform interested parties of the innovation activities of its electricity distribution licensees, Northern Powergrid (Yorkshire) Electricity Distribution plc, and Northern Powergrid (Northeast) Ltd. It covers the period from 1 April 2013 to 31 March 2014. It has been prepared in accordance with standard condition 46 of the electricity distribution licence, the associated regulatory instructions and guidance (published by Ofgem) and the Energy Networks Association (ENA) Engineering Recommendation (ER) G85, issue 2, 2007 (the Good Practice Guide). It also informs our returns under standard licence condition 47.

2. The key projects in Northern Powergrid during the reporting period are:

   - Projects dedicated to local Northern Powergrid needs:;
     - Network Risk Modelling KTP;
     - Demand-Side Management And Risk;
     - Distribution Load Estimate Methodology;
     - Load Forecast Scenario Modelling;
     - Stay Rod Testing;
     - Substation Environmental Monitoring;
     - Smart Data;
     - Failure on Demand; and
     - CBRM and Health Index Development,
   - Collaborative projects, including:
     - Superconducting Fault Current Limiter (SFCL);
     - Tree Growth Regulators;
     - Live Alert
     - Cable Core Temperature Sensor;
     - Cable Paper Moisture Meter;
     - Oil-filled Cable Additive;
     - UAV/VTOL – Unmanned Aerial Vehicle;
     - Ultrapole – Ultrasonic Woodpole Inspection;
     - ENA R&D programme; and
     - EA Technology Strategic Technology Programme (STP).

3. Qualifying spend for the period has been £435,958 and £569,615 for the Northeast and Yorkshire licence areas respectively, giving a total of £1,005,574 across the combined geographic area. This is virtually the same as the last reporting year.

Revision Record

Version	Date	Revision Details	Author
0.9	7/7/2014	Final draft	Chris Goodhand
1.0	24/7/2014	Final for publication	Chris Goodhand

Introduction

4. This report has been prepared by Northern Powergrid to inform interested parties of the innovation activities of its electricity distribution licensees, Northern Powergrid (Yorkshire) Electricity Distribution plc, and Northern Powergrid (Northeast) Ltd. It covers the period from 1 April 2013 to 31 March 2014.

5. A single report has been prepared because the two licensees are operated under common management, sharing best practice between them. Our approach to research and development is no exception, and we draw no arbitrary distinction in the innovation carried out for the two licensees. Projects and programmes are therefore set up and progressed jointly for both licensees. Finally, the report breaks out the relevant expenditure by licensee to support regulatory reporting requirements.

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

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

8. The report has been prepared in accordance with standard condition 46 of the electricity distribution licence, the associated regulatory instructions and guidance (RIGs) and the Energy Networks Association (ENA) Engineering Recommendation (ER) G85 (the Good Practice Guide (GPG)), which states:

3.4 Annual Regulatory Reporting Requirements for IFI Projects

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

- *IFI budget carry-forward*
- *eligible IFI expenditure*
- *eligible IFI internal expenditure*
- *combined distribution network revenue*
- *the IFI annual report.*

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

- *IFI carry- forward nearest £1k*
- *eligible IFI expenditure nearest £1k*

- *eligible IFI internal expenditure nearest £1k*
- *combined distribution network revenue nearest £0.1m*

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

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

- Collaborative projects led by the Energy Networks Association (ENA) R&D working group, including:
  - ENA R&D programme (including work undertaken for the Ofgem/DECC Smart Grid Forum);
- The EA Technology Limited (EATL) Strategic Technology Programme (STP), including:
  - Module 2 (Overhead Networks);
  - Module 3 (Cables);
  - Module 4 (Substations);
  - Module 5 (Distributed Energy);
  - Various engineering knowledge-sharing technical forums to develop STP proposals;
  - Energy Storage Operators' Forum;
  - Protective Coatings Forum; and
  - Partial Discharge User Group.
- Collaborative projects, including:
  - Superconducting Fault Current Limiter;
  - Cable Core Temperature Sensor;
  - Cable Paper Moisture Meter;
  - Oil-filled Cable Additive;
  - UAV/VTOL – Unmanned Aerial Vehicle;
  - Ultrapole – Ultrasonic wood pole inspection;
  - Tree Growth Regulators; and
  - Live Alert.
- Internal innovation projects dedicated to local Northern Powergrid needs:
  - Network Inference Study
  - Substation Environmental Monitoring;
  - Network Risk Modelling, phase two;
  - Demand-Side Management And Risk;
  - Distribution Load Estimate Methodology;
  - Load Forecast Scenario Modelling;

- Stay Rod Testing;
- Substation Environmental Monitoring;
- Smart Data;
- Failure on Demand; and
- Condition Based Risk Management (CBRM)

10. As permitted by the GPG, this report aggregates portfolios of projects under collaborative umbrellas such as the ENA, EATL's STP, and internal costs in developing and managing projects.

Project Reporting

Externally-driven activities

11. In this section we consider those projects driven by bodies outside the distribution sector where, although we have the choice as to whether or not we become involved, they fall outside our direct governance. For such projects we therefore effectively take the role of unpaid sub-contractors, often making considerable contributions in kind, as well as financially supporting these, often, nationally important initiatives.

12. Electricity Networks Futures Group (ENFG) remains active and it is anticipated that further work from this source remains highly likely through 2014 and 2015, although perhaps not at the level seen over the last two years. This year has seen less of this type of work than has been typical recently.

13. Preparatory and proposal preparation activities have been undertaken during the reporting period, primarily with a variety of partners, collaborators and suppliers, in the domain of the low-carbon agenda. We submitted an unsuccessful tier two project bid to Ofgem's Low Carbon Network Fund (LCNF) during the 2013 bidding round. A smaller version of this activity, based on a sub-set of the original learning outcomes, has been designed and we are currently seeking alternative funding routes, including Technology Strategy Board support..

14. We continue to investigate opportunities for cross-utility projects based on the common requirements of our societal stakeholders.

ENA

15. The tangible outputs of collaboration with other DNOs, through the ENA R&D working group, are the major projects described in detail in the following tables.

16. A range of other activities have also been delivered through the ENA although some of these, which are innovation by any broad definition, are not IFI eligible. These are not reported here.

17. The remaining active projects are reported below:

ENA Collaborative Programme

Project Title	**ENA R&D Programme**			
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 financial year	Internal £1,800 External £13,179 Total £14,979	Expenditure in previous (IFI) financial years	Internal £37,095 External £249,184 Total £286,279	
Total Project Costs (Collaborative + external + Northern Powergrid)	£89,874+	Projected 2014/15 costs for Northern Powergrid	Internal £10,000 External £50,000 Total £60,000	
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 issues requiring technical investigation and development: DC Injection: Investigation into the corrosion effects of DC on DNO networks with specific emphasis on assessing the impact of DC flows in the neutral conductors and providing evidence that a max of 20 milliamps as per British Standards is suffice. 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.			
Type(s) of innovation involved	Incremental to radical	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
Expected benefits of project	These projects. In the context of the extended portfolio of activities, 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.			
Expected timescale to adoption	Year 2015	Duration of benefit once achieved	10-20 Years	
Probability of success	75%	Project NPV (Present Benefits – Present Costs) x Probability of success	£100,000	

Potential for achieving expected benefits	Then nature of these activities is such that the chances of delivering the required learning outcomes is high.
Project progress to March 2014	DC Injection: From the review undertaken it is concluded that: Normal corrosion rates in soils for metallic components, typically used in LV circuits can range from < 1 µm/yr up to 0.1 mm/yr in very aggressive conditions. However, in the majority of cases expected corrosion rate in soils would be in the 0.001 to 0.01 mm/yr range. If DC stray current occurs, this could significantly increase the corrosion rate and could lead to early age failures, but this would be dependent on the current density at the point of discharge (i.e. dependent on the level of current and surface area of discharge). Where the current density exceeds 10 µA/cm² (100 mA/m²) on copper and steel components the stray current corrosion will become sufficiently high that a problem could be expected within 10 to 20 years. Higher current densities could lead to problems in shorter period and lead sheath cables are likely to be the most susceptible components. Based on a review of the earthing arrangements typically adopted in the UK (i.e. PME), any problem (if it were to manifest itself) would be expected to occur at LV substations, mainly on the substation earthing arrangement, at additional PME points and on lead sheath cable. Damage to components located at the PV inverter location are unlikely, unless a TT or IT system is utilised. The complex and variable nature of the DC injection from PV systems is such that estimating the actual amount of cumulative DC will be difficult to assess, and either a probabilistic model or worst case assessment will be required. Reactive Power (REACT): All Grid Supply Points (GSPs) were analysed considering the active and reactive power during minimum demand recorded by National Grid from 2005 to 2012. Three indices were created to cater for the 2012 Q/P ratio, its decline from 2005, and relative size of the GSP. Finally, the combination of these indices produced the list of the top 10 critical and control GSPs per DNO. The lists of critical and control GSPs are being used to discuss with the DNOs of which final selection of the GSPs that will be modelled in detail. In addition, half-hourly data for these top critical GSPs have also been provided by National Grid for further analysis. The costs for the Smart grid Forum workstream three, phase three activity, reported last year, were over-stated. A reduction of £24, 879 to the overall IFI claim for this year has been made on account of this.
Collaborative partners	ENA member companies
R&D provider	Various

EA Technology Strategic Technology Programmes

Project Title	**Strategic Technology Programme Overhead Network Module 2**		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £2,850 External £54,108 Total £56,958	Expenditure in previous (IFI) financial years	Internal £21,795 External £358,572 Total £38,036
Total Project Costs (Collaborative + external + Northern Powergrid)	Rolling programme across all DNOs	Projected 2014/15 costs for Northern Powergrid	Internal £2,500 External £55,000 Total £57,500
Technological area and / or issue addressed by project	The Module 2 programme for budget year 2013/14 aimed to optimise overhead network design, improve operational performance, maximise potential benefits, improve financial performance and minimise risk associated with overhead networks, whilst having due regard for the environment and energy efficiency. The programme also aimed to deliver continuous improvement in terms of the 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 climate change. **Projects Funded in 2013/14: Completed at the end of March 2014:-** - S2126_7 Monitoring conductor temps – Stage 7: Consistent analysis of 3 years' data - S2156_3 Further development of pole leakage detector - S2162_2 Residual strength of wood poles - Stage 2: 2nd batch of poles - S2171_2 Wedge clamps comparative tests - Stage 2: With realistic tensions at DWF - S2174_2 Participation in Cigré WG B2.43 (OHL rating calculations) Stage 2: 2012/13 - S2177_2 Vib & ice load testing at DWF of fibre-wrapped condctr - Stage 2: Testing - S2180_1 Vibration assessment of polymeric long-rod insulators - S2182_1 Field testing screw anchors for pole stays **Projects Funded in 2013/14: Ongoing at the end of March 2014:-** - S2151_3 Alternatives to wood poles – Stage 3: Composite poles tests - S2162_3 Residual strength of wood poles - Stage 3: Last 20 poles plus analysis/writing up - S2164_4 Probabilistic wind and ice map for UK - Stage 4: weather maps		

<table>
<tr><td></td><td colspan="4">- S2174_3 Participation in Cigré WG B2.43 (OHL rating calculations) Stage 3: 2013/14
- S2174_X CIGRE WG43 work funded by EATL
- S2183_1 Relationship between measured ice loads and conductor size
- S2185_1 Performance of CPI wedge taps with shear-off bolts
- S2186_1 In-situ Megger testing of wood poles on de-energised HV OH lines

Updated information can be found at :- https://www.stp.uk.net</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental, to Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">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;
• Development of tools, technology and techniques to reduce risk or cost, or to increase speed of capital deployment of member-company programme delivery;
• A better understanding of how overhead line assets perform in service, which can be used to determine the overall asset management policy;
• Reduction in levels of premature failure of assets;
• Avoidance of redesign, reconstruction or refurbishment of overhead lines, where this is driven by a perceived need to increase ratings or strengthen lines and is required to conform with existing standards, but may actually 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;
• Extension of the service life of poles and reduction in potential levels of failures;
• Reduction in lifetime costs by the appropriate use of alternative materials;
• Improved methodology for determining conductor ratings, to provide greater confidence;</td></tr>
</table>

	• Positive impact on environmental performance and, in many cases, positive impacts on safety; • Improved understanding for members 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	Range 1-5 years - dependent on project	Duration of benefit once achieved	Range 3-5 years - dependent on project
Probability of success	Typically >50%		
Potential for achieving expected benefits	A number of STP projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified provided that the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since its inception.		
Project progress to March 2014	Most projects or project stages started in the module during 2013/14 have been completed, but some projects span more than one year and will be completed in 2014/15.		
Collaborative Partners	Other DNOs		
R&D providers	EA Technology		

<table>
<tr><td>Project Title</td><td colspan="3">Strategic Technology Programme: Cables Module 3</td></tr>
<tr><td>Description of project</td><td colspan="3">A DNO research & development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £1,200
External £65,568
Total £66,768</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £11,464
External £410,627
Total £422,091</td></tr>
<tr><td>Total Project Costs
(Collaborative + external + Northern Powergrid)</td><td>Rolling programme across all DNOs</td><td>Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £1,500
External £65,500
Total £67,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The STP Cable Networks programme for budget year 2013/14 aimed to optimise underground cable network design, improve operational performance, maximise potential benefits, improve financial performance and minimise risk associated with underground cable networks, 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 of all aspects of the underground cable network to meet the individual business requirements of member companies.
Several of the projects contribute to the industry's knowledge of variation in climate change.

<u>Projects Funded in 2013/14: Completed at the end of March 2014</u>

- S3168_3 Comparing future designs of HV (≥100V to 66kV) and EHV (>66kV up to and including 400kV) polymeric cables – Stage 3: Recommendations for future tests;
- S3175_1 Bentonite grouts for ducted cable circuits;
- S3177_1 Special stabilised backfill: Survey of existing products and potentialities;
- S3207_1 Shrink-back of polymeric oversheath materials: Study of type and process;
- S3208_1 Measurement of thermo-mechanical properties of MV and HV Polymeric cables;
- S3210_2 Developing an effective test procedure for testing metallic cable sheaths for integrity: Experimental comparison of techniques;
- S3218_2 Development of a specification for silicone-based filling compounds to be used in EHV cable terminations;
- S3224_1 Extra High Voltage (EHV) outdoor terminations - Additional user requirements;
- S3226_1 Technical Evaluation of On line Testing of HV Cables;
- S3227_1 Assessment of the reliability and performance of Thermo Setting joints;
- S3228_1 Determination of the amounts and types of ground contamination which may affect cable sheaths.

<u>Projects Funded in 2013/14: In Progress at the end of March 2014:-</u>

- S3168_4 Comparing future designs of HV (≥100V to 66kV) and EHV (>66kV up to and including 400kV) polymeric cables;</td></tr>
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<table>
<tr><td></td><td colspan="4">- S3174_1 (REVISED) Evaluating the Performance of Service Termination Equipment;
- S3187_4 Development of an ENA engineering recommendation for the use of sealant systems for cable ducts and transits;
- S3204_1 Design tool for bonding arrangements of cable circuits;
- S3214_3 Research and evaluation of the effectiveness of Tan-Delta testing and polarisation index for condition assessment of ageing cables: Trial and evaluation for paper cables ;
- S3216_1 Cross-bonding and segregation of cable systems in tunnels and shared resources by utilities: Researching the issues;
- S3245_1 Development of CRATER 'Lite'.

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 to Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">Projects in this module will positively contribute to an increase in the performance and reliability of the cable network. In many cases the cable asset 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, reducing the risk of potential costly failures;
- Successful and practical methods for sealing ducts;
- Alternatives to current design and installation practices that offer benefits in lower lifetime cost and higher performance (e.g. increased ratings);
- Reduced risk in environmentally sensitive areas;
- A reduction in the number of accidents / incidents, so increasing safety of staff and the public;
- Reduction in excavation required in locating leaks from fluid-filled cables, reduction in the times and costs of leak location, and also reduced outage times;
- A reduction in digging, causing less disruption to the public, reducing impact on the environment and avoiding disposal of soil to landfill;
- Offset future increases in CAPEX and OPEX;
- CI/CML savings per connected customer;
- Reduced cable purchase costs;
- Enforced network resilience;
- Implementation of strategies for reducing cable failures, resulting from excessive forces;
- Reduction in number of cable faults;
- Reduced design costs.</td></tr>
<tr><td>Expected timescale to adoption</td><td colspan="2">Range 1-2 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 3-5 years - dependent on project</td></tr>
</table>

Probability of success	Typically >50%	Project NPV = (PV Benefits – PV Costs) x Probability of success	Not calculated
Potential for achieving expected benefits	A number of STP projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified provided that the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since its inception.		
Project progress to March 2014	Most projects or project stages started in the module during 2013/14 have been completed, but some projects span more than one year and will be completed in 2014/15.		
Collaborative Partners	Other DNOs		
R&D providers	EA Technology		

Project Title	**Strategic Technology Programme: Substations Module 4**		
Description of project	A DNO research & development collaboration hosted by EA Technology		
Expenditure for financial year	Internal £8400 External £47,136 Total £55,536	Expenditure in previous (IFI) financial years	Internal £47,688 External £372,369 Total £420,057
Total Project Costs (Collaborative + external + Northern Powergrid)	Rolling programme across all DNOs	Projected 2014/15 costs for Northern Powergrid	Internal £5,000 External £47,000 Total £53,00
Technological area and / or issue addressed by project	The STP Substations programme for the budget year 2013/14 aimed to improve operational performance, maximise potential 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 improvement in terms of safety and environmental performance of existing and future substation assets, to meet the individual business requirements of member companies. **Projects Funded in 2013/14: Completed at the end of March 2014:-** - S4181_8 On-going Programme of Transformer Post Mortems - S4243_3 Commissioning and Testing Procedures Workshop for LV / HV Switchgear & Transformers up to 132kV - S4268_1 Technical Evaluation of BS 5730 and IEC 60422: Insulating Oils in Service - S4277_1 Researching the Suitability and Benefits of Midel 7131 in On Load Tap Changers - S4278_1 Technical Evaluation of Products used in the Maintenance of Electrical Plant and Equipment - S4296_1 Power Transformer Mid Life Refurbishment - S4301_1 Researching Primary and Grid Transformer Operating Temperature to Enhance Peak Rating Prior to Peak Loading: Researching and Assessing the Issues - S4309_1 Examining Voltage Potential Indicating Systems and Voltage Detection Systems on Electrical Switchgear up to and including 33kV - S4311_1 Hydrogen Fuel Cells - S4185_9 Developing Strategic Asset Management Processes Through Technical Liaisons with European Utilities - S4225_3 Analysis of New BS148, (Reclaimed Oil), and Revised IEC60296, (Unused Oil) - S4237_2 Battery Cabinet Temperature Control-Benefit Evaluation of Battery Performance - S4269_3 Operational and Environmental Evaluation of SIPP Node Intelligent Bund Pump Technology: Site Trial - S4286_1 Oil Analysis and Interpretation for Control Transformers and Bushings - S4293_1 Technical Assessment of GPS Reliance in Protection and SCADA Systems		

<table>
<tr><td></td><td colspan="4">- S4302_1 Researching Market Solutions for the Repair of Epoxy Based Solid State Insulation for Electrical Switchgear up to and Including 132kV
- S4304_1 Operational Evaluation of On-load Tapchanger Dynamic Resistance Measurement Equipment

<u>Projects Funded in 2013/14: In Progress at the end of March 2014:-</u>

- S4181_9 On-going Programme of Transformer Post Mortems
- S4185_10 Developing Strategic Asset Management Processes Through Technical Liaisons with European Utilities
- S4221_2 Out of Phase Modelling
- S4221_3 Out of Phase Modelling: Additional Research
- S4247_1 Identifying tests to determine the Continuous Rating of CT's in Service
- S4247_2 Identifying Tests to determine the Continuous Rating of CT's: Additional Research
- S4255_2 Mechanical Strength of Transformer Paper Insulation: Verification of Tear Index Procedure
- S4265_2 Literature Review of Remedial Treatment of Degraded Polymeric Materials
- S4266_3 Analysis and Statistical Review of SF6 Gas Condition within 11 and 33kV Circuit Breakers in order to Prolong Operational Life
- S4288_1 G59/2 & EGIP Witness testing: Guide for Commissioning Engineers
- S4303_1 Evaluating the Effectiveness of VRLA Battery Monitoring Techniques used in Primary and Grid Substations
- S4307_1 Considerations for LV Supplies in Secondary Substations Classified as 'Hot' Sites in Accordance with ENA ER G60
- S4310_1 Understanding the dielectric performance capability of HV Insulation of selected 11kV circuit breakers under "normal" service conditions against the environmental performance criterion of IEC 62271-1</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental to Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">Projects within this module have been cost effective and 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;
- Optimised safety and environmental requirements for management of insulating oils and SF6;
- Technical liaison with International Utilities to share new technology</td></tr>
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	and failure modes; - Offsetting of future increases in CAPEX and OPEX; - Development of condition-based assessments, or tests, to determine asset condition; - Prevention of failures of oil-filled equipment, tap changers, earth switches, which will improve safety and avoid unnecessary scrapping of serviceable components, thereby alleviating environmental impact; - Extension of serviceable life of switchgear and transformers; - Further development of technical understanding of protection-system maintenance requirements; - Understanding of the degradation and failure processes of substation plant and equipment, and quantification of the risks associated with those processes; - Further development of technical understanding of operational staff in complex electrical issues; - Mitigation of risk to environment; - Increased safety of staff and public from reducing risk of fire and the number of accidents / incidents; - Reduced lifetime costs and improved functionality from the appropriate use of new technology.		
Expected timescale to adoption	Range 1-4 years - dependent on project	Duration of benefit once achieved	Range 1-6 years - dependent on project
Probability of success	Typically >50%	Project NPV = (PV Benefits – PV Costs) x Probability of success	Not calculated
Potential for achieving expected benefits	A number of STP projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. These will be identified, providing the outcome of the early stage is positive. However, STP has delivered a number of notable innovations since its inception.		
Project progress to March 2014	Most projects or project stages started in the module during 2013/14 have been completed, but some projects span more than one year and will be completed in 2014/15.		
Collaborative Partners	Other DNOs		
R&D providers	EA Technology		

<table>
<tr><td>Project Title</td><td colspan="3">Strategic Technology Programme Networks for Distributed Energy Resources Module 5</td></tr>
<tr><td>Description of project</td><td colspan="3">A DNO research & development collaboration hosted by EA Technology</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,400
External £42,648
Total £45,048</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £38,893
External £432,652
Total £471,545</td></tr>
<tr><td>Total Project Costs
(Collaborative + external + Northern Powergrid)</td><td>Rolling programme across all DNOs</td><td>Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £3,500
External £60,000
Total £63,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The STP Networks for Distributed Energy Resources programme for budget year 2013/14 aimed 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 programme also aimed to cost-effectively improve the operational efficiency and business performance of member companies within prevailing regulatory constraints. We have included the costs for the new Energy Storage Operators Forum within this activity

<u>Projects Funded in 2013/14: Completed at the end of March 2014:-</u>

- S5264_1: Consumer voltage optimisation – consumer impact
- S5264_2: Consumer voltage optimisation – network impact
- S5264_3: Consumer voltage optimisation – network applications
- S5267_2: Generation diversity: assessing the minimum load to be used for solar and hydro connection assessments
- S5267_3: Generation diversity: Assessment and visualisation for wind, solar and hydro
- S5268_1: LV Connections – phase detection

<u>Projects Funded in 2012/2013: In Progress at the end of March 14:-</u>

- S5167_5: Enhanced ratings for OHL connections to wind farms – implementation of outputs – gap analysis of national standards
- S5241_2: Managing the risks with multiple points of supply
- S5243_1: AC Cable Connections; practical and electrical limits to their lengths
- S5245_2: Designing networks with lower supply impedances

Updated information can be found at :- <u>https://www.stp.uk.net</u></td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental to Radical</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

<table>
<tr><td>Expected benefits of project</td><td colspan="3">Projects within this module have been cost effective and help improve reliability and safety of generation connection in distribution networks in line with government policy.

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

• Investigation of distributed generation connection methods without undue reinforcement, while at the same time improving supply quality by reducing CMLs and voltage unbalance;
• Increased understanding amongst all member companies of technical, commercial and regulatory issues and development of effective solutions to these issues;
• Development of understanding of the implications of connecting low-carbon technologies to the distribution network in terms of safety, design, reliability, security and power quality;
• Optimised implementation, wherever possible, of the government's low-carbon strategy and accommodation of the likely growth of DG;
• Improved management of the implications of connecting distributed resources to the distribution network in terms of the statutory, regulatory and commercial frameworks;
• Investigation of low-carbon network designs and plan transition from passive to active networks;
• Improved power quality issues due to dynamic load change;
• Enabling of the development of strategies to manage power quality levels and customer expectations;
• Highlighting of the issues and benefits of smart grids, smart meters and active network management systems, ultimately improving CMLs;
• 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;
• Optimisation by all participants of network design and financial and operational performance as the levels of storage, managed demand and distributed generation increase on the distribution networks;
• Development and emergence of distributed generation, demand-side management, storage technologies.</td></tr>
<tr><td>Expected timescale to adoption</td><td>Range 1-3 years - dependent on project</td><td>Duration of benefit once achieved</td><td>Range 2-5 years - dependent on project</td></tr>
<tr><td>Probability of success</td><td>Typically >50%-</td><td>Project NPV = (PV Benefits – PV Costs) x Probability of success</td><td>Not calculated</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">A number of STP projects are at an early stage and the project cost may not always reflect the likely full costs of implementation. However, STP has delivered a number of notable innovations since its inception.</td></tr>
</table>

Project progress to March 2014	Most projects or project stages started in the module during 2013/14 have been completed, but some projects span more than one year and will be completed in 2014/15.
Collaborative Partners	Other DNOs
R&D providers	EA Technology

Project Title	**Protective Coatings Forum**		
Description of project	Quality control and consultancy services related to protective coatings for overhead line towers and substation plant.		
Expenditure for financial year	Internal £2,550 External £7,093 Total £9,643	Expenditure in previous (IFI) financial years	Internal £12,331 External £48,408 Total £60,740
Total Project Costs (Collaborative + external + Northern Powergrid)	£52,626	Projected 2014/15 costs for Northern Powergrid	Internal £2,500 External £7,000 Total £9,500
Technological area and / or issue addressed by project	Issues relating to protective coatings for lattice towers and substation plant are explored at this forum with speakers from the member companies, academia and various global suppliers. The scope of the forum covers supplier, product and specification development, manufacturing standards, preparation and installation techniques legislation, batch testing, installation inspection and testing of field samples. Systems for specialist applications are explored, developed and introduced.		
Type(s) of innovation involved	Primarily incremental improvement		
Expected benefits of project	The expected benefits of the agenda items addressed during 2013-14 are: • An industry standard specification for paint systems • An industry maintained assessed manufacturers list • An industry list of assessed testing instruments • Monitoring of production batch samples and samples recovered from site • Quality assurance inspections of installations • Development of specialist systems for environmentally sensitive areas • Innovative approaches to review alternatives to standard paint systems • To have manufacturers develop systems to overcome technical issues • To be informed of changes to associated European legislation • To be a knowledgeable forum able to inform and influence national and international technical bodies and associations. These benefits will enhance the way in which lattice towers and substation plant are protected from the effects of weathering.		
Expected timescale to adoption	Range 1-3 years - dependent on legislation	Duration of benefit once achieved	On-going
Probability of success	Range 50-100% dependent on	Project NPV	Not calculated

	project		
Potential for achieving expected benefits	A number of specific forum topics led onto various new systems being either introduced or rejected, thus improving asset life, system reliability and impact on the environment.		
Project progress to March 2013	The minutes from meetings, presentations and a file index of projects completed have been issued to members. This may have a positive impact on one or more of the asset management policies.		
Collaborative Partners	DNO members		
R&D provider	EA Technology Limited and suppliers technical engineers		

Project Title	**Partial Discharge User Group**		
Description of project	The Partial Discharge User Group is a technical forum where information on partial discharge-related failures can be discussed.		
Expenditure for financial year	Internal £4,800 External £6,455 Total £11,255	Expenditure in previous (IFI) financial years	Internal £26,130 External £44,924 Total £71,054
Total Project Costs (Collaborative + external + Northern Powergrid)	£266,190	Projected 2014/15 costs for Northern Powergrid	Internal £2,500 External £6,500 Total £9,000
Technological area and / or issue addressed by project	Partial discharge is the primary cause of disruptive failure of HV switchgear. The Partial Discharge User Group is a technical forum where information on partial discharge-related failures can be disseminated and the understanding of the impact of partial discharge on switchgear can be enhanced through targeted investigative research and development work. This will in turn enhance the way in which HV assets are managed and maintained and will make a positive impact on the safety of operators working in substations.		
Type(s) of innovation involved	Primarily incremental improvement		
Expected benefits of project	Due to the ageing profile of switchgear and the introduction of air-insulated switchgear designs using cast resin, there is less tolerance of the effects of partial-discharge activity. Unless the condition of the switchgear is actively assessed and managed there will be an increase in failure rates. The expected benefits of the projects taken in the financial year 2013-14 remain: • Understanding of the potential partial discharge-related failure points for all types of switchgear. • Determination of the mechanism of failure related to surface discharge. • Ascertaining of the end of life of switchgear found to be experiencing surface-related partial discharge. • Understanding of the typical sound signatures of surface-related discharge by use of analysis in the time and frequency domain. • Enhanced interpretation of routine partial-discharge surveys. • Better targeting of maintenance. • Preservation or reduction of the low failure rate for HV distribution switchgear. • Understanding of the effect of the environment on the levels of partial discharge activity and the condition of switchgear. • Access to advice and support. • On site assistance.		

	• Production of a partial discharge "Best Practice Guide". • Use of a substation wiki.		
Expected timescale to adoption	Range 2 - 5 years dependent on project.	Duration of benefit once achieved	On-going
Probability of success	50-100% dependent on project.	Project NPV (Present Benefits – Present Costs) x Probability of success	Not calculated
Potential for achieving expected benefits	During 2013-14 the PD User Group continued to invest in database of results that enables significant and key information to be quickly drawn from the large population of historical results. This has been built on over several years and the database now incorporates pictures, drawings, failure records and sound files (for the analysis of heterodyned ultrasonic activity). This greatly enhances the incident-reporting facilities, which helps engineers to better interpret the results of partial-discharge surveys and make an assessment of whether switchgear is in need of immediate attention. The database is currently being web enabled to allow members direct access from their computers for reference or to upload information from their computers. Continuing the investigation previously referred to, different types of switchgear and components commonly used by the DNOs are sited at EA Technology and investigated for discharge activity, in some cases creating a discharge source to be monitored. The aim of this work is to try to determine the mechanism of failure associated with surface discharge to try to determine the end-of-life period once a discharge source has been found.		
Project progress to March 2014	A number of new instruments and monitors have been developed, and existing instruments improved and tested by members. The database has been updated, and there is now a better understanding of acceptable levels of partial discharge in the more modern types of switchgear. This has developed a greater understanding of potential failure mechanisms of the new types of switchgear being introduced to the networks. Progress has been made on how best to optimise the environment for switchgear prone to partial discharge in terms of temperature and humidity. Plant-specific partial-discharge issues have progressed.		
Collaborative Partners	DNOs		
R&D provider	EA Technology Ltd		

Project Title	**Engineers' Forums – Cable, OHL, Plant and Protection**		
Description of project	These are biannual forums attended by engineers from the UK distribution network operators. Each area of technical interest (Cables, OHL, Plant and Protection) holds its own separate series of meetings. The aim of the forums is to allow engineers to share knowledge and raise awareness of issues that affect the industry as a whole, including plant failures / safety and new developments in the specific technology areas, allowing fast take-up of innovation and best practice		
Expenditure for financial year	Internal £4,500 External £8,746 Total £13,246	Expenditure in previous (IFI) financial years	Internal £49,419 External £32,494 Total £81,913
Total Project Costs (Collaborative + external + Northern Powergrid)	£326,471	Projected 2014/15 costs for Northern Powergrid	Internal £5,000 External £8,000 Total £13,000
Technological area and / or issue addressed by project	Issues are explored with speakers from the Member Companies, academia and various suppliers both in the UK and overseas. The scope of the forum covers manufacturing, installation, operation and maintenance issues along with implications on safety. Failure modes are reviewed to improve cable reliability along with analysis of asset management tools, techniques and technologies.		
Type(s) of innovation involved	Primarily incremental improvement and dissemination of new knowledge		
Expected benefits of project	The expected benefits of the agenda items undertaken during 2013-14 are: • To consider common problems and seek to identify common solutions (e.g. equipment performance, failures etc) • To be informed of new technologies and innovation (e.g. what is new from the manufacturers, technical bodies etc.) • To consider the impact of technical changes in the design and operation of power networks from the specific technological perspectives • To consider cost-effective management solutions for networks (e.g. safety, reliability, environment, maintenance, testing, commissioning etc.) • To be a knowledgeable forum able to inform and influence national and international technical bodies and associations. This in turn will enhance the way in which technological aspects of networks and assets are managed and maintained and safely operated.		
Expected timescale to adoption	Range 1-3 years dependent on project.	Duration of benefit once achieved	Ongoing
Probability of success	50-100% dependent on project.	Project NPV (Present Benefits – Present Costs) x Probability of success	Not calculated

Potential for achieving expected benefits	A number of specific forum topics lead onto various successful preventative projects, thus improving safety and system reliability.
Project progress to March 2014	The minutes from meetings, presentations and a file index of cable issues have been sent to members. This may have a positive impact on one or more of the asset management policies at individual DNOs.
Collaborative Partners	DNOs
R&D provider	EA Technology Ltd

Project Title	**Energy Storage Operators' Forum (ESOF)**		
Description of project	This is a new biannual forums initiated in 2013. The aim of the forums is to allow network operators and others to share knowledge and raise awareness of issues as they arise with this new class of network assets.		
Expenditure for financial year	Internal £8,400 External £8,890 Total £17,290	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total £0
Total Project Costs (Collaborative + external + Northern Powergrid)	£102,000	Projected 2014/15 costs for Northern Powergrid	Internal £8,000 External £8,00 Total £16,000
Technological area and / or issue addressed by project	All aspects of the ownership and operation of storage devices are within the scope of this activity.		
Type(s) of innovation involved	Primarily incremental improvement and dissemination of new knowledge.		
Expected benefits of project	The expected benefits are: • To consider common problems and seek to identify common solutions (e.g. equipment performance, failures etc) • To be informed of new technologies and innovation (e.g. what is new from the manufacturers, technical bodies etc.) • To consider the impact of technical changes in the design and operation of power networks from the specific technological perspectives • To consider cost-effective management solutions for networks (e.g. safety, reliability, environment, maintenance, testing, commissioning etc.) • To be a knowledgeable forum able to inform and influence national and international technical bodies and associations. • To influence the direction of new innovative work, required by the industry as a whole, to allow the safe and successful implementation of this important technology		
Expected timescale to adoption	Range 1-3 years dependent on project.	Duration of benefit once achieved	Ongoing
Probability of success	75-100% dependent on project.	Project NPV (Present Benefits – Present Costs) x Probability of success	Not calculated
Potential for achieving expected benefits	A number of specific forum topics lead onto various successful preventative projects, thus improving safety and system reliability.		

Project progress to March 2014	Outcomes delivered by the ESOF during the year include: • Created, co-authored, reviewed and published the first revision of the good practice guide for energy storage; • Published our white paper entitled the 'State of charge of GB'; • Attended 2 hosted visits to Crawley and Capenhurst, viewing the Chalvey community storage facility; • Coordinated an HSE visit driven by ESOF interest for three senior HSE safety inspectors; • Hosted 7 DNO's to and event at Newton Aycliffe to view our energy storage systems; • Created, co-authored and reviewed the LCNF conference presentation material; • Attended the LCNF conference in Brighton and presented on behalf of the ESOF along with 3 co presenters; and • Attended and presented at the good practice guide launch event at the iMechE in Westminster.
Collaborative Partners	Electricity North West, National Grid, Scottish Power, SSE, UKPN, Western Power Distribution
R&D provider	EA Technology Ltd

Other Collaborative Projects

Project Title	**Tree Growth Regulators**			
Description of project	The project proposes to investigate the effect of the plant growth regulator paclobutrazol (PBZ) on tree vitality and growth rates. Six field trial sites have been established, supported by thirteen observational sites throughout the UK to represent a diverse range of bioclimatic zones. There are two sites in each of the participating network operators' distribution service areas. Tree species selected for PBZ evaluation were selected to represent those that occur commonly on or near overhead networks.			
Expenditure for financial year	Internal £900 External £16,000 Total £16,900	Expenditure in previous (IFI) financial years	Internal £3,310 External £117,200 Total £120,510	
Total Project Costs (Collaborative + external + Northern Powergrid)	£715,000	Projected 2014/15 costs for Northern Powergrid	Internal £0 External £0 Total £0	
Technological area and / or issue addressed by project	Rate of vegetation growth and use of Tree Growth Regulators to reduce maintenance costs			
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		15	-2	**17**
Expected benefits of project	The outputs of the project are data and information on the effect of PBZ on tree growth rates across a range of species and bioclimatic areas. This data complies with ORETO experimental requirements and will be used to apply for a licence for the use of PBZ for utility vegetation management. PBZ could then be used as part of utility vegetation programmes to reduce growth rates on restricted-cut sites and reduce overall vegetation management costs. This would also reduce the disturbance to landowners and the high costs of returning each year to maintain clearances from locations where only a restricted cut is possible.			
Expected timescale to adoption	3 years	Duration of benefit once achieved	20 years	
Probability of success	75%	Project NPV (Present Benefits – Present Costs) x Probability of success	>£1,000,000	

Potential for achieving expected benefits	All objectives stipulated in the original proposal and subsequent interim reports, have been achieved. In addition, no particular factors can be foreseen that would result in delays in the achievements of any of the stated objectives in the original research proposal, ie that of obtaining the appropriate regulatory clearances.
Project Progress to March 2014	This activity was completed in early 2014. Project progress has been a general confirmation of the behaviours and trends seen in the earlier growing periods. A full set of reports and supporting data are now available. In 2011, as in 2010, both field and observational site data indicated a significant positive benefit of PBZ application on tree vitality and growth. PBZ effects were manifest by reduced shoot growth and trunk diameter and increased root growth. In 2012 the trial shows that the effect of the PBZ is beginning to decline in some, but not all, of the tree species under investigation. These general trends continued through the 2013 and 14 growing seasons. The previously observed effects of PBZ on vitality and growth varying between tree species, with some species such as English oak and beech particularly sensitive, while others such as poplar and willow are far less so have been further confirmed in the latest growing season. These latter species also appear to loose what sensitivity they have much quicker than others. Irrespective of field or observational site, no symptoms of phytotoxicity have, to date, been recorded on any PBZ-treated tree. All objectives stipulated in the final IFI research project, "The effects of Tree Growth Regulators (TGRs) on Fast Growing Trees and Application to Utility Arboriculture" have been achieved. Syngenta, the providers of the PBZ used in this trial will now seek appropriate regulatory clearance for utility application of this material. There is also now a large set of carefully characterise trees, in various locations and of various species available for follow up study. Thought will be given to trials which may enhance our understanding of the use of PBZ allowing its most effective and economic use.
Collaborative Partners	Scottish and Southern Energy, WPD, UK Power Networks
R&D provider	Bartlett Tree Experts, ADAS

<table>
<tr><td>Project Title</td><td colspan="3">Superconducting Fault Current Limiter</td></tr>
<tr><td>Description of project</td><td colspan="3">This project aims to design, develop and trial three 11kV Superconducting Fault Current Limiting (SFCL) devices on three UK networks.

A project extension is exploring the device characteristics under differing fault conditions and seeking to understand the activities required to maintain capability.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,150
External £15,047
Total £18,197</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £90,380
External £709,813
Total £800,193</td></tr>
<tr><td>Total Project Costs
(Collaborative + external +
Northern Powergrid)</td><td>£3,000,000+</td><td>Projected costs for 2014/15
Northern Powergrid</td><td>Internal £2,000
External £32,000
Total £34,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">The design of the first two trial units incorporates a non-linear ‘high-temperature’ superconducting ceramic in series with a circuit breaker for the clamping and clearance of fault energy. When the material is operated at below its critical temperature it loses all electrical resistance, thereby allowing load current to flow with negligible losses. In the event of a fault, the increased current density or the loss of cooling medium (liquid nitrogen) causes the temperature of the superconducting material to rise and it reverts to a normal resistive state.

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

The third trial unit design employs a pre-saturated core reactor design. A superconducting winding carries a DC current that drives the core into saturation under normal operation. The AC current is unimpeded under normal operation: however, in the event of a fault, the magnetic field opposes the DC field with sufficient magnitude to drive the core out of saturation, thus effectively inserting an inductance into the AC circuit, reducing the peak fault current to approximately 40% of its prospective value.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>11</td><td>-4</td><td>15</td></tr>
<tr><td>Expected benefits of project</td><td colspan="3">To develop, understand and address the issues associated with the connection of an 11kV fault current limiting device to the network.

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

Expected timescale to adoption	1 years	Duration of benefit once achieved	20 years
Probability of success	75%	Project NPV (Present Benefits – Present Costs) x Probability of success	£840,000
Potential for achieving expected benefits	The project has met all objectives and a functioning device has been delivered, installed and commissioned. This is now operating on our network and the trial continues in order to allow the understanding of how the device performs over an extended period of time.		
Project progress to March 2014	Following successful implementation and operation of the device this activity was extended to allow improved understanding of the operational characteristics and maintenance requirements. The occurrence of network faults is a relatively rare event and an extended trial allows us to both understand the capabilities of the SFCL under different network fault conditions and also to understand the nature of maintenance activities required to ensure the capability is available when called upon.. The manufacturer of the third device went into administration in December 2013. A device service had been initiated to understand the wear characteristics of the removable, moving parts which had not been completed when the supplier went into administration. It is anticipated that this activity will be re-initiated and completed during 2014-15.		
Collaborative Partners	Electricity North West, Scottish Power Energy Networks		
R&D provider	Ex-Applied Superconductor Ltd, now ASG. Milan, Italy		

<table>
<tr><td>Project Title</td><td colspan="3">Cable Core Temperature Sensor</td></tr>
<tr><td>Description of project</td><td colspan="3">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, potentially allowing real-time thermal ratings.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,400
External £41,200
Total £43,600</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs
(Collaborative + external +
Northern Powergrid)</td><td>£174,400</td><td>Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £5,000
External £5,000
Total £10,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">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; and
Direct heat flux measurement to quantify the amount of heat exiting the cable, using the thermoelectric effect - depending on the direction of conversion between heat and electricity.</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>18</td><td>-2</td><td>20</td></tr>
<tr><td>Expected benefits of project</td><td colspan="3">It is expected that the development of such a sensor would allow 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.</td></tr>
<tr><td>Expected timescale to adoption</td><td>2018</td><td>Duration of benefit once achieved</td><td>25 Years</td></tr>
<tr><td>Probability of success</td><td>25%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of success</td><td>£ 194,000</td></tr>
</table>

Potential for achieving expected benefits	The initial 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 measures to assist with network management.
Project progress to March 2014	The project started in January 2014. Stage 1, the analytical and experimental proof of principle, has been completed. The direct temperature measurement technique has been identified as the method which offers the greatest potential for success and will now be further investigated.
Collaborative Partners	Electricity North West, Scottish Power, SSE, UKPN, Energy Innovation Centre.
R&D provider	The Technology Partnership (TTP) Ltd.

<table>
<tr><td>Project Title</td><td colspan="4">Cable Paper Moisture Meter</td></tr>
<tr><td>Description of project</td><td colspan="4">The project is the development of a paper moisture analyser that can be used by field staff to test the moisture content of paper insulated cables prior to jointing operations. The project is to be split into three phases:
Stage 1: Develop Multi-Frequency laboratory instrument
Stage 2: Develop Prototype Field Instrument and issue to DNO members for field trials.
Stage 3: Instrument Production, which is to be funded by EATL subject to a positive market assessment.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £600
External £38,598
Total £39,198</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs
(Collaborative + external +
Northern Powergrid)</td><td>£117,594</td><td colspan="2">Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £ 1,500
External £ 6,500
Total £ 8,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The current moisture assessment method, which has been in existence for several decades, is difficult to use and requires a naked flame. This project sets out to:
• Develop a multi-frequency instrument that can be used to analyse the moisture content of paper insulated cables;
• Produce results with a high level of confidence and consistency. The more accurate measurement should alleviate the potential for cables being re-commissioned when unsuitable and the potential future failure; and
• Remove the safety risk associated with the use of a gas burner to heat wax to a temperature of 120°C.</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>18</td><td>-2</td><td>20</td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">Benefits are staff safety, improved customer service through reliability and financial. Jointing team safety is improved, increased network performance results from the decreased failure rate on jointed cables and repair costs are decreased due to both increased accuracy in the assessment required cable lengths to be replaced and by reduced excavation.</td></tr>
<tr><td>Expected timescale to adoption</td><td>2016</td><td colspan="2">Duration of benefit once achieved</td><td>10 Years</td></tr>
<tr><td>Probability of success</td><td>10%</td><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of success</td><td>£ 505,000</td></tr>
</table>

Potential for achieving expected benefits	Although multi frequency measurement has not been applied to this application academic literature indicates potential to deliver. Additionally preliminary evaluation work also gave some encouraging results. One of the unknowns is whether it can be successful with the variety of cables of different ages and from different manufacturers. A further unknown is the complexity of the final instrument which will determine both ease of use and cost.
Project progress to March 2014	Investigations into two distinctly different technologies are complete; one being capacitive the other infrared spectroscopy. The capacitive measurement technique was shown to be sensitive to moisture content. Further research showed that frequency response for the capacitive technique is strongly dependent on moisture content and this was seen as the lower risk option for further exploration. A technology and system has now been identified that can operate the necessary levels of sensitivity whilst also being small and portable for ease of use by cable jointers.
Collaborative Partners	Electricity North West, Scottish Power, UKPN, Energy Innovation Centre.
R&D provider	EA Technology Ltd.

Project Title	**Live Alert**			
Description of project	The Energised Alert is a high-voltage detection device, currently capable of detecting voltages of above 2kV. The project's objectives are to: • extend the voltage sensing range downwards from 2000 Volts; • undertake a full market appraisal; and • undertake full evaluation of the technology whilst in operation. This project aims to take the Energised Alert device from TRL 4 to 8.			
Expenditure for financial year	Internal £0 External £0 Total £0	Expenditure in previous (IFI) financial years	Internal £1,250 External £23,261 Total £24,511	
Total Project Costs (Collaborative + external + Northern Powergrid)	£71,356	Projected 2014/15 costs for Northern Powergrid	Internal £ 2,500 External £ 2,500 Total £ 5,000	
Technological area and / or issue addressed by project	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.			
Type(s) of innovation involved	Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		14	-5	**19**
Expected benefits of project	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			
Expected timescale to adoption	Year 2015	Duration of benefit once achieved	25 Years	
Probability of success	25%	Project NPV (Present Benefits – Present Costs) x Probability of success	£ 227,017	
Potential for achieving expected benefits	The project is on target to achieve the expected technical benefits although there have been several delays due to external factors..			

Project progress to March 2014	• 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 4 was completed and issues surrounding device sensitivity were identified. Analysis of this problem has been undertaken and solutions identified. This has delayed the project beyond the initially expected completion date. Testing to validate the solutions was scheduled for 2013/14 The project has been stalled pending contract extension discussions, both to extend the project to solve the issues identified in Stage 4 and to allow the addition of UKPN . It is currently anticipated that the project will be able to re-start during 2014 . No claim against IFI allowances has been made this year.
Collaborative Partners	Electricity North West, Scottish Power, SSE, UKPN, Energy Innovation Centre,
R&D provider	Live Alert

Project Title	**Gendrive Phase Balancer/Voltage Regulator**			
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	Internal £300 External £36,251 Total £36,551	Expenditure in previous (IFI) financial years	Internal £0 External £0 Total £0	
Total Project Costs (Collaborative + external + Northern Powergrid)	£146,204	Projected 2014/15 costs for Northern Powergrid	Internal £0 External £0 Total £0	
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	Significant	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		12	-3	**15**
Expected benefits of project	Successful development of the Gendrive device would: • Allow 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	Year 2015	Duration of benefit once achieved	20 Years	
Probability of success	10%	Project NPV (Present Benefits – Present 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 good level of optimism that this project will deliver the technical benefits sought.			
Project progress to March 2014	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 although the most likely outcome is that the project will be terminated.			

Collaborative Partners	Electricity North West, Scottish Power, SSE, UKPN, Energy Innovation Centre,
R&D provider	GenDrive Ltd.

<table>
<tr><td>Project Title</td><td colspan="4">Oil-filled Cable Additive</td></tr>
<tr><td>Description of project</td><td colspan="4">The project seeks to identify, develop and assess self-repairing systems for oil and fluid filled cable sheaths such that damage to the sheath will self-heal, to avoid oil leakage losses and the resulting environmental clean-up, as well as preventing contamination of the cable that could compromise its performance and lead to premature cable failure.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,550
External £103,218
Total £105,768</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs
(Collaborative + external +
Northern Powergrid)</td><td>£317,304</td><td colspan="2">Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £ 2,500
External £19,265
Total £12,765</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The project is investigating chemical and material additives which change their nature on contact with their environment under leakage conditions. The project consists of three stages:
• Stage 1 - critical review and selection of potential repair technologies and the sourcing of the component compounds and design of test rigs;
• Stage 2 - first level scoping assessment of prospective repair technologies to assess their ability to function in cables subjected to damage; and
• Stage 3 - second level evaluation of the best candidate repair technologies from Stage 2 with recommendations on which technologies to commercialise and the best route for commercialisation.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-1</td><td>11</td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">Across the whole of the GB distribution network the current cost of this problem is of the order of several £M per annum. Implementation of cable with self-heal properties would help resilience to these issues. Specifically;
• .Financial savings from reduced frequency of cable repair as a result of leakage;
• Reduced necessity to repair damaged underground cables and the consequential environmental impact.;
• Reduced ground contamination issues; and
• Reduced customer disruption from premature cable failure</td></tr>
<tr><td>Expected timescale to adoption</td><td>Year 2015</td><td colspan="2">Duration of benefit once achieved</td><td>20 Years</td></tr>
<tr><td>Probability of success</td><td>10%</td><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of success</td><td>£ 76,055</td></tr>
</table>

Potential for achieving expected benefits	Prior work in this area by EDF illustrated that there is potential for success in delivering this project although the relatively low technology readiness level (that is 3) at commencement should be noted. The project will draw direction on EDFs experience in this area as a subcontractor to the project.
Project progress to March 2014	An interim report was produced in February 2014 which showed good progress on identifying healing additives and mechanisms. Aged oils from DNOs and lab oils from other parties is allowing these mechanisms to be tested out in the laboratory.
Collaborative Partners	Electricity North West, UKPN, Energy Innovation Centre, Gnosys Global Ltd.
R&D provider	EA Technology Ltd.

<table>
<tr><td>Project Title</td><td colspan="4">UAV/VTOL – Unmanned Aerial Vehicle</td></tr>
<tr><td>Description of project</td><td colspan="4">The use of helicopters to inspect overhead line assets, whilst necessary and cost effective, 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 [CAA] approval 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 network operators and be viable for current and/or as yet undefined future operations; and
• • 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 financial year</td><td>Internal £600
External £91,151
Total £91,751</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 +
Northern Powergrid)</td><td>£550,506</td><td>Projected 2014/15 costs for
Northern Powergrid</td><td colspan="2">Internal £2,500
External £25,000
Total £27,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The project seeks to address both issues of technical capability of UAS based inspection and the regulatory and economic issues that act as barriers to implementation and must be overcome to allow successful deployment of this class of vehicle.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Radicalt</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>18</td><td>-2</td><td>20</td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">A UAS offers significant cost savings when compared to helicopter deployment. Being able to operate beyond the visual line of sight will result in significant efficiency improvements through higher productivity more circuit being surveyed during inspection periods.

Other benefits that unmanned aerial systems will bring include:
• Reduced environmental impact with greatly reduced fuel consumption.
• Reduced disruption to land owners, livestock and local residents during inspection.
• Reduced safety risk by using un-manned apparatus to retrieve data.
• Reduced Civil Aviation restrictions in the vicinity of airports, chemical plants, MOD land etc.</td></tr>
</table>

	• Reduction in 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.		
Expected timescale to adoption	2017	Duration of benefit once achieved	30 Years
Probability of success	30%	Project NPV (Present Benefits – Present Costs) x Probability of success	£ 624,442
Potential for achieving expected benefits	The approach of this project is designed to address the CAA requirements, seen as the main barrier to implementation, at every stage in order increase the potential for achieving expected benefits. This allows a sensible stage-gate approach to achieve the best chance of successful delivery.		
Project progress to March 2014	The project commenced in March 2014. Consequently the project is currently in the early stages of mobilization.		
Collaborative Partners	Scottish Power, SSE, UKPN, Northern Gas Networks, Scotland Gas Network, Southern Gas Networks, Energy Innovation Centre.		
R&D provider	VTOL Ltd.		

<table>
<tr><td>Project Title</td><td colspan="4">Ultrapole – Ultrasonic Woodpole Inspection</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 objective of assessing pole condition 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 make 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</td><td>Internal £600
External £36,218
Total £36,818</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs
(Collaborative + external +
Northern Powergrid)</td><td>£147,272</td><td colspan="2">Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £2,500
External £15,000
Total £17,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Wooden poles are affected by their environment and can lose their physical integrity. This leads to issues of both network reliability and staff and public safety. Ultrasound can be used to detect changes in wood density due to rot or other deterioration. Current techniques use ultrasound to analyse cross sections of the pole, ‘slices’, which are normally at ground level. This project aims to develop a technique to use ultrasound longitudinally and thus from one point access the top and bottom of the pole.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Significant</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-1</td><td>11</td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">This project will determine whether ultrasonics can be used to assess the condition of the complete wooden pole. If achievable this will provide a tool to assess overhead line poles without having to climb the pole or dig below ground level. This will be a safer and more cost effective method than those currently available.</td></tr>
<tr><td>Expected timescale to adoption</td><td>Year 2015</td><td colspan="2">Duration of benefit once achieved</td><td>20 Years</td></tr>
<tr><td>Probability of success</td><td>10%</td><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of success</td><td>£ 76,055</td></tr>
</table>

Potential for achieving expected benefits	Potential for achieving the results looks to be good but the project is still in its very early stages..
Project progress to March 2014	The project started in March 2014. An initial kick off meeting has been held. Test materials have been obtained and test equipment ordered.
Collaborative Partners	Electricity North West, Scottish Power, SSE, UKPN, Energy Innovation Centre.
R&D provider	Acuity Products Ltd.

Northern Powergrid's internal innovation programme

<table>
<tr><td>Project Title</td><td colspan="4">CBRM Extension – Health Indices – Stage 5: Direct data upload to cloud-based CBRM tool</td></tr>
<tr><td>Description of project</td><td colspan="4">EA Technology previously completed work on producing condition based risk management (CBRM) models for Distributed Substations (DSS) and Wood Pole Overhead Line (OHL). This applies health index analysis and CBRM on all of Northern Powergrid's wood pole overhead lines and distribution substations. However IT hosting issues have provided a barrier to seeing the project through to deployment by making testing, bug-fixing and updating extremely difficult to do. Therefore a stage 4 of the project was implemented in 2012/13 which ensured that the software tool could also run on an internet cloud. Our final step for fully evaluating whether CBRM can become a usable tool within the business is to prove that we are able to update the databases via direct data upload to the cloud based application. This final functionality will provide the means to recalculate health indices with fresh data whenever we wish to do so, during the cloud-based tool's one year evaluation period.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £600
External £38,598
Total £39,198</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 +
Northern Powergrid)</td><td>£39,198</td><td>Projected 2014/15 costs for
Northern Powergrid</td><td colspan="2">Internal £5,000
External £42,566
Total £47,566</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">EA Technology has recently completed work on producing CBRM models for Distributed Substations (DSS) and Wood Pole Overhead Line (OHL). Northern Powergrid now need seamless access to the technology to test how it works in an operational environment with regular data updates and without bugs. This project will enable this testing environment to be set up.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>16</td><td>-3</td><td>19</td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">Financial
A robust and defensible investment plan based on a sound understanding of the assets, their current and future condition, and an assessment of future condition, performance and risk. This will enable the optimum replacement/refurbishment programme based on minimising cost and maintaining a defined level of performance. There is also an added benefit that this work can be used as a basis for the new tier 2 output measures for ED1.

Knowledge Transfer
"The principal outputs of this project will be CBRM models, all of which will provide health indices, POF values and criticality ratings for individual and combined assets in year 0 and future years with and without interventions. The engineering parameters and the methodologies provide knowledge that can be retained within the business for continuity into future years."</td></tr>
</table>

	Environmental Assets for which condition degradation has environmental impacts, such as oils leaks from distribution plant, are identified during the processing of condition data into health indices. Network Performance Assets for which condition degradation affects network performance, such as unreliable overhead lines, are identified during the processing of condition data into health indices.		
Expected timescale to adoption	1 year	Duration of benefit once achieved	4 Years
Probability of success	75%	Project NPV (Present Benefits – Present Costs) x Probability of success	£55,007
Potential for achieving expected benefits	We are confident that we have a functional CBRM software tool and a set of Health Indices that we can already access on an internet cloud as well as on our servers. Direct data uploading functionality into cloud based implementations of CBRM is proven in other DNO's so we have no reason to believe it cannot work here. A small amount of risk lies with the level of resource / complexity required for preparing the data interface.		
Project progress to March 2014	The amended CBRM models have been delivered and work as expected. The software is up and running on an internet cloud as well as on our servers. This final stage will enable CBRM data update capability on the cloud. This will help us to test upload functionality as part of assessing whether the tool is suitable for adoption by the business. We originally aimed for the stage to complete during 2013/14. However resource has been diverted onto RIIO-ED1 work. Resource is required to retrieve a large amount of 2014 distribution substation data in order to test the updating facility and it is not now expected to become available until 2014/15. Once it is up and working, if the CBRM tool passes this test then the next project stage is planned to extend CBRM to other asset classes, update degradation assumptions and to tailor all models to suit new condition points This will start after the new scripts are defined and complete after our new Oracle Spatial asset management system has been installed. This is unlikely to commence until late in 2014/15 and even 2015/16.		
Collaborative Partners			
R&D provider	EA Technology Ltd		

<table>
<tr><td>Project Title</td><td colspan="4">Environmental Monitoring of Distribution Substations</td></tr>
<tr><td>Description of project</td><td colspan="4">The scope of this project was to install temperature and humidity logging equipment in twenty different substations across the Northern Powergrid region and monitor for a minimum of 365 days continuously at each of the 20 locations. EA Technology supplied, installed, monitored and uninstalled the logging equipment at the substations. A final report was produced providing details of potential impact on asset management policies and future projects.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,900
External £30,015
Total £33,915</td><td colspan="2">Expenditure in previous financial years</td><td>Internal £5,730
External £74,627
Total £80,357</td></tr>
<tr><td>Project Value</td><td>£80,357</td><td colspan="2">Projected 2014/15 costs</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">Distribution substation design and the optimal indoor environment for network assets. Such assets, installed within substation buildings and enclosures, are affected by their environment which, in turn, could impact the service life of the equipment, how it performs and future maintenance requirements. This project seeks to better understand this.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>8</td><td>-4</td><td>12</td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">The expected benefits of this project are:
To understand the typical and extremes of temperature and humidity which plant enclosed in buildings are subjected to;
To understand if we are under or over specifying the environmental resilience of the plant in service;
To consider if plant service life can be increased by improving the local environment; and
To provide scope or focus for future projects within this area</td></tr>
<tr><td>Expected timescale to adoption</td><td>2013</td><td colspan="2">Duration of benefit once achieved</td><td>40 Years</td></tr>
<tr><td>Estimated success probability (at start of project)</td><td>35%</td><td colspan="2">Project NPV (Present Benefits – Present Costs) x Probability of success</td><td>£45,179</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The environment within substation buildings varies with different building designs and locations. Once the variations are understood the company policy documents will be updated to ensure that the installed assets are enclosed in the optimum environment.</td></tr>
</table>

Project progress March 2014	The environmental monitoring equipment has now been installed within 20 substation buildings for the required 365 days. The data downloaded has been studied by EA Technology Limited and a report submitted to Northern Powergrid. The report identified extremes of temperature and humidity, areas where the environment was close to exceeding documented thresholds and a number of areas where we may need to focus future projects. In turn an internal report was compiled and disseminated around the business.
Collaborative Partners	None
R&D provider	EA Technology Ltd

Project Title	**Demand-Side Management and Risk**		
Description of project	This project sought to develop a method to assess where and how much demand side resource is located on the network, which can used to provide benefits for a range of issues such as peak lopping. The method includes an assessment of the demographics of the consumers located across the network as well as an assessment of the potential benefit of accessing and applying this demand side resource by locating vulnerable network components to defer network reinforcement. The project builds on a previous network risk project but also brings a cross-functional approach, combining both sociological practices of consumers on the network and engineering characteristics of the network, to solving a technical network issue.		
Expenditure for financial year	Internal £4200 External £15,481 Total £19,681	Expenditure in previous (IFI) financial years	Internal £12,920 External £85,390 Total £98,310
Total Project Costs (Collaborative + external + Northern Powergrid)	£159,500	Projected 2014/15 costs	Internal £0 External £0 Total £0
Technological area and / or issue addressed by project	The project covers a broad range of issues, focussing mainly on deferring network reinforcement but with potential benefits in finding cheaper connection arrangements. Models have been developed to explore the maximum peak loading feeders can accommodate before the demographic of the consumers is assessed to quantity the availability and cost of applying demand side resource to solve network reinforcement issues.		

Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		8	0	**8**

Expected benefits of project	An increased understanding of demand on the network under current conditions and under future growth scenarios resulting in a methodology for influencing demand so that network reinforcement can be deferred with confidence where appropriate. A deeper understanding of how demand is constructed on the network and how different demographic factors influence demand and the potential demand side resource.		
Expected timescale to adoption	Year 2015	Duration of benefit once achieved	Ongoing
Probability of success	Complete	Project NPV (Present Benefits – Present Costs) x Probability of success	£733,432

Potential for achieving expected benefits	The project has delivered against its objectives. However, those objectives have been largely overtaken by CLNR, which seems likely to promote alternative routes to unlocking the domestic demand side. Our effort has been far from wasted, as the knowledge generated within this project has been a major contribution to the social science component of CLNR. As such, we could reasonably argue that we'll generate the same (or even greater) level of benefits as originally expected, just delivered in a different manner.
Project Progress to March 2014	The project has delivered against its objectives, and funding has now ceased. The models and interim reports have been produced as planned, with the bonus of some academic papers to aid broader dissemination.. The key contribution of this project has been to the social science component of CLNR. The knowledge generated here has been used to develop CLNR customer interview questions and analyse the results. The fieldwork effort and benefits have been shared between this project and CLNR. The legacy of this project will therefore be embedded in the wider work carried out under CLNR. We await only the final PhD thesis to tie off the last threads.
Collaborative Partners	Customer Led Network Revolution
R&D provider	Durham Energy Institute (Durham University)

<table>
<tr><td>Project Title</td><td colspan="3">Network Risk Management KTP</td></tr>
<tr><td>Description of project</td><td colspan="3">This project involves the deployment of a previously developed methodology to quantify network risk and to develop a network risk modelling assessment tool. This work takes the outputs of the previous Network Risk modelling project and seeks to embed the results into Northern Powergrid's business processes through a process of case-study development and learning and is designed to bridge the technology readiness from 4 to 8. The project is 50% funded through the Technology Strategy Board's Knowledge Transfer Partnership (KTP) programme.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £4,800
External £20,509
Total £25,309</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £16,355
External £111,157
Total £127,512</td></tr>
<tr><td>Total Project Costs
(Collaborative + external +
Northern Powergrid)</td><td>£230,000</td><td>Projected 2014/15 costs</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">A number of issues arising in recent years have tended to increase the level of network risk, and therefore interruptions in supply including:
Severe weather conditions are occurring more frequently
Customer needs and expectations are increasing, particularly at times of network duress
Decreasing reliability of an ageing infrastructure
The additional demands on the network caused by distributed generation
Increasing levels of both accidental and deliberate damage
Increasing utilisation of distribution networks expected over the next 20 years due to increasing penetration of electric vehicles and domestic heat pumps
It is essential to contain and mitigate this increased risk by scientific and accurate evaluation of that risk under different circumstances.

A reliable and acceptable way of measuring the expected network was developed in the first phase of the Network Risk project. This second phase is designed to better understand how to use this knowledge in real network situations and decision making. The project will then further develop this knowledge into a set of tools, probably IT enabled, which can be used to provide support, with risk quantified and optimised, to improve decision making for capital, operational, design and regulatory issues.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>20</td><td>-1</td><td>21</td></tr>
<tr><td>Expected benefits of project</td><td colspan="3">Reducing interruptions to power supply generally requires advancing investment. The opportunity is to balance the expense of investment with the risk of not investing to give the most efficient solution overall. Some of these potential gains are less tangible than others, in that they represent contingencies that become less likely, such as avoiding possible penalty costs. The most tangible of these benefits come from</td></tr>
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<table>
<tr><td></td><td colspan="3">actual cost savings as a result of gaining the confidence to defer actual capital expenditure on replacement or reinforcement projects, for a number of years, at the cost of either carrying out lesser projects, and/or of acceptable increases in network risk.

As a result of this project Northern Powergrid will gain:
▪ Enhanced ability to assess the probability and extent of outages due to aging and overload, leading to more efficient means to balance
o Deferring investment for replacement or reinforcement;
o Minimising high-impact low-probability wide-area interruptions to supply;
o Planning major outages to reduce overall cost.
▪ A reduction in the incidents that result in interrupted supply, thereby reducing financial penalties including compensation payments to customers.
▪ Prioritised investment in new or replacement infrastructure to ensure financial and manpower resources are used more efficiently.</td></tr>
<tr><td>Expected timescale to adoption</td><td>Immediate</td><td>Duration of benefit once achieved</td><td>10 Years+</td></tr>
<tr><td>Probability of success</td><td>90%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of success</td><td>£9,085,055</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="3">The project has now closed, and has already made a significant contribution, as we've identified over £14m of benefits to customers from rebalancing investment. This is a combination of avoiding inefficient investment, and reinvesting the savings in schemes that delivered material reductions in the number and duration of interruptions to electrical supply.

Having successfully embedded this knowledge with the Company's engineers, similar savings will accrue over coming years.</td></tr>
<tr><td>Project progress to March 2014</td><td colspan="3">The project has now closed, and funding has ceased.

Many reports and models have been prepared in collaboration with the Company's engineers, leaving a knowledge base to apply to future projects.

The KTP has directly led to the publication of 13 peer reviewed conference papers, one book chapter and one high quality journal paper. The work has also assisted in the award of more than £3m in research grants from Industry and Research councils. There have been direct breakthroughs related to Distribution Network Risk but also many spill over benefits such as the ability of the Company's engineers better to understand the impact on network risk of energy storage, demand side response, real time thermal ratings and superconducting power cables.

The independent Technology Strategy Board assessment of the partnership gave us a relatively rare "A" rating for this project.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="3">None</td></tr>
<tr><td>R&D provider</td><td colspan="3">Durham Energy Institute (Durham University). Transferred to Newcastle University from May 2013.</td></tr>
</table>

<table>
<tr><td>Project Title</td><td colspan="4">OHL Stay Rod Testing</td></tr>
<tr><td>Description of project</td><td colspan="4">The project is a collaborative project to investigate the use of a non-intrusive (NI) instrument for testing the condition of in situ overhead-line stay rods.

EDM International Inc has developed an instrument that uses a magnetostrictive sensor. This is attached to the stay rod above ground level and provides a profile relating to the degree of corrosion in the rod below ground.

The test instrument is to be used on a number of stay rods in the UK and the results independently evaluated by EA Technology (EATL) by recovering a sample of rods and testing in a laboratory to establish the accuracy of the test instrument (under predetermined, representative conditions).</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £300
External £0
Total £300</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £1,400
External £10,990
Total £12,390</td></tr>
<tr><td>Total Project Costs
(Collaborative + external +
Northern Powergrid)</td><td>£26,397</td><td colspan="2">Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The UK electricity distribution industry continues to use a stay-wire, (anchor) rod and wood-block combination to provide stability for overhead-line supports.

Stay wires and rods will, depending on a number of circumstances, degrade over their lifetime, typically 30-40 years. Failure of either can lead to failure of the support, which in turn can lead to a cascade failure of the line.

Currently the only reliable means of assessing the condition of entire rods is through excavation, but this is expensive and not always practical. Therefore once a defective stay wire has been identified we need to be sure of the integrity of the stay rod, otherwise that will be replaced at the same time.

This is therefore extremely limiting and potentially restrictive to maintaining an active condition assessment profile of the stays and anchor assembly, as well as adding unnecessary costs to any replacement programme.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>-7</td><td>20</td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">It is anticipated that a front-running programme of assessments using this non-intrusive technique would allow us to retain stay rods on around 35 Woodhouse masts that would otherwise be replaced. Accounting for the cost of the inspections, we would experience savings of the order of £22,920.

Further benefit would be realised if this technique were to be</td></tr>
</table>

	implemented more widely as an overhead-line assessment technique – the Woodhouse mast assets account for just 10% of the total EHV overhead-line asset base in Yorkshire, or 5% of the total overhead-line asset base in Northern Powergrid. Accounting for the cost of the inspections, we would experience savings of the order of £242,000 over a ten-year period. Replacing stays (including rods and wires as necessary) before failure will lead to a reduction in the probability of failure of these assets as a result of this failure mode, which provides benefits in the areas of safety, environmental and network performance.		
Expected timescale to adoption	2014 (project complete – see below)	Duration of benefit once achieved	10 Years
Probability of success	60%	Project NPV (Present Benefits – Present Costs) x Probability of success	£74,969
Potential for achieving expected benefits	The project benefits discussed above would be realised if this project proves the non-intrusive assessment technology to work to an agreed level of accuracy (to be confirmed during the laboratory testing). The success of the project is subject to both participating DNOs providing sufficient numbers of sites and rods to be evaluated by the non-intrusive instrument and at the laboratory.		
Project progress to March 2014	Stage 1 of the project involved the on-site testing of stay rods using the stay rod tester described above. This was completed in August 2012. A number of stay rods were subsequently recovered in the Northern Powergrid area and shipped to the laboratory for testing. The testing of these samples was completed in the previous reporting year. Further analysis of the equivalent rods in ENW was planned and considered critical to the overall success of the project following analysis of the Northern Powergrid rods. However the project has suffered significant delays due to difficulties in sourcing samples from our project partner, ENW and during the 2013/14 reporting year it became clear the recovery of the rods would not be achieved in any reasonable timeframes. Therefore NPG and ENW reluctantly decided to close the project out without any further testing of ENW rods. Therefore the project is now complete. A final report was issued by EATL on 09/10/2013 - the results of the project are conclusively inconclusive (it is clear from our reasonable sample size that the results from the stay rod tester are inconsistent). This in itself is a good outcome from the project, in that it provides valuable feedback on the integrity of the assessment technique.		
Collaborative Partners	Electricity North West (ENW), Beaver Management Services Limited (BMSL), EA Technology Ltd		
R&D provider	EDM International Inc.		

<table>
<tr><td>Project Title</td><td colspan="3">Failure on Demand</td></tr>
<tr><td>Description of project</td><td colspan="3">This project has two key elements:

The forensic investigation of two AEI/GEC BRVP17 and two South Wales C4X switchgear mechanisms will enable understanding of the degradation processes and the cause of the slow opening of the switchgear. The information obtained will assist in developing an appropriate strategy to ensure the reliability of the remaining population of assets, with the objective of reducing the rate of Failure on Demand (FoD) incidents. Learning on asset degradation will also feed into our decision support tools developed on the CBRM platform.

The production of an approved new product specification, supported by field trials, for retrofit AEI/GEC BRVP17 and South Wales C4X circuit breakers will provide a cost-effective alternative solution to replacing a whole switchboard where one or two individual units are identified to have unacceptable performance that cannot be rectified through maintenance.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,600
External £11,216
Total £14,816</td><td>Expenditure in previous (IFI) financial years</td><td>Internal £13,250
External £53,624
Total £66,874</td></tr>
<tr><td>Total Project Costs
(Collaborative + external +
Northern Powergrid)</td><td>£75,000</td><td>Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £3,000
External £5,000
Total £8,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="3">To carry out forensic analysis of the moving portion of a total of four sample circuit breakers (two South Wales Switchgear type C4X and two AEI/GEC type BVRP17), to include intrusive examination of the mechanism and analysis of the lubricants applied. The work will be carried out by a third party and will comprise the following key activities:

- Analysis of background information, including previous trip-timing profiles and maintenance procedures
- Completion of three consecutive trip-timing profiles on each circuit breaker
- Visual examination and photography in the ‘as received’ condition
- Detailed examination of the mechanism to determine the general condition and identify any degradation, condition of lubricants, corrosion, wear, alignment etc.
- Removal of lubricant from mechanisms to assess condition with regard to the ability to lubricate adequately
- Dismantling of mechanism as required
- Optical and electron microscopy of components as required
- Compilation and issue of report

To facilitate the removal of switchgear moving portions for analysis and to provide Northern Powergrid with approved retrofit moving portions as an alternative option to replacing a whole switchboard where failures are confined to one or two specific units, it is proposed to specify,</td></tr>
</table>

<table>
<tr><td></td><td colspan="4">assess, purchase, retrofit install and trial two AEI/GEC BVRP17 moving portions and two South Wales Switchgear C4X units.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-5</td><td>15</td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">The successful implementation of any intervention strategies including maintenance activities in light of forensic findings and the use of retrofit units will reduce financial penalties due to FoD interruptions by 20%, achieved over a 15-year period (in line with the 11kV CB maintenance frequency) following completion of the project.</td></tr>
<tr><td>Expected timescale to adoption</td><td>2012</td><td>Duration of benefit once achieved</td><td colspan="2">15 Years</td></tr>
<tr><td>Probability of success</td><td>90%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of success</td><td colspan="2">£258,029</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">There is a moderate risk that the forensic analysis does not identify the failure mode with any degree of certainty, or that the failure mode identified is not reflective of the remaining assets of that type on the system.</td></tr>
<tr><td>Project progress to March 2014</td><td colspan="4">The installation of four retrofit units to facilitate the removal of the original units has been completed. The original moving portions have been recovered and transported to EA Technology for forensic analysis. Analysis of the BVRP17 unit has identified a failure mode, and this information will inform our maintenance Code of Practice and Maintenance Workface Documents.

The field trials of the retrofit units have been ongoing for a period of one year. Partial discharge tests were carried out in April 2014 and one of the four retrofit units exhibited signs of partial discharge. The retrofit unit was replaced by the manufacture and PD monitoring equipment remains in place on site to monitor the new unit. The source of PD was proven not to be the retrofit unit itself, but may be due to poor electrical connection between the fixed and moving portion. The investigation is ongoing. Following conclusion of the investigation, the project close-down report will be produced.</td></tr>
<tr><td>Collaborative Partners</td><td colspan="4">None</td></tr>
<tr><td>R&D provider</td><td colspan="4">EA Technology Ltd</td></tr>
</table>

Project Title	**Ground Mounted Fault Passage Indicator**		
Description of project	The development of a new type of fault passage indicator that is intended to measure the magnetic field strength associated with each phase conductor in a three phase cable to give an indication of both phase-to-phase and phase-to-earth faults. The device is intended to use three magnetic field sensors placed around a trefoil cable in close proximity to each phase core. The device is intended to overcome the problems associated with earlier types of fault passage indicators, namely: - They only provide earth fault indication; - They are difficult to retrofit to existing switches; - Issues of unreliability where split-core current transformers have been used; and - Many of those presently in service require a manual re-set following fault detection (this has been overcome by more modern types but the retro-fit problems remain).		
Expenditure for financial year	Internal £900 External £0 Total £900	Expenditure in previous (IFI) financial years	Internal £1,730 External £45,600 Total £47,330
Total Project Costs (Collaborative + external + Northern Powergrid	£170,000	Projected 2014/15 costs for Northern Powergrid	Internal £10,000 External £60,000 Total £70,000
Technological area and / or issue addressed by project	To correlate the externally detected magnetic fields around a three phase cable to the positive, negative and zero sequence currents within the phase conductors, thereby determining fault types.		

Type(s) of innovation involved	Incremental	Project Benefits Rating	Project Residual Risk	**Overall Project Score**
		16	3	**13**

Expected Benefits of Project	Supply quality is the area where significant improvements can be achieved as faulted sections will be identified faster and more accurately. Again, linking the device to an automation scheme will allow rapid restoration of customers disconnected for HV distribution faults. Typical restoration times of 1 to 2 hours will be reduced to a few minutes by integrated fault detection and automatic switching schemes. Technical benefits include simplified retrofit to existing switches compared with present designs of fault-passage indicators and simplified detection of phase to phase faults.		
Expected Timescale to adoption	Year 2015	Duration of benefit once achieved	20 years
Probability of Success	Complete	Project NPV (Present Benefits – Present Costs) x Probability of success	£39,355

Potential for achieving expected benefits	Stage 5 has confirmed that Hall Effect sensors are able to detect the magnetic fields associated with the phase core currents in a three phase cable. Further development in now required to both optimally position the sensors around the cable and design suitable electronic circuitry for detection of fault currents.
Project Progress to March 2014	Tests using a three phase primary injection test set have been carried out on both paper-insulated corrugated aluminium sheathed (PICAS) and steel wire armoured (SWA) cables using both search coil sensors and Hall Effect sensors. Both of these sensor types are detecting the magnetic field around the outside of the cable and it has been confirmed that the steel wire armour does not prevent the detection of the magnetic field. Tests have been carried out to establish whether, in the case of an earth fault where all of the fault current returns via the sheath, the resulting net magnetic field is sufficient to be detectable. These tests have shown that with a single phase and the sheath energised quite low levels of current can be detected. The Hall effect sensors are producing a more representative output, with less distortion, than the search coil sensors. Stage 5 testing has confirmed that the measured fields around the cable are in line with those predicted in the mathematical assessment. Summary of progress to date: Stage 1 – Feasibility (STP module 4) – Complete. Stage 2- Mathematical assessment – Complete. Stage 3 – Assessment of sensor types – Complete. Stage 4 – Design of the test environment – Complete. Stage 5 – Testing at EA Technology Ltd to determine the magnetic fields that occur around cables – Complete. Outlook / actions ahead: – Tender for the prototype products to be manufactured. – Carry out a field trial to verify the correct functionality of the prototype GMFPI. – Review the field trial results and decide if to proceed to volume production and field installation of the GMFPI.
Collaborative Partners	None
R&D Provider	EA Technology Ltd

<table>
<tr><td>Project Title</td><td colspan="4">Lubrication Project</td></tr>
<tr><td>Description of project</td><td colspan="4">The project is a collaborative research project solely between Northern Powergrid and Imperial College, London to review legacy lubrication materials and techniques, analyse the main degradation mechanisms and utilise laboratory tests to determine optimised lubrication requirements in different environments and applications across the Northern Powergrid distribution networks.

The project is split into three stages :

Stage 1: Northern Powergrid to Identify equipment types and legacy lubricants used within Northern Powergrid. Imperial College, London to develop a test protocol to mimic the conditions that grease will be expected to operate in and thus determine a method of artificially aging grease samples to allow a series of tests to be used to determine the static friction of the degraded grease.

Stage 2: Site visits to observe typical maintenance operations and collect samples of lubricants used in the various interfaces

Stage 3: Develop a report to confirm the suitability, and expected lifetime of lubrication materials used within Northern Powergrid together with recommendations for any improved lubrication materials currently available and or frequencies of application.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £9,900
External £80,000
Total £89,900</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs
(Collaborative + external + Northern Powergrid)</td><td>£95,000</td><td colspan="2">Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £5,000
External £0
Total £5,000</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">• To determine the relative performance and likely lifetime of legacy lubricants used on different switchgear types.
• To specifically review the performance of AC90 lubricant especially where it may be applied to existing switchgear without the complete removal of other previous Original Equipment Manufacturer (OEM) or legacy lubricants
• To obtain a better understanding of a series of Failure on Demand (FOD) events occurring on a small population of Primary Circuit Breakers within Northern Powergrid which have resulted in unacceptably high CML's and CI's</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>13</td><td>1</td><td>12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• Improvements in our switchgear maintenance policy through the identification or confirmation of appropriate lubrication materials and frequencies of application.
• Increased network performance by a reduction in FOD events</td></tr>
</table>

Expected Timescale to adoption	2015	Duration of benefit once achieved	20 years
Probability of Success	25%	Project NPV (Present Benefits – Present Costs) x Probability of success	£81,815
Potential for achieving expected benefits	A comprehensive study is underway which, if a solution can be identified, should be successful. The complex and probably interactive nature of the problems under examination contributes to a relatively large risk that the project is not successful and that the expected benefits are not delivered.		

Project Progress to March 2014	• Stage 1 has been completed:
	  • Northern Powergrid has identified the types of legacy lubricants and switchgear installed on the network.
	  • Imperial College have developed the following test protocol:
	  • Low temperature volatility ageing test : to measure the effect of base oil evaporation over an extended period of time. These tests will accelerate the ageing process of the greases over a determined temperature and time.
	  • UV exposure: this test is designed to measure the degradation of the grease when it is exposed to UV rays.
	  • Water wash out: degradation of the grease by water inclusion i.e. rainfall or humid environments will be measured.
	  • After each of the artificial ageing tests have been completed, a tribometer will be used to determine the static friction of the degraded grease which will show the effect the artificial ageing has had on the performance of the grease.
	  • A Fourier Transform Infra-Red Spectrometer (FTIR) will be used to determine the level of degradation by the change in the chemical composition of the grease.
	• Stage 2 is currently under way		

Collaborative Partners	Imperial College of Science, London, Technology and Medicine. Tribology Group, Department of Mechanical Engineering		
R&D Provider	Imperial College of Science, London, Technology and Medicine. Tribology Group, Department of Mechanical Engineering		

<table>
<tr><td>Project Title</td><td colspan="4">Smart Data</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The project will develop a geospatial information system (GIS) demonstrator showing how smart data can be uploaded and applied to improve key business decision making.</td></tr>
<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>13</td><td>-5</td><td>18</td></tr>
<tr><td>Expected benefits of project</td><td colspan="4">Financial
There may be some financial benefit provided from improved decision making. Such preparedness and good planning also minimises potential financial waste and optimises how we use the new technology.

Knowledge Transfer
The principal output of this project is a comprehensive overview of what kinds of data and representation solutions might be expected in managing our network in a low carbon future. It will also implement a practical demonstrator. This knowledge will be valuable to the business in understanding and planning how we use the new data in future decision support. The demonstrator may well form the basis for specifying design requirements for future network management systems.

Environmental
This project is part of the E-Futures doctoral training centre that is training a new generation of scientists and engineers to address the challenges inherent in making the transition to a sustainable energy future.

Network Performance
Improvement in network performance is a probable project outcome due to intelligent use of data about faults, customers and repair teams in a geo-spatial representation.</td></tr>
<tr><td>Expected timescale to adoption</td><td>4 years</td><td>Duration of benefit once achieved</td><td colspan="2">6 Years</td></tr>
<tr><td>Probability of success</td><td>25%</td><td>Project NPV (Present Benefits – Present Costs) x Probability of success</td><td colspan="2">£8,976</td></tr>
<tr><td>Potential for achieving expected benefits</td><td colspan="4">The project potential rests on the criteria “basic technology sub-system validation in laboratory environment”. That is because GIS systems are already well established but the challenge here is to integrate these with new types of smart data. However there is also some risk in that there is uncertainty about how far our own systems will have developed to be able to provide meaningful parameters. There are also new innovative elements to smart grids which might present unforeseen problems.</td></tr>
</table>

Project progress to March 2014	Interaction with the PhD student has been useful and productive to date. The following milestones have been met:- • 1st year (PhD transfer) report Data identification & collection and requirements analysis for 1st prototype completed. . • Prototype of the GIS demonstrator underway. This is the 2nd year of a 3 year project. The key outputs over the next year will be the final report and copy of thesis in September/October 2015 and delivery of the GIS demonstrator at the same time as the final report.		
Collaborative Partners	Sheffield University Schools of Management and of Information Systems		
R&D provider	Sheffield University		
Description of project	Low carbon energy networks are being developed at Northern Powergrid which utilise distributed energy resources (DERs) and smart home technologies. This project is in the form of part-sponsorship of a university PhD being carried out under the auspices of Sheffield University's EFutures programme. It aims to understand what information will become available with the introduction of new smart meter and low carbon technologies into the market place, and to establish how we can derive business benefit from it by either changing existing processes or introducing new processes. The relevance of this project to the business then is that it aims to make a significant contribution to the next generation of network management systems through understanding and showing the capabilities of geospatial diagrams and data representation with regards to low carbon and smart data, in terms of the impact they can have on network management. The project contributes to our preparedness for the future by enhancing our understanding of the data management implications of low carbon technologies.		
Expenditure for financial year	Internal £4,200 External £10,000 Total £14,200	Expenditure in previous (IFI) financial years	Internal £ 2,800 External £10,000 Total £12,800
Total Project Costs (Collaborative + external + Northern Powergrid)	£39,200	Projected 2014/15 costs for Northern Powergrid	Internal £1,500 External £10,000 Total £11,500

<table>
<tr><td>Project Title</td><td colspan="4">Element Energy - Load Forecasting Scenario Model</td></tr>
<tr><td>Description of project</td><td colspan="4">This project is to develop a load growth scenario modelling tool for Northern Powergrid's (NPG) North Eastern and Yorkshire networks. The tool will assist NPG's scenario planning by giving an improved understanding of the likely rate and spatial distribution of load growth over the medium to long-term, when uptake of new low carbon technologies (LCTs) is expected to impose significant challenges to network operators. This tool will inform investment planning for the latter stages of ED1 and beyond.

The tool will give insights into the rate at which LCTs are likely to be connected to the network and the impact on electrical load of improving energy efficiency in the domestic and commercial building stock. These uptake rates will be developed from an understanding of the consumer and their appetite for investment in new energy technologies, rather than being predicated on scenarios that meet the UK's carbon dioxide reduction targets (the DECC uptake scenarios will also be incorporated into the model for comparison and for consistency with the SGF Workstream 3 model).</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,550
External £0
Total £0</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £5,250
External £67,750
Total £73,000</td></tr>
<tr><td>Total Project Costs
(Collaborative + external + Northern Powergrid)</td><td>£73,000</td><td colspan="2">Projected 2014/15 costs for Northern Powergrid</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The development and delivery of a load growth model with improve our distribution load estimates that materially increases the accuracy and robustness of the demand forecasts compared with the current Northern Powergrid method, will facilitate enhanced robustness of investment planning decisions both internally and externally in the future.

Accounting for the cost of process development and implementation, we would experience savings in the order of 5% of a typical annual reinforcement investment for the first five years of ED1.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-2</td><td>12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">This tool will provide a forecast of where on the networks this load growth is likely to occur. This will be based on highly segmented data on the makeup of the building stock on a fine geographic scale. By combining this data with NPG's own circuit data, the model will not only provide a prediction of the geographic distribution of load growth, but will also associate the load to specific network assets, for example particular distribution substations. This will be a powerful tool for identifying where and when 'hot-spots' on the network may occur due to technology clustering.</td></tr>
</table>

Expected Timescale to adoption	2013	Duration of benefit once achieved	10 Years+
Probability of Success	60%	Project NPV (Present Benefits – Present Costs) x Probability of success	£100,174
Potential for achieving expected benefits	The learning elements of this project will be judged to be successful if we adopt a more informed view of future load growth. A number of industry-wide studies into load forecasting and LCT take up have been carried out and we are building further on that existing knowledge This methodology will be readily taken up if successful as there is a specific business need for a more robust process for determining future demand levels.		
Project Progress to March 2014	Delivery of an enduring load scenario model Occurred in March 2014. Detailed translation of external legislative drivers to a set of scenario inputs has been developed, with detailed network architecture, enabling the load and generation to be built up from distribution substation to GSP level. Detailed review sessions have taken place and Element have worked on ensuring an enduring model is made for future use and providing a number of improvements to assist in user data input and interpretation of scenario basis in terms of data associated. The testing of the model commenced in April 2014 and will continue through the year with completion expected towards the end of 2014.		
Collaborative Partners	None		
R&D Provider	Element Energy		

<table>
<tr><td>Project Title</td><td colspan="4">Distribution Load Estimates (DLE) Methodology</td></tr>
<tr><td>Description of project</td><td colspan="4">This project is to apply computational/statistical analysis tools and techniques to the available demand data with a view to identifying the presence or otherwise of underlying trends within the data itself or linked to other parameters. The details of the analysis required are left intentionally vague in order to permit a high degree of flexibility and interpretation.

This project is aimed at using a computational approach to undertake a forensic analysis of the available data to identify and analyse underlying demand trends. The key deliverable from this project is a fully documented new tool/model and process for forecasting demand which is materially more accurate/more robust to internal and external challenge than the present process.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £2,660
External £10,000
Total £12,660</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £2,660
External £10,000
Total £12,660</td></tr>
<tr><td>Total Project Costs
(Collaborative + external + Northern Powergrid)</td><td>£132,378</td><td colspan="2">Projected 2014/15 costs for
Northern Powergrid</td><td>Internal £3,325
External £47,265
Total £50,560</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">The project scope associated with this piece of work is to gain a deeper understanding of underlying historic demand trends of customers supplied by the Northern Powergrid distribution networks so that their future needs can be better understood and forecast. The study will include assessment of historic data for the entire primary substation, supply point and grid supply point populations across both Northern Powergrid licences, thus covering the EHV-HV, EHV-EHV, 400kV/275kV/132kV-EHV and 132kV-HV substations; where EHV levels are typically 33kV and 66kV and HV levels are 11kV and 20kV. LV distribution substation loading is out of scope.</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>10</td><td>-2</td><td>12</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">• The development and delivery of a revised DLE methodology that materially increases the accuracy and robustness of the demand forecasts, compared with the current Northern Powergrid method, will facilitate enhanced robustness of future investment planning decisions, both internally and externally.
• Should the project successfully identify a number of high correlating factors and incorporate these factors into an improved methodology for forecasting maximum demands across the planning horizon, it is anticipated that the reinforcement plan will become more stable, and potential schemes will have an improved robustness and investment driver case.
• It is anticipated that due to the improved process, the resulting investment plan will be more robust.</td></tr>
</table>

Expected Timescale to adoption	2016	Duration of benefit once achieved	10 Years+
Probability of Success	60%	Project NPV (Present Benefits – Present Costs) x Probability of success	£2,092
Potential for achieving expected benefits	The learning elements of this project will be judged to be successful if, for the new load forecasting process delivered, the material differences between the proposed and current approaches can be described and explain the difference and which approach better meets the project objectives and why A number of industry-wide studies into load forecasting have been carried out, focusing mainly on economic drivers to future changes in loading. The learning from historical changes in loading represents a change to the development approach as does the use of mathematical and statistical modelling to determine those historical trends. The output will be readily taken up if successful as there is a specific business need for a more robust process for determining future demand levels.		
Project Progress to March 2014	Since initiation of the project in 2012, research the following is representative of the key elements of progress on the literature search to date: • Literature search into machine learning as a potentially methodology for time series trend analysis and future profile prediction. NGET data has been used to demonstrate ANFIS (Adaptive Network based approach to Fuzzy Interference System) as a potential methodology for time series future trend prediction. A paper was produced on the methodology and further expansion of the work carried out following review with Northern Powergrid. • Detailed review of the Northern Powergrid load forecasting process and access/familiarity with Northern Powergrid systems and data. Historic data shared and MD algorithm and error calculations completed to increase dataset and process knowledge. • Wider literature review covering retail, financial and energy sectors progressed resulting in documentation of key approaches. • Varied trend analysis via a range of mathematical methods, including principal component analysis and k-means clustering as a means to carry out load categorisation and to enable historic trends to be used in developing algorithms to apply by substation to determine future load profiles.		
Collaborative Partners	None		
R&D Provider	Durham Energy Institute (Durham University)		

<table>
<tr><td>Project Title</td><td colspan="4">Network Inference Study</td></tr>
<tr><td>Description of project</td><td colspan="4">There is an increasing weight of expectation on GB electric distributors to deploy active network management (ANM), to permit more connections with less reinforcement. This is illustrated by a raft of LCNF projects, including our own Customer-Led Network Revolution (CLNR).

Experience with CLNR GUS confirms the need for solutions which are simple to deploy and maintain. This project seeks to build upon the SGS rule-based approach (which is already simpler to deploy than GUS CLNR) to eliminate the need for accurate and timely updates on network topology (switch state), which is proving difficult to secure.</td></tr>
<tr><td>Expenditure for financial year</td><td>Internal £3,300
External £25,851
Total £29,115</td><td colspan="2">Expenditure in previous (IFI) financial years</td><td>Internal £0
External £0
Total £0</td></tr>
<tr><td>Total Project Costs
(Collaborative + external + Northern Powergrid)</td><td>£29,115</td><td colspan="2">Projected 2014/15 costs</td><td>Internal £3,500
External £52,000
Total £55,500</td></tr>
<tr><td>Technological area and / or issue addressed by project</td><td colspan="4">This project will explore whether a simplified rule/case-based topology processing technique based on existing circuit analogue measurements could infer network topologies without the need for switch status inputs, and thereby leverage existing measurements and contain costs associated with other, more complicated approaches. This project tests the feasibility of the concept through desktop evaluation, including prototype implementations in modelling software. It is important to determine when and how such techniques may respond incorrectly to dynamic network topologies and hence how to ensure results are used safely. The proposed technique will be compared with other approaches including full state estimation.

Distribution network issues to be addressed in this project include both thermal and voltage management for an intact network as well as a network in n-1 outage conditions. The rule base would identify the network topology and hence facilitate a response to it such as instructing set-points for control equipment such as tap changers, capacitor banks and even generation set points through the sgs power flow and sgs voltage applications. This will determine what level of simplicity of rules can be obtained for inferences that would guide the configuration of the deployed ANM system. Identifying the correct network topology is key because distribution network problems, and their resolution, depend on the network configuration and the nature of demand and generation</td></tr>
<tr><td rowspan="2">Type(s) of innovation involved</td><td rowspan="2">Incremental</td><td>Project Benefits Rating</td><td>Project Residual Risk</td><td>Overall Project Score</td></tr>
<tr><td>12</td><td>-1</td><td>11</td></tr>
<tr><td>Expected Benefits of Project</td><td colspan="4">The set-up, maintenance and testing of complex ANM solutions could easily tie up a chartered engineer full-time, giving £75k/yr that could be saved by simpler solutions</td></tr>
</table>

Expected Timescale to adoption	2015	Duration of benefit once achieved	10 Years+
Probability of Success	50%	Project NPV (Present Benefits – Present Costs) x Probability of success	£61,308
Potential for achieving expected benefits	This is a feasibility study, so we will certainly find out if this kind of approach is feasible. Based on the work package one report, there are likely candidate solutions. The rest of this project will examine their feasibility, so 50% remains a fair estimate of the probability of overall success.		
Project Progress to March 2013	The first, scoping report has been received and approved. Candidate solutions have been identified, and will be examined in detail in 2014/15.		
Collaborative Partners	None		
R&D Provider	Smarter Grids Solutions		

Benefits Realised

18. An essential part of any R&D programme is that the outcome of completed projects is rolled out into 'business as usual' products and processes and we see this as an increasingly accelerating process as IFI is now increasingly mature and the pipeline of projects producing tangible results is beginning to have an impact on day-to-day operations and decision making. This will continue to be important in the forthcoming ED1 period.

    In addition we have been able to exploit some of the synergies between projects. Much of the work that we have recently completed on demand side management and on network risk have fed directly into supporting outcomes on the CLNR LCNF tier two project..

    The network risk project also provided new options for our well justified business planning resulting in considerable and enduring savings for our customers.

19. Reviewing some of the projects in this report yields:

    - **Future network development**. Our 11kV superconducting fault current limiter was energised during the summer of 2012 and has continued to perform well over the last year. It is now coming to the end of its trial period but the learning is now being developed into design standards so this new technology is ready for network roll-out. In addition an extension to the original project is exploring the physical performance of the device and operational management aspects.

      Other projects investigated new technologies for voltage control and phase balancing at low voltage as well as investigating the development of devices to release network headroom through a retro-fittable real time thermal rating system on cables.

    - **Managing risk**. Work to understand the relationship between customer behaviours and preferences and network risk has continued in 2013 and is now complete.. This socio-technological understanding has been useful in allowing us to understand how new low carbon technologies and the facilitating network approaches will be received by customers. This has informed our planning for smart grid implementation.

      Our extension project to the original Network Risk research project, continued to be especially useful across a wide range of business activities and informs network planning, capital programmes, low carbon network options, connection activities and several others. We have been able to use this to support our planning activities for the RIIO ED1 price control activity.

    - **Managing the assets**. The, now quite longstanding, programme of projects to improve condition monitoring through the development of health indices continues to have an increasingly beneficial impact on our ability to manage both the installed and future asset base effectively and efficiently. We have and will continue to roll this out across additional classes of assets and to enhance our capability.

      This year also saw the completion of our substation environmental monitoring project. This allows an improved understanding of the environment in which our assets operate and has supported an ongoing activity to improve the control of substation conditions.

    - **Strategic development**. The STP activities fall into this category, as they add to the body of knowledge without necessarily having an immediate impact. Similarly a considerable amount of collaborative resource has been expended on work to understand the network's future configuration through the Smart Grid Forum, although not all of these activities have been funded through IFI they are none the less complementary to the innovation activities presented here.

20. We have continued to support the Energy Innovation Centre (EIC). This is an activity undertaken in collaboration with all but one of the other DNOs. It is designed to both identify and encourage innovations from new sources, such as other industries or SMEs with no previous experience of working with the electricity distribution network operators. Several new projects have been identified through this source during the year. The costs of running the EIC have been distributed across the running projects identified from this activity. Also through the EIC, and for the first time, we are also involved in a cross-utility project in conjunction with gas distribution

Programme Planning and Co-ordination

21. To co-ordinate and, as importantly, disseminate innovative activity across the business, we have previously established improved internal systems. The resource expended on running the innovation process as a whole within Northern Powergrid is not a project within its own right: however, without this commitment no R&D would be possible within the company. This cost includes project administration, project management, reporting, internal group meetings and preparatory work on future projects, where such costs cannot be directly associated with a project.

22. An innovation strategy was published as part of the well-justified business planning submission. This laid out the key areas of activity for innovation that allow us to meet the requirements of our stakeholders. This document now guides all of our innovation planning and acquisition and will be maintained to ensure that it remains current.

23. The changes in governance requirements from the current IFI regime to the RIIO ED1 Network Innovation Allowance (NIA) require some management to minimise transition issues. We have tried to ensure that all projects initiated under IFI will be completed during 2014/15. We it has been clear that this is not practical we have sought to ensure that all new contracts, and in particular intellectual property arrangements, are NIA eligible and will register projects as such in March 2015.

NPV Methodology

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

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

Summary of Current Portfolio

26. The following summarises the full portfolio and the expenditure incurred during 2013–14.

		Expenditure		
	No. of Projects	Internal	External	Total
ASL superconducting fault current limiter	1	£3,150	£15,047	£18,197
Cable Core Temperature Sensor	1	£2,400	£41,200	£43,600
Cable paper moisture meter	1	£600	£38,598	£39,198
CBRM Extension Work	1	£1,200	£24,190	£25,390
Demand side impact on network risk & design	1	£4,200	£15,481	£19,681
Distribution Load Estimates Methodology	1	£4,500	£53,171	£57,671
EATL Cable Engineer's Forum	1	£1,500	£2,238	£3,738
EATL Energy Storage Operators Forum	1	£8,400	£8,890	£17,290
EATL OHL Engineer's Forum	1	£1,200	£2,264	£3,464
EATL Partial Discharge Users Group	1	£4,800	£6,455	£11,255
EATL Plant Engineer's Forum	1	£900	£2,219	£3,119
EATL Protection Engineer's Forum	1	£900	£2,025	£2,925
EATL Protective Coatings (Painting Forum)	1	£2,550	£7,093	£9,643
Element Energy	1	£2,550	£0	£2,550
ENA Portfolio	2	£1,800	£13,179	£14,979
Failure on Demand	1	£3,600	£11,216	£14,816
Gendrive phase balancer/voltage regulator	1	£300	£36,251	£36,551
GM FPI (Phase 2)	1	£900	£0	£900
Lubrication study - Imperial College	1	£9,900	£80,000	£89,900
Network Inference Study -phase 1	1	£3,300	£25,815	£29,115
Network risk management KTP	1	£4,800	£20,509	£25,309
OHL Stay Rods	1	£300	£0	£300
Oil-filled Cable Additive	1	£2,550	£103,218	£105,768
SG Forum WS3 Phase 2 and 3	1	£0	-£24,879	-£24,879
Smart data	1	£4,200	£10,000	£14,200
Strategic Technology Programme module2 Overhead lines	16	£2,850	£54,108	£56,958
Strategic Technology Programme module3 Underground Cables	18	£1,200	£65,568	£66,768
Strategic Technology Programme module4 Substations & Plant	30	£8,400	£47,136	£55,536
Strategic Technology Programme module5 Embedded Generation	10	£2,400	£42,648	£45,048
Substation environmental monitoring	1	£3,900	£30,015	£33,915
Tree Growth Regulators	1	£900	£16,000	£16,900
UAV/VTOL (EIC)	1	£600	£90,551	£91,151
Ultrapole (EIC)	1	£600	£36,218	£36,818
Programme Management		£37,800		£37,800
	104	£129,150	£876,424	£1,005,574

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

Number of active IFI projects	104
NPV of current project portfolio	£12,215,538
Summary of other benefits anticipated from active IFI projects	Marginal improvement in reliability
Total expenditure in reporting period.	£1,005,574
Total expenditure to date	£7,480,763
Benefits actually achieved from IFI projects to date	see text

Summary of 2013/14 IFI investment

28. We can also summarise the discussion above to provide the data specifically requested in the RIGs, split in direct proportion to revenue in each of the two licence areas:

Summary IFI Expenditure 2013-14

IFI Summary 2013-2014 (Final)

Eligible Project Spending (external)	£876,424
Eligible Project Spending (internal)	£129,150
IFIEt, Grand Total	£1,005,574
Revenue Yorks, RDt	£355,203,151
Revenue North East, RDt	£271,856,804
Total 2013-14 (CBR)	£627,059,955
ptrit, Pass Through Rate 13-14	80%
IFI Maximum (0.5% of CBR)	3,135,300
KIFIt, Carry forward to 2014-2015	1,567,650
Incentive revenue adjustment, IFIt	£804,459

29. In proportion to the revenue split between the two licensees, eligible project spending is;

	Eligible Spending	Carry Forward
Yorks	£569,615	£888,008
North East	£435,958	£679,642
Total	£1,005,574	£1,567,650

Outlook for 2014/15

30. We envisage that the portfolio of IFI projects to be worked on in 2014/15 will largely be made up from:

- Continuing to support the 'in progress' projects listed in this report, notably:
  - EA Technology STP programme;
  - ENA collaborative work including activity on smart-grid development;

- Cable Core Temperature Sensor;
- Cable Paper Moisture Meter;
- Oil-filled Cable Additive;
- UAV/VTOL – Unmanned Aerial Vehicle;
- Ultrapole – Ultrasonic Woodpole Inspection;
- Ground-mounted FPI follow up;
- Smart Data;
- Distribution Load Estimate Methodology; and
- Energy Innovation Centre, Ellesmere Port.

o Developing new projects, collaboratively, such as through the ENA, where possible, but otherwise alone, including:

- Seeking alternative materials and designs to replace wooden poles;
- Design and implementation of an innovative automatic network management scheme in a congested part of our network;
- Continued development of health indices and output measures programme, both in breadth and depth;
- Development of approaches to the use and visualisation of large data and ;
- Monitoring in substations for improved network control;
- Customer energy projects which support both our network development and corporate social responsibility needs.